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Agricultural Productivity Ratings for Soils of the Willamette Valley

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Agricultural Productivity Ratings for Soils of the Willamette Valley

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Development of productivity ratings for Oregon soils began in 1976 with the help of a small grant from the OSU Agricultural Research Foundation. Additional support has been provided since then by the OSU Extension Service.

We owe special thanks to Cheung Lau, who did much of the initial thinking, and to Bill Rogers and Michael Pauly, who worked on the project in its later phases.

Contents

Introduction

This circular is written for farmers, Extension agents, farmland appraisers, realtors, land use planners, and all citizens interested in wise land use. The ratings given in table 1 rank all soils of the Willamette Valley in terms of their native productivity potential. They also indicate the relative extent to which fertilizers, drainage, and irrigation can improve productivity.

The circular explains how productivity ratings can help farmers make soil management decisions tailored to the soil resources on their own farms. It tells how appraisers and realtors can use productivity ratings to establish fair sale prices or rental rates. Assessors can use the ratings to set equalized tax rates based on the actual resource quality of a parcel of land. The circular explains how planners and county commissioners can use productivity ratings to help them make difficult decisions when choosing among competing uses for agricultural land.

As a matter of record, the circular also includes an explanation of the procedures used to derive the ratings and the mathematics used to check their accuracy. The ratings and their uses, however, can be easily understood without reference to the technical material in the appendixes.

Productivity ratings are numbers that indicate the relative value of a soil for agricultural use. The number scale runs from 0 to 100. High numbers indicate a combination of high yield potentials and wide diversity of adapted crops. Low numbers generally indicate lower yields and less diversity. A few soils, however, may have low ratings because they are suited for only one or two crops, yet the yields of those crops could be quite acceptable.

Productivity ratings are calculated by evaluating the effect of various soil properties like texture, depth, drainage, and fertility on the growth and yield of agricultural crops. If actual yield data were available for all crops grown (over 100) on all soils (over 80) in the valley, we wouldn't need to determine productivity ratings by any other method. There is very little yield information for specific soils, however, so productivity ratings are the next best thing.

The Soil Conservation Service does provide yield estimates for a few major crops on some of the more common soils. These estimates were used as targets for ratings determined from soil properties. By using the available data to calibrate the procedure, we can then use it with confidence to calculate productivity ratings for many other soils for which little or no yield information is available. Details of the calculation and calibration of the ratings are spelled out in the appendixes.

Productivity ratings are useful tools for evaluating soil resource quality and planning for the best use of agricultural land. Most farms or parcels of land have several different kinds of soils. Productivity ratings provide an objective way of identifying the best soils, the worst soils, and the soils of intermediate value.

They can—and should—be used in conjunction with soil surveys to see how much good soil there is, or how much poor soil. In this way, they can be used to help determine a fair purchase price, or a fair rental fee, for a piece of agricultural land.

Similarly, they can be used to formulate equalized tax assessment rates, the better soils being taxed at higher rates than the poorer soils. The overall productivity of a parcel can also be used to help decide whether the parcel should be preserved for agricultural use or whether the productivity is low enough that it would be appropriate to subdivide into smaller lots.

Farmers can use the ratings to see how much gain in productivity they might achieve by draining wet soils or irrigating droughty ones. The applications are discussed more thoroughly in the chapter beginning on page 11.

Productivity Ratings

Agricultural productivity ratings for soils of the Willamette Valley are given in table 1. Soils included and the meanings of the numbers listed are explained in the sections that follow.

Soils

The table lists virtually all soils on the flood plains and terraces of the main valley floor, as well as soils on the higher terraces and low foothills at the margins of the valley. It does not list soils of the Cascades, the Coast Range, or the interior valleys of either mountain range. It does not include organic soils, nor does it include miscellaneous land types like terrace escarpments or riverwash. Soils on slopes steeper than 30% are excluded also.

Soils are listed alphabetically by soil type. A soil type is a soil series (e.g., Willamette) plus the texture of the surface soil (e.g., silt loam). Soil types, along with the slope phases on which they occur, form the names of most of the mapping units used in soil surveys of the valley. The table includes ratings for every single-phase soil mapping unit identified in the soil surveys of Benton, Clackamas, Lane, Linn, Marion, Polk, Washington, and Yamhill counties.

Only the mapping units of complexes (e.g., Ritner-Price complex, 12 to 30% slopes) and undifferentiated soils (e.g., Steiwer and Chehulpum soils, 3 to 40% slopes) are omitted. In both cases, it would be appropriate to use ratings for the more limiting soil to express the productivity of the mapping unit.

Native productivity

Highly productive soils are deep, fertile, well drained, medium-textured soils that receive adequate precipitation to support high yields of agricultural crops. Such soils are given the maximum productivity rating of 100. Penalty points are deducted from the maximum if the soil is shallow, acid, wet, gravelly, droughty, or if any other property adversely affects crop growth. The native productivity rating is the balance that remains after all penalty points have been subtracted from 100.

Native productivity ratings allow comparisons among soils before considering any kind of management inputs like fertilizer, lime, drainage, or irrigation. Note that the range of values runs from 0 to 75. The maximum value is for Willamette silt loam, 0 to 3% slopes. Willamette loses 5 points because it is a little too acid for some crops, and it loses 20 points because of moisture stress caused by lack of rainfall during Oregon's dry summers.

Minimum values occur when a soil has so many things wrong with it that all the penalties add up to 100 points or more. Zero productivity does *not* mean that nothing will grow on the soil. Even soils like Camas, Helmick, and Witzel will support some grasses that could be used for native pasture or hay. Zero values do emphasize that the numbers in table 1 are *ratings,* not absolute values of yield potential. By comparison with other soils, however, these soils have the lowest productivity, whereas Willamette and Chehalis have the highest.

Table 1. Agricultural Productivity Ratings for Willamette Valley Soils

Soil type	Slope	Native productivity	Corrections for Amendments	Corrections for Drainage	Corrections for Irrigation	Max. Productivity Dryland	Max. Productivity Irrigated
Abiqua silty clay loam	0-3%	70	+5	0	+20	75	95
	3-5%	70	+5	0	+20	75	95
Abiqua silty clay loam, occasionally flooded	0-3%	67	+5	0	+20	72	92
Aloha silt loam	0-3%	42	+11	+18	+22	71	93
	3-7%	39	+11	+18	+22	68	90
	8-15%	30	+11	+18	+22	59	81
Amity silt loam	0-3%	55	0	+18	+20	73	93
Awbrig silty clay loam	0-3%	0	+19	+3	+13	22	35
Bashaw silty clay loam	0-3%	20	+11	0	+9	31	40
Bashaw clay and silty clay	0-3%	20	+11	0	+9	31	40
	3-12%	14	+11	0	+9	25	34
Bellpine silty clay loam	3-12%	30	+20	0	+24	50	74
	12-20%	27	+20	0	+15	47	62
	20-30%	21	+20	0	0	41	41
Bellpine cobbly silty clay loam	2-30%	11	+23	0	0	34	34
Borges silty clay loam	0-8%	22	+15	+11	+6	48	54
Bornstedt silt loam	0-8%	40	+21	+8	+25	69	94
	8-15%	34	+21	+8	+16	63	79
	15-30%	28	+21	+8	0	57	57
Briedwell silt loam	0-3%	28	+14	0	+46	42	88
	0-7%	28	+14	0	+46	42	88
	3-12%	25	+14	0	+46	39	85
	7-12%	25	+14	0	+46	39	85
	7-20%	22	+14	0	+46	36	82
	12-20%	22	+14	0	+46	36	82
Briedwell gravelly loam	0-7%	28	+14	0	+46	42	88
Briedwell cobbly loam	0-7%	26	+15	0	+47	41	88
Briedwell stony silt loam	0-7%	22	+16	0	+31	38	69
	7-12%	19	+16	0	+31	35	66
	12-20%	16	+16	0	+31	32	63
Briedwell extremely stony loam	0-7%	12	+18	0	0	30	30
Camas gravelly sandy loam	0-3%	0	+19	0	+39	19	58
Carlton silt loam	0-7%	65	+5	+9	+20	79	99
	7-12%	62	+5	+9	+20	76	96
	12-20%	59	+5	+9	+20	73	93
Cascade silt loam	3-8%	22	+19	+13	+19	54	73
	7-12%	19	+19	+13	+19	51	70
	8-15%	13	+19	+13	+19	45	64
	12-20%	13	+19	+13	+19	45	64
	15-30%	5	+19	+13	0	37	37
	20-30%	5	+19	+13	0	37	37
Cascade silt loam, stony substratum	3-8%	22	+19	+13	+19	54	73
	8-15%	13	+19	+13	+19	45	64
	15-30%	5	+19	+13	0	37	37
Cazadero silty clay loam	0-7%	45	+16	0	+12	61	73
	7-12%	42	+16	0	+12	58	70
	12-20%	39	+16	0	+12	55	67
Chapman loam	0-3%	69	+7	0	+24	76	100
Chapman loam, occasionally flooded	0-3%	66	+7	0	+24	73	97
Chehalem silt loam, silty clay loam	3-12%	44	+5	+10	+24	59	83
Chehalis silt loam, silty clay loam (non-flooded)	0-3%	75	+5	0	+20	80	100
Chehalis silt loam, silty clay loam (occ. overflow)	0-3%	72	+5	0	+20	77	97
Chehulpum silt loam	3-12%	42	+15	0	+8	57	65
	12-35%	33	+15	0	0	48	48
Clackamas gravelly loam	0-3%	26	+13	+10	+37	49	86
Clackamas gravelly silt loam	0-3%	26	+13	+10	+37	49	86
Clackamas silt loam	0-3%	31	+11	+10	+34	52	86
Cloquato silt loam	0-3%	69	+6	0	+22	75	97
Coburg silty clay loam	0-3%	60	+5	+8	+20	73	93

Soil type	Slope	Native productivity	Corrections for Amendments	Drainage	Irrigation	Max. Productivity Dryland	Irrigated
Coburg silty clay loam, occasionally flooded	0-3%	57	+5	+8	+20	70	90
Concord silt loam	0-3%	25	+16	+8	+21	49	70
Conser silty clay loam	0-3%	30	+11	+8	+21	49	70
Cornelius silt loam	3-8%	40	+16	+8	+25	64	89
	8-15%	34	+16	+8	+16	58	74
	15-30%	28	+16	+8	0	52	52
Cornelius variant silt loam	0-3%	30	+12	+20	+17	62	79
	3-7%	27	+12	+20	+17	59	76
	7-12%	24	+12	+20	+17	56	73
Cottrell silty clay loam	2-8%	35	+16	+7	+12	58	70
	8-15%	29	+16	+7	+12	52	64
	15-30%	23	+16	+7	0	46	46
Courtney gravelly silty clay loam	0-3%	0	+24	+4	+30	28	58
Cove silty clay loam	0-3%	2	+12	+4	+13	18	31
Cove silty clay loam, thick surface	0-2%	2	+12	+4	+13	18	31
silty clay loam, fan	2-7%	0	+12	+4	+13	16	29
clay	0-2%	2	+12	+4	+13	18	31
Dayton silt loam	0-3%	10	+22	+4	+27	36	63
Dayton silt loam, thick surface	0-3%	10	+22	+4	+27	36	63
Dayton silt loam, clay substratum	0-3%	10	+22	+4	+27	36	63
Delena silt loam	3-12%	14	+21	+8	+10	43	53
Dixonville silty clay loam	3-12%	48	+11	0	+26	59	85
	12-20%	45	+11	0	+17	56	73
	12-30%	39	+11	0	0	50	50
	20-30%	39	+11	0	0	50	50
Dupee silt loam	3-12%	37	+11	+11	+18	59	77
	3-20%	33	+11	+11	+18	55	73
	12-20%	33	+11	+11	+18	55	73
Hardscrabble silt loam	2-7%	17	+16	+8	+8	41	49
	7-20%	8	+16	+8	+8	32	40
Hazelair silty clay loam and silt loam	2-7%	18	+14	+3	+7	35	42
	3-12%	15	+14	+3	+7	32	39
	7-20%	11	+14	+3	+7	28	35
	12-20%	11	+14	+3	+7	28	35
	20-30%	4	+14	+3	0	21	21
Hazelair silty clay loam, acid variant	2-7%	15	+17	+3	+7	35	42
Hazelair silty clay loam, eroded	2-15%	9	+16	+2	+8	27	35
Helmick silt loam	3-12%	0	+22	+5	+9	27	36
	12-20%	0	+21	+5	+8	26	34
	20-50%	0	+15	+4	0	19	19
Helvetia silt loam	0-12%	57	+5	+8	+20	70	90
	3-8%	60	+5	+8	+20	73	93
	7-12%	57	+5	+8	+20	70	90
	8-15%	54	+5	+8	+20	67	87
	12-20%	54	+5	+8	+20	67	87
	15-30%	48	+5	+8	0	61	61
	20-30%	48	+5	+8	0	61	61
Hillsboro loam	0-3%	70	+5	0	+20	75	95
	3-7%	70	+5	0	+20	75	95
	7-12%	67	+5	0	+20	72	92
	12-20%	64	+5	0	+20	69	89
Holcomb silt loam	0-3%	28	+13	+8	+21	49	70
Holcomb silty clay loam	0-3%	23	+13	+8	+21	44	65
Huberly silt loam	0-3%	15	+26	+8	+26	49	75
Hullt clay loam	2-7%	42	+16	0	+22	58	80
	2-12%	39	+16	0	+22	55	77
	7-20%	36	+16	0	+22	52	74
	20-30%	30	+16	0	0	46	46
	2-30%	30	+16	0	0	46	46

Soil type	Slope	Native productivity	Corrections for Amendments	Drainage	Irrigation	Max. Productivity Dryland	Irrigated
Jory silty clay loam,	2-7%	48	+15	0	+20	63	83
silt loam, and	2-12%	45	+15	0	+20	60	80
clay loam	7-12%	45	+15	0	+20	60	80
	12-20%	42	+15	0	+20	57	77
	20-30%	36	+15	0	0	51	51
Jory stony silt loam	3-8%	28	+22	0	+17	50	67
	8-15%	22	+22	0	+17	44	61
	15-30%	16	+22	0	0	38	38
Kinton silt loam	2-7%	37	+16	+8	+26	61	87
	3-8%	37	+16	+8	+26	61	87
	7-12%	34	+16	+8	+16	58	74
	8-15%	31	+16	+8	+16	55	71
	12-20%	31	+16	+8	+16	55	71
	20-30%	25	+16	+8	0	49	49
Labish silty clay loam	0-1%	0	+21	+6	+17	27	44
Labish mucky clay	0-1%	0	+21	+6	+17	27	44
Lacomb silty clay loam	2-7%	25	+21	0	+26	46	72
	7-15%	19	+21	0	+16	40	56
Latourell loam	0-3%	70	+10	0	+20	80	100
	3-8%	70	+10	0	+20	80	100
	8-15%	64	+10	0	+20	74	94
	15-30%	58	+10	0	0	68	68
Laurelwood silt loam	3-7%	67	+11	0	+22	78	100
	3-12%	64	+11	0	+22	75	95
	7-12%	64	+11	0	+22	75	95
	12-20%	61	+11	0	+22	72	92
	20-30%	55	+11	0	0	66	66
Linslaw loam	0-3%	25	+20	+10	+20	55	75
Malabon silty clay loam	0-3%	70	+5	0	+20	75	95
Malabon silty clay loam, occasionally flooded	0-3%	67	+5	0	+20	72	92
Malabon variant loam	0-3%	37	+20	0	+20	57	77
Marcola cobbly silty clay loam	2-7%	4	+16	+6	+31	26	57
McAlpin silty clay loam	0-3%	50	+5	+11	+16	66	82
	3-6%	48	+5	+11	+16	64	80
McBee silty clay loam	0-3%	55	+5	+9	+20	69	89
McBee variant loam	0-3%	39	+1	+18	+22	58	80
Melbourne silty clay loam	2-7%	43	+20	0	+20	63	83
	7-12%	40	+20	0	+20	60	80
	12-20%	37	+20	0	+20	57	77
	20-30%	31	+20	0	0	51	51
Multnomah silt loam	0-3%	32	+26	0	+26	58	84
	15-30%	20	+26	0	0	46	46
Natroy silty clay loam	0-3%	10	+11	0	+9	21	30
Natroy silty clay	0-3%	10	+11	0	+9	21	30
Nekia silty clay loam,	2-7%	30	+21	0	+26	51	77
silt loam, and	2-12%	27	+21	0	+26	48	74
clay loam	7-12%	27	+21	0	+26	48	74
	12-20%	24	+21	0	+16	45	61
	20-30%	18	+21	0	0	39	39
Nekia stony silty clay loam	2-12%	7	+28	0	+23	35	58
Nekia very stony silty clay loam	2-30%	0	+28	0	0	28	28
Newberg sandy loam, fine sandy loam, loam, and silt loam	0-3%	57	+7	0	+33	64	97
Noti loam	0-3%	0	+35	+10	+8	45	53
Oxley gravelly silt loam	0-3%	13	+13	+10	+32	36	68
Panther silty clay loam	2-12%	0	+12	+4	+9	16	25
	4-20%	0	+11	+4	+8	15	23
Pengra silt loam	1-4%	35	+12	+3	+9	50	59
Philomath silty clay	3-12%	15	+8	0	+11	23	34
	12-45%	3	+8	0	0	11	11
Philomath cobbly silty clay	3-12%	5	+11	0	+13	16	29
	12-45%	0	+10	0	0	10	10

Soil type	Slope	Native productivity	Corrections for Amendments	Drainage	Irrigation	Max. Productivity Dryland	Irrigated
Philomath stony silty clay	3-12%	0	+14	0	+14	14	28
	12-45%	0	+13	0	0	13	13
Pilchuck fine sand, fine sandy loam	0-3%	10	+20	0	+40	30	70
Powell silt loam	0-3%	20	+24	+13	+20	57	77
	0-8%	17	+24	+13	+20	54	74
	3-8%	17	+24	+13	+20	54	74
	8-15%	8	+24	+13	+20	45	65
	15-30%	0	+24	+13	0	37	37
Price silty clay loam	3-12%	36	+22	0	+24	58	82
	12-20%	33	+22	0	+24	55	79
	20-30%	27	+22	0	0	49	49
Quatama loam	0-3%	65	+5	+9	+20	79	99
	3-8%	65	+5	+9	+20	79	99
	7-12%	62	+5	+9	+20	76	96
	8-15%	59	+5	+9	+20	73	93
	12-20%	59	+5	+9	+20	73	93
	15-30%	53	+5	+9	0	67	67
Rickreall silty clay loam	3-12%	20	+23	0	+7	43	50
	12-20%	17	+23	0	+7	40	47
	20-50%	0	+23	0	0	23	23
Ritner gravelly silty clay loam	3-12%	0	+27	0	+26	27	53
	12-30%	0	+25	0	0	25	25
Ritner cobbly silty clay loam	2-12%	0	+28	0	+26	28	54
	3-30%	0	+26	0	0	26	26
	12-30%	0	+26	0	0	26	26
Salem gravelly silt loam, and gravelly loam	0-3%	55	+12	0	+26	67	93
Salkum silty clay loam, and silt loam	2-8%	35	+21	0	+22	56	78
	7-12%	32	+21	0	+22	53	75
	8-16%	29	+21	0	+22	50	72
	6-20%	29	+21	0	+22	50	72
Salkum silty clay loam, basin	0-6%	35	+21	0	+22	56	78
Santiam silt loam	0-3%	52	+11	+6	+18	69	87
	3-6%	52	+11	+6	+18	69	87
	0-7%	52	+11	+6	+18	69	87
	7-12%	49	+11	+6	+18	66	84
	6-15%	46	+11	+6	+18	63	81
	12-20%	46	+11	+6	+18	63	81
Saum silt loam	2-7%	53	+14	0	+28	67	95
	3-8%	53	+14	0	+28	67	95
	7-12%	50	+14	0	+28	64	92
	8-15%	47	+14	0	+28	61	89
	12-20%	47	+14	0	+28	61	89
	15-30%	41	+14	0	0	55	55
	20-30%	41	+14	0	0	55	55
Sifton gravelly loam	0-3%	22	+32	0	+17	54	71
Sifton variant gravelly clay loam	0-3%	20	+13	0	+27	33	60
Silverton silt loam	2-12%	48	+11	0	+26	59	85
	12-20%	45	+11	0	+17	56	73
Stayton silt loam	0-7%	20	+33	0	+7	53	60
Steiwer silty clay loam, loam, and silt loam	3-6%	55	+10	0	+24	65	89
	3-12%	52	+10	0	+24	62	86
	5-20%	49	+10	0	+15	59	74
	12-20%	49	+10	0	+15	59	74
	20-30%	43	+10	0	0	53	53
	20-50%	35	+10	0	0	45	45
Steiwer silty clay loam, basalt substratum	5-20%	49	+10	0	+15	59	74
	20-30%	43	+10	0	0	53	53
Steiwer silt loam, acid variant	3-20%	39	+15	0	+15	54	69
Suver silty clay loam	3-12%	2	+27	+5	+9	34	43
	12-20%	0	+26	+5	+9	33	42
	20-30%	0	+24	+4	0	28	28

Soil type	Slope	Native productivity	Corrections for Amendments	Drainage	Irrigation	Max. Productivity Dryland	Irrigated
Veneta loam,	0-7%	45	+16	+3	+25	64	89
silt loam	0-12%	42	+16	+3	+16	61	77
	7-20%	39	+16	+3	+16	58	74
	12-20%	39	+16	+3	+16	58	74
Veneta loam,	2-7%	55	+15	0	+24	70	94
loamy subsoil variant	7-20%	49	+15	0	+15	64	79
	20-30%	43	+15	0	0	58	58
Veneta variant silt loam	0-7%	50	+15	+4	+24	69	93
Verboort silty clay loam	0-3%	5	+17	+4	+27	26	53
Waldo silty clay loam, silt loam	0-3%	17	+9	+12	+31	38	69
Wapato silt loam, silty clay loam	0-3%	20	+8	+16	+29	44	73
Wapato gravelly silty clay loam	0-3%	13	+10	+16	+33	39	72
Whiteson silt loam	0-3%	8	+15	+4	+26	27	53
Willakenzie silty clay loam,	2-12%	47	+15	0	+24	62	86
clay loam	12-20%	44	+15	0	+15	59	74
	20-30%	38	+15	0	0	53	53
Willakenzie silty clay loam,	2-7%	50	+15	0	+24	65	89
moderately shallow	7-20%	44	+15	0	+15	59	74
Willamette silt loam	0-3%	75	+5	0	+20	80	100
	3-7%	75	+5	0	+20	80	100
	3-12%	72	+5	0	+20	77	97
	7-12%	72	+5	0	+20	77	97
	12-20%	69	+5	0	+20	74	94
Willamette silt loam, wet	0-3%	65	+5	+9	+20	79	99
	3-7%	65	+5	+9	+20	79	99
Willamette silt loam, gravelly substratum	0-3%	62	+9	0	+23	71	94
Witham silty clay loam, silty clay	2-7%	12	+5	+8	+8	25	33
Witzel cobbly silt loam	3-12%	8	+21	0	+14	29	43
Witzel very stony silt loam,	3-12%	0	+21	0	+14	21	35
very cobbly loam	3-30%	0	+21	0	0	21	21
Woodburn silt loam	0-3%	65	+5	+8	+16	78	94
	0-7%	65	+5	+8	+16	78	94
	3-12%	62	+5	+8	+16	75	91
	7-12%	62	+5	+8	+16	75	91
	12-20%	59	+5	+8	+16	72	88
Yamhill silt loam	2-7%	55	+10	0	+24	65	89
	7-12%	52	+10	0	+24	62	86
	12-20%	49	+10	0	+15	59	74
	20-30%	43	+10	0	0	53	53
Yamhill silt loam,	2-7%	55	+10	0	+24	65	89
moderately shallow	7-20%	49	+10	0	+15	59	74

Corrections

Most farmers don't depend solely on native productivity to sustain crop yields. They improve upon existing conditions by adding fertilizer and lime, draining wet soils, and irrigating dry soils. Table 1 shows how much they can increase native productivity ratings by each management practice taken independently. Corrections simply add back some or all of the points previously deducted in deriving the native productivity score.

Amendments. Penalty points are deducted for low native fertility, for excessive soil acidity, and for anything like shallow depth or coarse fragments that reduce the volume of soil from which plant roots can extract nutrients. These limitations can be partially or completely overcome by adding fertilizer and/or lime to the soil.

The actual amounts of lime or fertilizer needed in any given situation can only be determined through a careful soil testing program. Besides differences in native fertility, different crop requirements and different prior fertilization practices must be considered in making a lime or fertilizer recommendation.

Oregon State University, through its Soil Testing Laboratory and its network of county Extension agents, is well equipped to provide sound, up-to-date advice on how much fertilizer or lime to add to a given soil for a given crop. Several reputable commercial laboratories are also equipped to test soil for lime and fertilizer requirements.

Numbers in the "Amendments" column of table 1 are not specific fertilizer recommendations. They are ratings corrections that show how many points can be added to the native productivity score to make up for some or all of the penalty points previously deducted for nutrient deficiencies.

Some general inferences can be made from the magnitudes of these corrections. Most of the small corrections (less than 10 points) are associated with soils having relatively few inherent deficiencies (native productivity 50 or more). These deficiencies are easy to correct. Adding the necessary amendments will likely be profitable.

These same soils are also likely to respond favorably to very intensive fertility management. Thus fertilizer applications well beyond those needed to simply overcome native deficiencies also are likely to pay off in higher yields.

A few small amendment corrections are associated with very poor soils (native productivity less than 20). In these cases, there isn't much to be gained simply by adding fertilizer or lime, and it may not pay to do so unless the soils are drained and irrigated as well.

Large corrections (more than 10 points) indicate that several factors contribute to native fertility limitations. Most soils in this category have native productivity ratings below 50. Applications of fertilizer and/or lime will surely improve the soil, especially those soils with the higher native productivities. In many soils, however, the full benefit of the amendments may not be realized unless necessary drainage and irrigation improvements are made as well.

Zero entries in the "Amendments" column do not mean that the soil can't be improved. Zeroes mean simply that there were no penalty points deducted in the first place, so there's nothing to correct.

Drainage. Any soil that is less than well drained loses points in the rating system. The wetter the soil, the more points deducted. Artificial drainage with surface ditches and tile lines can improve the soil to varying degrees. Drainage systems, however, should be professionally designed to fit specific soil conditions and topography.

Permeable soils with only slight degrees of wetness and good drainage outlets are given back up to 90% of the points deducted for natural wetness. Tight, clayey soils with poor drainage outlets are given back only 10 or 20% of the original deduction.

Some inferences can be made from the magnitudes of the drainage corrections, but they are not all simple and straightforward. A correction of +8, for example, may result from correcting 80% of 10 points originally deducted for a moderately well drained soil, or from correcting 20% of 40 points originally deducted for a poorly drained soil. Correcting drainage should be quite profitable in the moderately well drained soil, but it may not pay at all in the poorly drained soil.

Additional information useful in interpreting drainage corrections is provided by the comparative sizes of native productivity scores and irrigation corrections. In general, low native productivity scores imply serious limitations and more complex—and expensive—remedies. Drainage is less likely to pay in such soils. Irrigated productivity scores assume that wet soils are drained.

Thus, even if a low drainage correction suggests little improvement with drainage alone, a large increase in irrigated productivity could very well mean that the drainage improvement would be a worthwhile investment.

Inferences from drainage corrections are summarized in table 2. For small drainage corrections (7 or less), drainage will probably pay for those soils that also have an irrigation correction of 20 points or more. Smaller irrigation corrections, added to small drainage corrections, imply the presence of serious limitations that are difficult to do much about.

Table 2. General Inferences from Drainage Corrections

	Associated ratings		Probable
Drainage correction	Native	Irrig. corr.	drainage feasibility
≤7	Any	≥20	V. Good
	Any	<20	Poor
8-9	≥50	Any	V. Good
	<50	>15	Good
	<50	<15	Poor
10-20	≥30	Any	Good
	<30	≥19	Fair
	<30	<19	Poor

Drainage corrections of 8 or 9 are very easily remedied in soils whose native productivity is 50 or more. If the native productivity is less than 50, but the irrigation correction is more than 15, there is a good chance that drainage will pay, though it will certainly be more expensive. Certainly the higher the native score, the greater the probability of profitable improvement. Soils that have low productivity (less than 50) and low irrigation correction (less than 15) are not likely to pay for the high costs of required drainage improvements.

Drainage corrections of 10 to 20 indicate that the soil has a fairly serious wetness problem to begin with. Some of these soils can be profitably drained, while others cannot. Drainage is likely to pay on soils whose native productivity is 30 or more.

Below 30, drainage will be difficult and expensive, and it is likely to pay only upon irrigation of soils whose irrigation correction is 19 or more. Within this group, the higher the ratings of both native and irrigated productivity, the higher the probability of success with drainage improvements.

Zero entries in the "Drainage" column (table 1) generally mean the soil is well drained. No penalty was assessed, so no correction is necessary. Bashaw and Natroy are the only two exceptions. Both soils are high shrink-swell clays that are very slowly permeable when wet. Subsurface drainage is possible, but the limitations are so severe that the likelihood of real improvement is essentially zero.

Irrigation. Virtually every soil in the Willamette Valley is limited by moisture stress during the summer. The only exceptions are the poorly drained Borges, Labish, and Noti soils, which have high water tables all year. Summer drought carried a rating penalty of 20 points. Additional points were deducted for shallow, sandy, or gravelly soils.

Farmers can usually remedy water stress created by these problems, sometimes completely, by irrigating the soil. Deep, permeable, well drained soils have excellent irrigation suitability. All of the penalty for water stress in the native state can be removed by irrigation.

Wet, clayey, slowly permeable soils have poor irrigation suitability. So do soils that have a lot of gravel in them. The irrigation correction for these soils ranges from 20 to 80% of the points originally deducted, depending on the severity of the problem.

Soils having slopes greater than 20% are considered nonirrigable, and these are the only ones for which the irrigation correction is zero.

Irrigation systems, like drainage systems, should be designed with the help of professionals. Site-specific soil factors that influence irrigation design include infiltration rate, water holding capacity, and slope. Site-specific environmental variables include seasonal evaporation rates and seasonal water use rates by different crops.

Farmers must consider all these factors carefully to determine the proper rate and frequency of irrigation and to decide on the optimum method of delivery of irrigation water. You can usually obtain advice from OSU Extension agents or from some of the major suppliers of irrigation equipment.

Interpretations of irrigation corrections are fairly straightforward: the higher the correction, the higher the feasibility of profitable irrigation. Soils having corrections of less than 10 points probably cannot be improved sufficiently to make irrigation pay. Corrections between 10 and 20 points are marginal, but may pay in some areas.

You can best judge corrections between 20 and 30 by looking at the native productivity and irrigated productivity scores. Soils with native productivities above 60 are generally highly suited for irrigation. Irrigation of less productive soils may also pay if the irrigated productivity is higher than 80. At lower productivity levels, the irrigation correction still indicates that farmers can make substantial gains with irrigation, but the profit margin may be minimal, especially if they are competing with producers on better soils.

Corrections of more than 30 points usually indicate that the soil is sandy or gravelly as well as having a rainfall deficit. Native productivity is low, but since water is the most limiting factor, irrigation is likely to remove 80 to 100% of the limitation. Water requirements will be high, and farmers will need to irrigate the soil at frequent intervals. But in soils like Briedwell and Newberg, the gains in productivity may well pay for the higher costs of good irrigation management.

Dryland productivity

Numbers in the "Dryland" column of table 1 are simply the sums of native productivity scores and the corrections for amendments and drainage. The minimum dryland score is 8, and the maximum is 80. These numbers, however, are still based on a 100-point scale, and the maximum dryland value reflects the limitation on potential productivity caused by a deficit in summer rainfall.

It is appropriate to compare dryland scores with irrigated scores of the same or other soils in areas where water is available and both irrigated and nonirrigated agriculture are practiced. If water is not available and irrigation is out of the question, it would be appropriate to expand the dryland scale by setting 8 equal to 0 and 80 equal to 100, and scaling every other score proportionately between 0 and 100.

Irrigated productivity

Numbers in the "Irrigated" column are the sums of native productivity scores plus all three corrections. They range from 8 to 100. These ratings best reflect the potential productivity of a soil under the highest levels of management possible. They assume that all necessary amendments are applied at appropriate rates, that artificial drainage is provided for soils that need it, and that irrigation water and the rights to use it are available.

High numbers indicate soils that can be used to obtain high yields for any of a wide variety of irrigated crops. Low numbers suggest that the choice of crops is very limited, and the yields of those few adapted crops may be limited as well. Small differences (1 or 2 points) between soils are probably not significant, but large differences clearly reflect true differences in potential value as an agricultural soil.

Applications of Productivity Ratings

Productivity ratings do not represent specific yields of any particular crop, but they do facilitate comparisons of relative agricultural value among the soils of an area. The rating system is sufficiently flexible to allow comparisons of the native productivity or intrinsic agricultural value of soils, the effects of various management inputs, maximum productivity under dryland management, or the maximum productivity under irrigated management.

Under different situations, one might wish to use the 100-point scale on which all numbers in table 1 are based, or to derive a new scale based on the range between maximum and minimum values for native productivity or dryland management. Similarly, one might wish to construct a new scale based only on those soils that occur in a given county or other portion of the valley.

Productivity ratings are most valuable when you use them together with soil survey maps of your area. That way the kinds of soils present will be readily apparent. You can easily measure the amount of each soil, and you can determine productivity ratings both for the individual soils and as a weighted average for your entire area.

Recent soil survey information is available for almost all of the Willamette Valley. Not all of it is published, but the information can be obtained at local Soil Conservation Service (SCS) offices. By 1987, soil surveys should be available for all of the Willamette Valley.

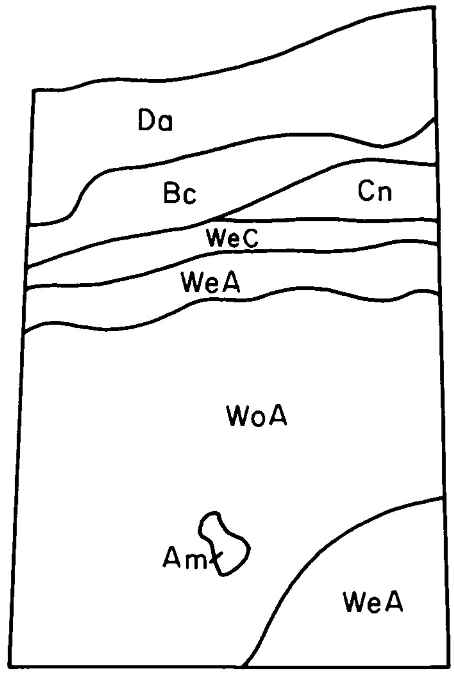
Three kinds of applications are discussed in the sections that follow. Each application is presented in broad terms, but with an example of its potential usefulness. It is anticipated that in actual use, these techniques will be continually refined and new applications will be discovered.

Agricultural management

One interesting application of productivity ratings is a general assessment of the quality of the soil resources any individual farmer has to work with. Although most farmers know from experience which soils are their good ones and which are poor, this method provides an independent, objective evaluation with a quantitative base. This method also allows them to evaluate the potential effect of changes in agricultural management, particularly drainage and irrigation.

Figure 1 shows the kinds of soils and their distribution on a 256-acre parcel in Benton County. We can measure the amount of each soil from figure 1, and we can extract from table 1 the relevant productivity data, giving the information in table 3.

Look first at the native productivities. Remember that 75 is the maximum possible score. Bashaw and Dayton stand out as very poor agricultural soils, and they occupy 25% of the total acreage. Fortunately, they occur side by side along the north portion of the tract. The rest of the soils are fair to excellent, and they occur as a large, connected block.



Am	Amity silt loam
Bc	Bashaw clay
Cn	Coburg silty clay loam
Da	Dayton silt loam
WeA	Willamette silt loam, 0-3%
WeC	Willamette silt loam, 3-12%
WoA	Woodburn silt loam, 0-3%

Figure 1. *Soil map of a 256-acre parcel of land in Benton County.*

We can calculate a weighted average native productivity for the entire tract by multiplying each soil's rating by the decimal fraction of the area it occupies and summing up all the products. Thus (.01 x 55) + (.09 x 20) + ... + (.48 x 65) = 54. Weighted average productivity ratings for each combination of improvements are calculated in the same way. The average ratings suggest that some overall improvement can be made by liming and fertilizing the soils. Little more would be gained by drainage alone, but drainage with irrigation brings about a substantial increase in productivity.

Further information that bears on management decisions is provided by the sizes of the corrections as discussed in the previous chapter. Bashaw and Dayton are both poorly drained soils, and they are so difficult to drain that there is virtually no effect on dryland agriculture.

The Dayton soil can be improved considerably with both drainage and irrigation, but the maximum productivity is still well below that of the better drained soils. The size of the change also suggests that to achieve it will be very expensive, which is true because drain tiles in Dayton would have to be very closely spaced.

The Amity, Coburg, and Woodburn soils, however, all have drainage corrections of +8 and native productivities of ≥50. The probability of increasing profits by artificially draining these soils is very high (table 2).

With both drainage and irrigation, the productivity of these soils can be brought up to very high levels (table 3). In fact, the weighted average productivity for the large block of Amity, Coburg, Willamette, and Woodburn in the south 3/4 of figure 1 can be changed from 67 (native) to 96 (irrigated).

Table 3. Acreage and Productivity Data for the Soils of Figure 1

			Productivity ratings			
Soil	Acres	% of total area	Native	With amendments	With amendments and drainage	With amend. drainage & irrigation
Amity	3	1	55	55	73	93
Bashaw	24	9	20	31	31	40
Coburg	10	4	60	65	73	93
Dayton	41	16	10	32	36	63
Willamette, 0-3%	44	17	75	80	80	100
Willamette, 3-12%	12	5	72	77	77	97
Woodburn, 0-3%	122	48	65	70	78	94
	256	100				
Weighted avg. productivity			54	62	67	85

The best management decision, therefore, seems to be to fertilize Dayton and Bashaw, but leave them undrained and unirrigated, and to drain the Amity, Coburg, and Woodburn soils and manage them intensively, along with the Willamette soils, under irrigated agriculture.

For the curious, productivity ratings can be used to shed light on any number of hypothetical management combinations. For example, what if the Woodburn soil area were to be drained, but not the Coburg? Overall productivity would decrease a little.

What if the Woodburn/Amity soil area were not drained but irrigated? Overall productivity would decrease a little.

What if the Dayton soil were tile-drained, but not the Bashaw? Overall productivity would increase a little.

Productivity ratings by themselves cannot and should not be used as the sole basis for management decisions, but they can be very helpful in attaching numerical values to the sizes of change that might be expected when a farmer decides to invest in agricultural improvements.

One other, much more subtle inference can be made from the data in figure 1 and table 3. From the text of the Benton County Area Soil Survey Report, we find that Amity has a more limiting drainage problem than Woodburn. We also find that the WoA mapping unit may include up to 5% Amity soils.

Figure 1 shows only one small patch of Amity in a broad Woodburn area, but the relationship between these two soils suggests that if there is one area of Amity large enough to map, there are probably several others scattered throughout the area that are too small to map.

There is some possibility that the *pattern* of these small wet spots could dictate the maximum intensity of use of the entire field. If that should happen, the *effective* productivity of Woodburn might be no better than that of the more limiting Amity soil. The difference is quite large in the native state, but almost disappears under intensive management.

Drainage of the Woodburn soil, however, should probably be designed as though the whole area were more like Amity to be sure that wet spots not apparent on the map do not prevent maximum use of these highly productive soil resources.

Buying, selling, or leasing agricultural land

Productivity ratings can provide an objective, unbiased indicator of the true quality of soil resources throughout the entire area of a parcel being bought, sold, or rented. The weighted average productivity ratings might be the only index number needed, since they incorporate the effects of both differences in the productivity levels among soils and the amounts of each kind of soil present.

If none of the soils have been improved in any way, use the weighted average native productivities. If the soils are fully developed with appropriate drainage and irrigation systems, use maximum irrigated ratings. If some soils are improved and others are not, calculate intermediate averages.

Figure 2 illustrates two possible curves that relate the sale price of a parcel of land to its weighted average productivity. Both curves start at the same minimum price for the poorest soils and end at the same maximum price for the very best soils. Curve A suggests a linear increase in sale value as productivity increases. The rate of change is constant throughout the entire range.

Curve B suggests that the price doesn't change very much throughout a range of very low productivities, then it increases rapidly as productivity increases. This curve also indicates that there may be less price differential among the highly productive soils, perhaps those with a rating of 85 or above.

The exact shape of the price/productivity relationships must be determined separately for each county in the valley. By correlating sales data with soil types in each area, it should not be difficult to construct the graph. Then the table of productivity ratings can be used to determine a fair sale price for any particular soil, or any group of soils in an area, and considering several options of existing or potential management improvements.

Of course, the price data need to be kept up-to-date, and perhaps the shape of the curve needs to be modified periodically. But the basic character of the soil resources will not change, and the usefulness of that information will remain applicable for a long time.

The parcel of land shown in figure 1 can be used to illustrate the process. The most productive soil in Benton County (Willamette silt loam, 0 to 3% slopes, irrigated) commands a price of about $4000 per acre. The minimum price for even the worst agricultural land is about $1000 per acre. Other data from Benton County suggest that a graph like curve B in figure 2 is more appropriate than curve A. This is shown in figure 3.

If our test parcel is fully improved with drainage and irrigation, the weighted average productivity is 85 (see table 3), and the sale price should be about $3600 per acre for the entire 256-acre piece. If there are no improvements, the productivity rating is 54, and the price should be about $2150 per acre.

In the more likely case where Dayton and Bashaw are unimproved except for fertilizer, and the rest of the soils are fully improved, the weighted average rating would be 79, and the appropriate sale price would be about $3200 per acre.

The fertilized-only Dayton soil by itself (rating = 32) should bring about $1500 per acre, whereas the entire block of more productive soils south of the Bashaw should bring about $3975 per acre (rating = 97).

Determination of a fair rental price would be done in the same way as for the purchase price. Rental data would need to be compiled locally and correlated with soil types to construct a graph of rental price versus productivity rating. Then for any given parcel or tract of land, the kinds and amounts of soils must be determined, followed by calculation of the appropriate weighted average produc-

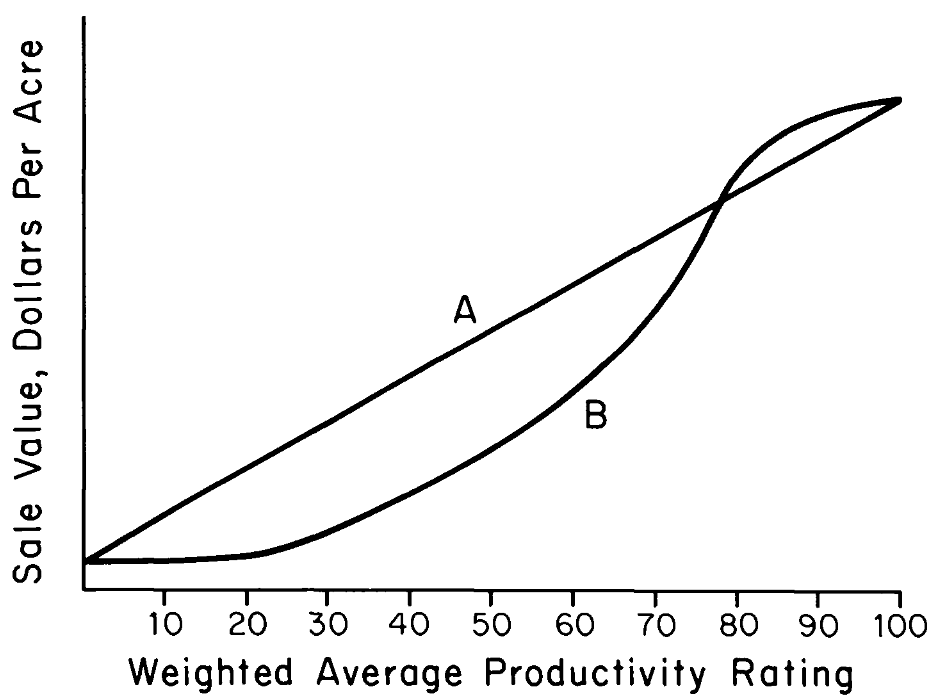


Figure 2. *Hypothetical relationships between the sale price of a parcel of land and its weighted average soil productivity.*

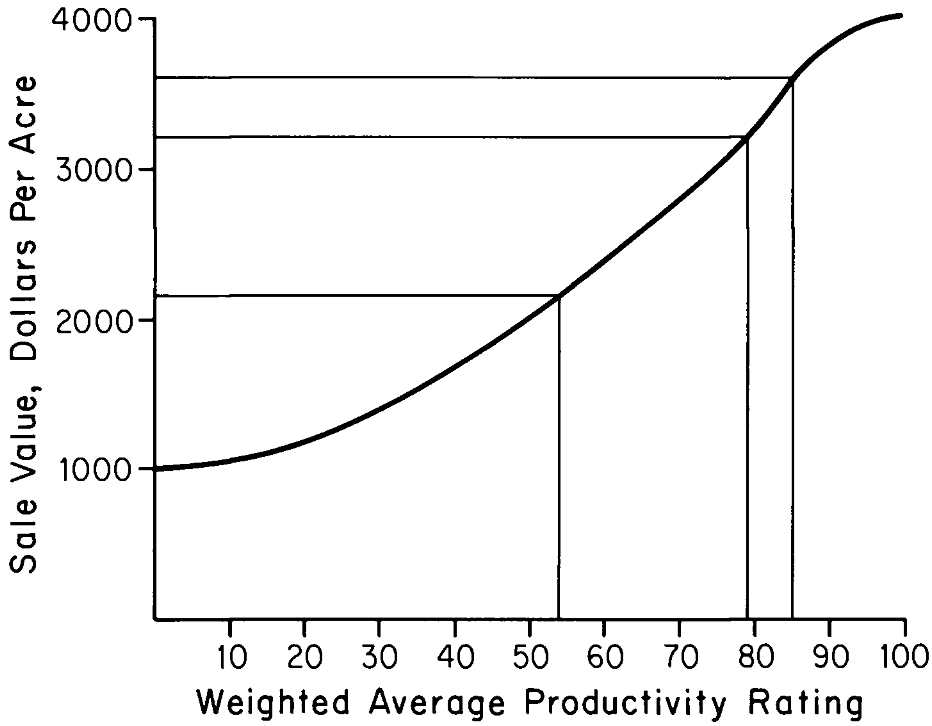


Figure 3. *Relationship between sale price (1981 data) and soil productivity in Benton County.*

tivity ratings, considering the kinds of management options that are available or potentially so, and using the data in table 1. Rental data must be kept current, but the productivity ratings and their ability to express a soil's potential for agriculture should endure.

Equalized tax assessment

Most county assessors already use some measure of soil quality in their determination of farm use value and farm land tax assessments. Often that measure is based upon or related to SCS classes of land capability. The trouble with capability is that it doesn't always indicate the true agricultural potential of a soil. Capability is more a measure of the risk of damage to a soil by erosion, and of the need for conservation treatments to prevent erosion and any further deterioriation in soil productivity.

An example of the relationship between productivity and capability is shown in figure 4. Data used to plot this graph were taken from the published soil surveys of Yamhill, Marion, and Benton counties. The graph does indicate that, *on the average,* productivity increases as capability improves. More important, however, are the facts that few soils fall right on the average, and there is wide variation in soil productivity *within* a given capability class.

Also, with few exceptions, any given yield can be obtained in three of the four classes shown. Tax assessments based on capability class ratings will tend to undervalue the better soils within a class and overtax the poorer soils within a class.

Productivity ratings provide a better measure of the true agricultural potential of the soils in a parcel or an ownership. They indicate not only the relative value of each individual soil in a parcel, but also the effect that the amounts of each different soil have on the overall productivity of the entire parcel.

By relating farm use values and tax assessment rates directly to weighted average productivity ratings, arbitrary classes of soil productivity are unnecessary, and the assessed value more accurately reflects the true quality of the soil resource and income potential that a farmer has to work with.

One method of computing tax assessments capitalizes land rent values on the basis of prevailing interest and tax rates. Productivity ratings could easily be used to determine the appropriate rental value, as discussed in the preceding sections and illustrated in figure 5.

The tax rates themselves, in dollars per thousand dollars of assessed value, also increase as productivity increases, so a graph of tax rate versus productivity could be constructed from locally derived data. Such a graph is shown in figure 6.

Once these two relationships are developed, and the weighted average productivity of the parcel in question has been determined, the tax assessment in dollars per acre can be computed. No guesswork or subjective evaluation of soil quality is necessary, as the assessment is based solely on the exact kinds and amounts of soils present on the farm or parcel.

The land parcel shown in figure 1 and the corresponding data in table 3 can be used to illustrate the procedure. First, assume there are no improvements on the parcel. The weighted average productivity would be 54. From figure 5, this parcel should rent for $49 per acre. From figure 6, the tax rate corresponding to a productivity of 54 should be $13.50 per $1000 of assessed value.

The equations for computing farm use value and the assessed tax are shown at the bottom of this page.

For this example, let's assume the management cost is $3 per acre and the prevailing interest rate is 12%.

The farm use value is:

$$\frac{49 - 3}{.12 + .0135} = \$344.57 \text{ per acre,}$$

The tax assessment is:

$$\frac{344.57}{1000} \times 13.50 = \$4.65 \text{ per acre,}$$

The total tax bill is:

256 acres x $4.65 per acre = $1190

Had all soils in the parcel been fully improved with amendments, drainage, and irrigation, the weighted average productivity would be 85, the rental value about $74 per acre, and the tax rate about $16.50/$1000. Equations A and B would yield a farm use value of $531.84 and a tax assessment of $8.77 per acre.

Under the more likely situation where the better soils are fully improved and the Dayton and Bashaw are not, the weighted average productivity is 79. In this case, the rent is $69, the tax rate is $16.00, the farm use value

$$\text{A. Farm use value} = \frac{\text{Rent per acre} - \text{Management cost per acre}}{\left(\frac{\text{Interest rate}}{100}\right) + \left(\frac{\text{Tax rate}}{1000}\right)}$$

$$\text{B. Tax assessment} = \left(\frac{\text{Farm use value}}{1000}\right) \times \text{Tax rate}$$

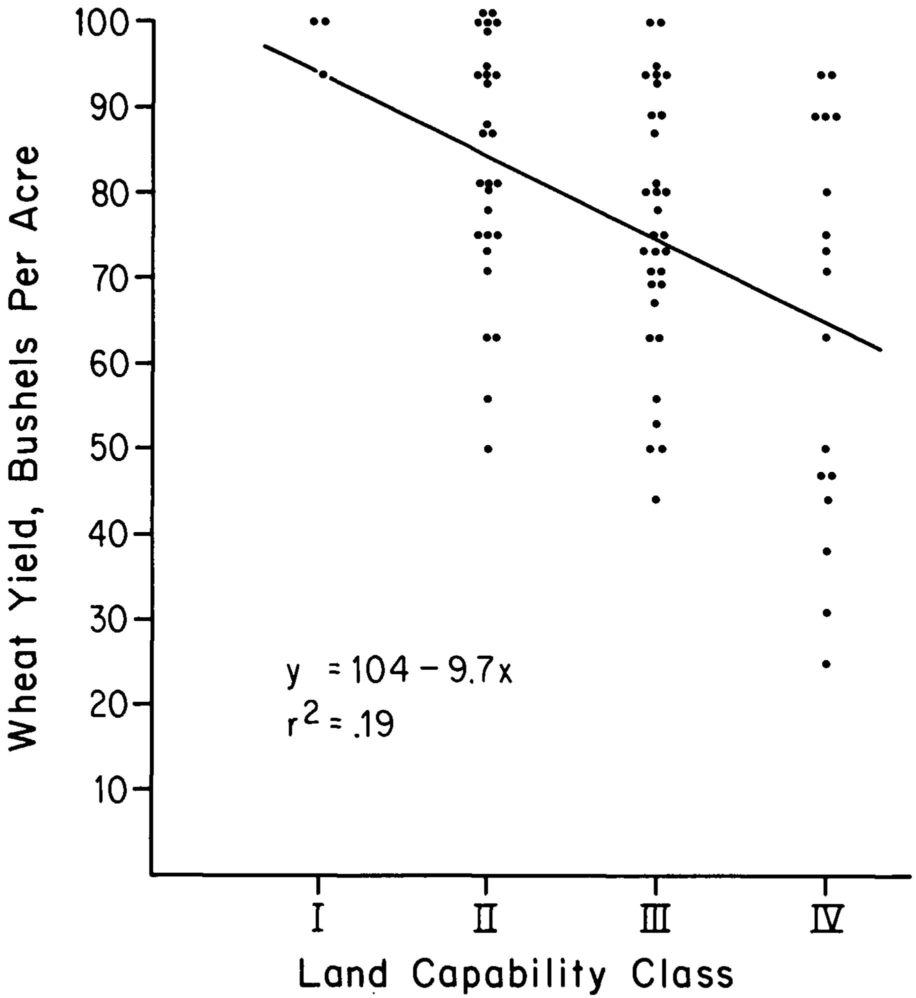


Figure 4. *Relationship between wheat yield and SCS land capability classification.*

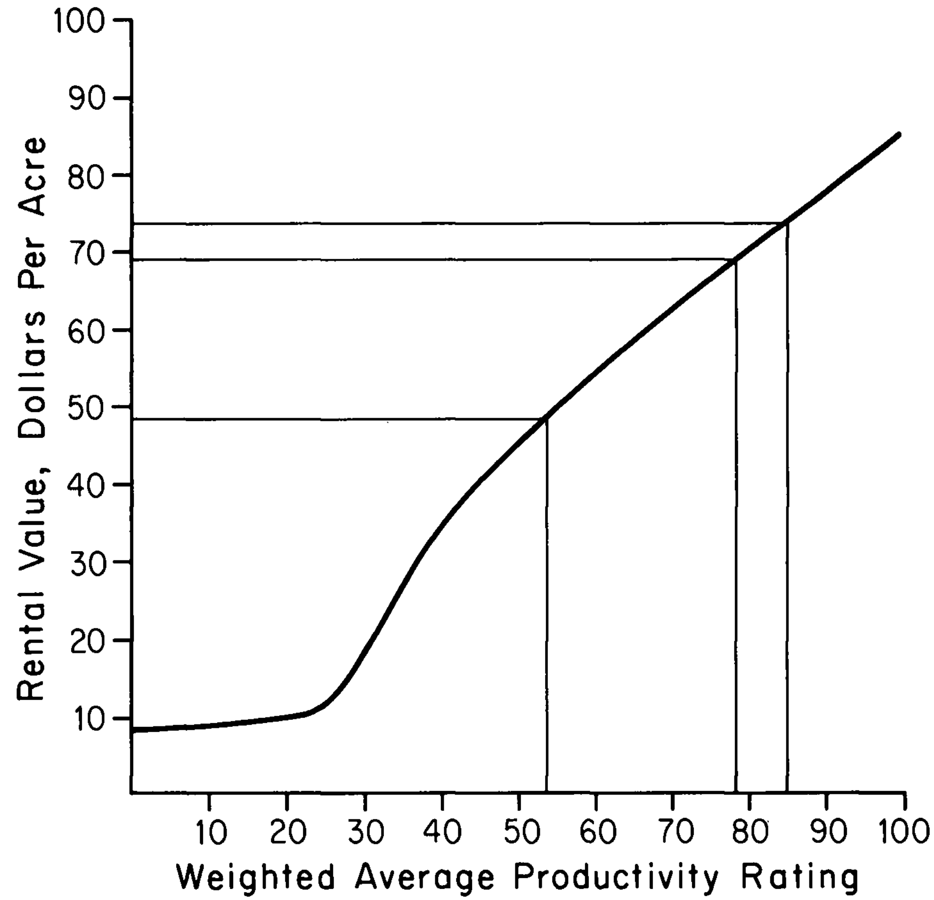


Figure 5. *Relationship between land rental value (1981 data) and soil productivity in Benton County.*

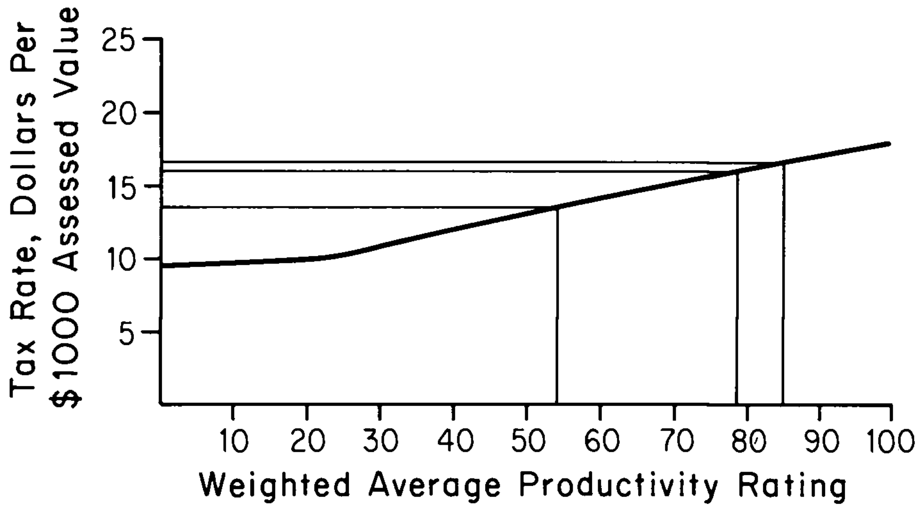


Figure 6. *Hypothetical relationship between tax rate and weighted average soil productivity.*

is $485.29, and the tax assessment is $7.76 per acre.

Another option is to prepare graphs or tables of the tax assessment directly as a function of the weighted average productivity. Such a graph is shown in figure 7. Each line in the figure already includes the effects of increases in productivity on the increases in income potential and tax rates. Because interest rates fluctuate, a family of curves is given to show the effects of this variable. The advantage of this approach is that one needs only to determine the weighted average productivity, and the tax can be taken directly from the graph for the appropriate interest rate.

The disadvantages are that new graphs would have to be constructed every time the relationship between productivity and prevailing interest and tax rates changed, and it may not be possible to read the graph precisely enough for interest rates between those plotted.

Using the same example, the unimproved parcel's rating of 54 corresponds with a tax assessment of $4.63 per acre on the 12% line. The fully improved rating of 85 corresponds with a tax of $8.75 per acre, and the intermediate rating of 79 commands a tax of $7.90 per acre.

This method is clearly much faster, and for that reason, if the graph is not accurate enough, it may be desirable to prepare tables of tax assessments that correspond to productivity ratings for a large number of combinations of interest and tax rates.

Preservation of agricultural land

Several factors affect the decision of whether to protect a parcel for agricultural use or commit it to development for nonagricultural purposes. One very important factor is the quality of the soil resources on the parcel. Certainly agricultural use should receive highest priority on the highly productive soils.

Soils of marginal productivity should be protected for agriculture if all other factors like size, location, and compatability with surrounding uses are also favorable for agriculture. Soils whose productivity is so low that profitable farming is not feasible could well be dedicated to other uses, as long as those uses don't interfere with agricultural management of adjacent soils of better quality.

The weighted average productivity of a parcel provides an objective indicator of the overall quality of the soil resources in the parcel. High numbers indicate that efforts should be made to dedicate the parcel to agricultural use. Low numbers indicate the parcel is not suited to agriculture. Intermediate numbers represent soils whose agricultural value is marginal.

Exact cutoff points between ratings for productive, marginal, and nonagricultural soils cannot be specified here, but these can be developed locally by correlating a number of weighted average productivities with their agricultural potential in that area.

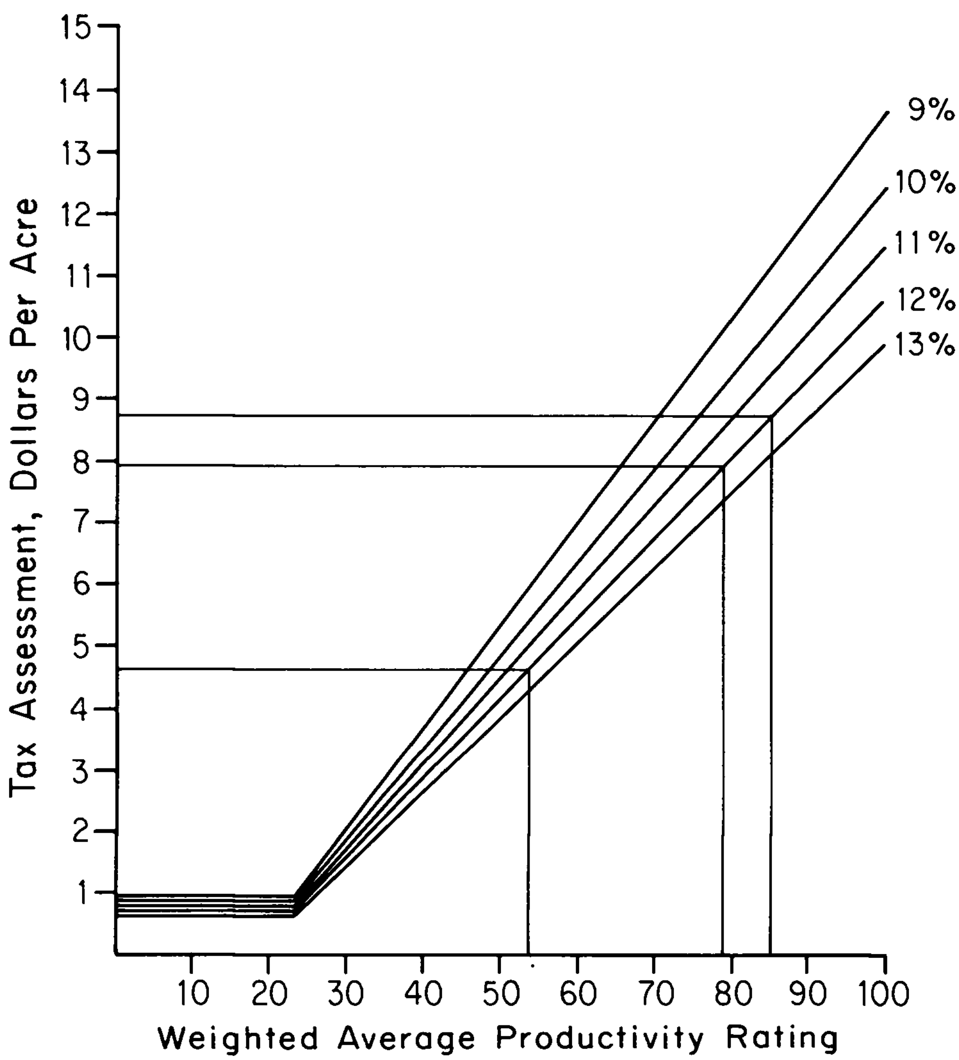


Figure 7. *Hypothetical relationships between tax assessments at specified interest rates and weighted average soil productivity.*

For this purpose, calculate weighted average productivities, using the maximum ratings that are feasible for each soil in a parcel. This will generally mean using the "Maximum Productivity—Irrigated" rating in the righthand column of table 1. If irrigation water is not available, however, or if the cost of water and the electricity to pump it exceed the benefits from increased yields, use the "Maximum Productivity—Dryland" rating.

Similarly, do not add in the drainage correction if the cost of drainage exceeds the benefits. By calculating the maximum feasible productivity, however, a land use decision can be based on the true agricultural *potential* of a parcel, and a wrong decision may be avoided by looking beyond what may be less than the best use of the land at the present time.

Land use decisions depend on more than the quality of soil resources. For example, a small parcel of highly productive soil may not be suited for agricultural use if it is surrounded by residential housing that leads to complaints or lawsuits about noise, odor, dust, pesticides, or vandalism.

Conversely, it may be desirable to maintain a parcel of poor or marginal soil in agricultural use if, by doing so, it can serve as a buffer to shield good agricultural land from nearby land uses that are incompatible with agriculture.

Thus, the evaluation of soil quality is necessary, but it is not enough to determine whether a given parcel of land is worthy of preservation for agricultural use. Weighted average productivities are good, unbiased indicators of relative soil quality and make the first step in the decisionmaking process an easy one.

The example parcel shown in figure 1 has a most feasible productivity rating of 79. That's not high enough to qualify as excellent agricultural land. But we have already seen that the average is the result of 25% very poor soil in the north quarter of the parcel and 75% very good soil in the south three-quarters of the parcel.

The lower portion is excellent agricultural land, and because the good soil occurs in one connected block, the evidence strongly indicates that the entire parcel should be preserved for agricultural use.

The poor soils won't contribute much to agricultural production, but they should not be used for nonagricultural purposes that would interfere with agricultural management of the good soils. It might be feasible, however, to locate farm-related structures on these soils in order to save every possible acre of the best soils for crop production.

Appendix A: Calculation of Productivity Ratings

The current system of soil classification uses funny-looking, difficult-to-pronounce names like Typic Albaqualf and Xeric Haplohumult. Yet these names, when fully understood, convey a great deal of information about the characteristics and behavior of the soil. That's because most of the words and syllables are taken from Greek or Latin roots that have universal meanings. Thus *aqu,* meaning water, identifies a wet soil, and *hum,* meaning humus, identifies one that is well supplied with organic matter.

The soil classification system is organized into six categories beginning with the very broad orders and increasing in detail down to the very specific series. The position of a syllable in the name indicates the categorical level, or relative importance of the property identified. Orders are always indicated by the last syllable. Next to that is a syllable that indicates the suborder property. A third syllable creates the name of a great group.

At this point, we already know at least three things about a soil by making inferences from the meanings of each syllable. This process is illustrated more fully for the Willamette Series in table 4. As you read down the table, information accumulates, so that at the suborder level, for example, you know both what the suborder prefix tells you and what the order syllable in the category above tells you.

Productivity ratings are calculated by assigning numerical values to every word or syllable that occurs in the names of Willamette Valley soils. The magnitude of each number represents the magnitude of the impact that the soil behavior inferred from Greek/Latin syllables has on soil productivity. Most effects are negative, though a few are positive.

Table 4. Categorical Breakdown and Soil Properties Implied by the Classification of the Willamette Series

WILLAMETTE: Fine-silty, mixed, mesic Pachic Ultic Argixeroll		
Order	oll (Mollisol)	fertile soil high in organic matter
Suborder	xer	soil receives winter rainfall, is droughty during summer
Great group	Argi	soil has an argillic horizon—i.e., one enriched in clay
Subgroup	Ultic	soil is a little more leached and acid than typical
	Pachic	surface soil is more than 20 inches thick
Family	mesic	soil has moderate temperatures with relatively long growing season
	mixed	soil contains a mixture of many kinds of minerals without any one being dominant
	Fine-silty	soil is medium-textured silt loam and silty clay loam
Series	Willamette	deep, well drained, fertile soil

In general, soils in the Mollisol Order are naturally the most productive, so that order is assigned a value of 100. Other orders are assigned lesser values according to their productivity relative to the Mollisols. Then we work backward through the name, deducting or adding points to the order values according to the properties and behavior indicated at each categorical level. Specific information about a series is taken from official series descriptions, SCS-5's, and OR-1's.

Complete criteria for assigning numbers are given in tables 5 and 6. Two completed worksheets, tables 7 and 8, illustrate the process for two of the soils of the area.

An important part of the rating calculation is the correction for management. By deducting points for every natural factor that limits productivity, the native productivity score indicates the general quality of the resource that a farmer has to work with.

Many of the natural limitations can be overcome, either wholly or in part, by appropriate management practices. Criteria for determining the extent of improvement in soil productivity are also shown in tables 5 and 6 as corrections for drainage, amendments, and irrigation.

Table 5. Criteria for Calculating Productivity Ratings for Willamette Valley Soils

I. Point values for soil orders

alf (Alfisol)	95
ent (Entisol)	90
ept (Inceptisol)	90
ert (Vertisol)	75
oll (Mollisol)	100
ult (Ultisol)	75

II. Point values for suborder prefixes

alb	-55 (-40 for wetness, -15 for abrupt textural change)
and	- 5
aqu	-40
hum	+ 5
ochr	0
psamm	-40 (-10 for low fertility, -30 for droughtiness)
umbr	0
xer	-20

III. Point values for great group prefixes

Alb	-15 (abrupt textural change)	
Arg	0	
Chrom	0	
Dystr	-20	
Fragi		
	Fragiochrept	-20 (-15 for pan, -5 for acidity)
	Fragiumbrept	-35 (-15 for pan, -20 for xeric moisture)
	All others	-15
Hapl	0	
Hum	-15 (excessive wetness)	
Ochr	0	
Pale	-15 (abrupt textural change)	
Pello	-10	
Umbr	-10 (excessive wetness)	
Vitr	-20	
Xer	-20	

IV. Point values for subgroup modifiers

Abruptic	-15	
Andic	- 5	
Aquic		
Vertisols	-10	
All other orders	-25	
Aquultic		
Alfisols	-30	(-25 wetness, -5 ultic)
Mollisols	-35	(-25 wetness, -10 ultic)
Argiaquic	+ 8	(no abrupt textural change)
Cumulic	+ 5	
Dystric		
Xeropsamments	-10	
All other great groups	-20	
Fluvaquentic	-10	
Fluventic	0	
Humic	+ 5	
Lithic	-25	
Mollic	+ 3	
Pachic	+ 5	
Typic	0	
Ultic		
Alfisols	- 5	
Mollisols	-10	
Umbric	+ 5	
Vertic	-20	
Xeric	-20	

V. Point values for family characteristics

A. Particle size

Clayey	-12	
Fine	- 5	
Very fine	-20	
Loamy		0
Coarse loamy		-5
Coarse silty		-3
Fine loamy		0
Fine silty		0
Medial	- 5	
Sandy	-30	
Skeletal		-30
Clayey-skeletal		-42
Loamy-skeletal		-30
Medial-skeletal		-35
Sandy-skeletal		-60
Fragmental	-50	

Contrasting classes—Use upper part only. Treat lower part as a restrictive layer that roots do not penetrate.

B. Mineralogy

Kaolinitic	- 5
Mixed	0
Montmorillonitic	- 5

C. Temperature

Mesic	0

D. Other

Acid	-10
Nonacid	0
Shallow	-25

VI. Point values for series adjustments

A. Surface texture

Silty clay loam, Silty clay, Clay — If particle size family is *fine,* and soil drainage class is *somewhat poor or poor,* then *deduct 5 points.*

All others 0

B. Coarse fragments—*Do not apply* if abruptic, albic, or fragipan characteristics or contrasting textures prevent plant roots from penetrating horizons that contain coarse fragments.

	Coarse Fragments 15–34% by volume or texture name modified by			Additional deduction for	
	Gravelly	Cobbly	Stony	35–59% or "Very"	≥60% or "Extremely"
Nonskeletal soils					
Surface	-5	-10	-20	-10	-15
Subsoil	-3	- 5	-20	-10	-15
Skeletal soils					
Surface	-2	- 6	-10	- 5	-10
Subsoil	0	- 3	- 5	0	-10

C. Drainage class

1. Soils (except Vertisols) *without* aqu anywhere in the name—assume well drained. Modify as indicated below for other drainage classes.

Well to moderately well	- 5
Moderately well	-10
Moderately well to somewhat poor	-15
Somewhat poor	-25

2. Aquic or Albic *suborders*—assume poorly drained. Modify if drainage is better than poor.

Somewhat poor	+ 15
Somewhat poor to poor	+ 5

3. Aquic *intergrades* (except Vertisols) and intergrades to Aquic suborders—assume somewhat poorly drained. Modify as below for other drainage classes.

Well	+25
Moderately well	+15
Moderately well to somewhat poor	+10
Poor	-15

4. Vertisols—Pelloxererts and Aquic Chromoxererts—assume somewhat poor or poor drainage. Modify if the drainage is better than that.

Well	+10
Moderately well	+ 5

D. Rooting depth

Points have *already been deducted* for root depth limitations associated with each of the following situations. No further deductions are necessary, but some additions may be in order.

Abruptic intergrades
Albic suborders and great groups
Aquic suborders
Fragi great groups
Lithic subgroups (unless depth to rock is ≤12")
Pale great groups of udults, xerults, xeralfs, xerolls
Shallow families
Skeletal families
Vertic intergrades
Vertisol order

1. Further deductions—made only for aquic subgroups, intergrades to aquic suborders, soils with contrasting textures, other soils that *do not have* any of the limitations above, but in which the rooting depth is less than 60 inches.

If rooting depth (inches) is	Deduct
>60	0
40-60	- 3
20-40	-15
12-20	-25
<12 (lithic or shallow)	-10
<12 (neither lithic nor shallow)	-35

2. Additions—made *only* if the soil name *does indicate* one of the above limitations *other than* aquic or skeletal, and rooting depth is nevertheless *more than* 60 inches.

Add back any of the original deduction resulting from physical barriers to root penetration that has not already been accounted for by intergrade adjustments.

E. Soil acidity

1. Alfisols and Mollisols

a. Ultic intergrades—assumes pH of ≥5.1 throughout

pH <5.1 in surface	-5
pH <5.1 in subsoil	-5
pH ≥5.6 throughout, and soil *not* Cumulic or Pachic	+5

b. Other intergrades—assumes pH ≥5.6 throughout

	pH 5.1-5.5	pH <5.1
Surface soil	-5	-10
Subsoil	-5	-10

2. Inceptisols, Entisols, and Vertisols

a. Acid families—asssumes pH <5.6 throughout

Surface soil pH ≥5.6	+5
Subsoil pH ≥5.6	+5

b. Dystric great groups and intergrades—assumes pH ≥5.1 throughout

Surface soil pH <5.1	-5
Subsoil pH <5.1	-5

c. Vitrandepts—same as Dystric great groups

d. All other great groups—assumes pH ≥5.6 throughout

	pH 5.1-5.5	pH <5.1
Surface soil	-5	-10
Subsoil	-5	-10

3. Ultisols—assumes pH ≥ 5.1 throughout
   a. Surface soil pH < 5.1 -5
   b. Subsoil pH < 5.1 -5

F. Flood frequency and duration—xeric moisture regimes only

Frequency	V. Brief	Brief	Long	V. Long
Rare	0	0	- 2	- 5
Common	0	- 3	-10	-15
Occasional	0	- 3	-10	-15
Frequent	-5	-10	-15	-20

G. Rainfall—total annual

1. Xeric soil moisture regimes

> 60 inches	-10
30–60 inches	0
20–30 inches	-10
15–20 inches	-25
12–15 inches	-55
< 12 inches	-70

2. Udic soil moisture regimes

> 60 inches	-10
30–60 inches	0
< 30 inches	-25

H. Droughtiness—apply to soils that *do not* have xer anywhere in the name but nevertheless have a significant dry period during the growing season.

1. Aquic soil moisture regimes (Aquic Suborders)
   Humaquepts 0 (permanent high water table)
   Soil associated with
   Xeric soils in a
   Mediterranean climate -20
2. Udic soil moisture regimes
   Soils that have dry summers in a marime climate
   associated soils are udic -10
   associated soils are xeric -20

I. Frost-free days

165-210	0
145-210	- 3
120-190	- 5
80-120	-10

J. Slope

Gradient (%)	Drainage: Well or mod well	Drainage: Somewhat poor or poor
0-3	0	0
3-7	0	-3
3-12	-3	-6
7-12	-3	-6
8-15	-6	-12
2-20	-6	-12
7-20	-6	-12
12-20	-6	-12
12-25	-9	-16
3-25	-9	-16
3-30	-12	-20
15-30	-12	-20
20-30	-12	-20
12-50	-15	-22
30-50	-20	-25
30-60	-20	-25
> 60	-60	-60

VII. Corrections for artificial drainage

A. Determine the total deduction for wetness as the sum of all deductions or adjustments for Aquic suborders, the wetness portion of Albic suborders, all types of Aquic intergrades, Hum- and Umbr- great groups, and both positive and negative series adjustments for drainage class.

B. Multiply the total from A by a coefficient taken from the table below. Enter the product as a positive correction for artificial drainage of wet soils.

Artificial drainage correction

Particle size and permeability	Uplands			Nearly level terraces and bottoms: Good outlets			Nearly level terraces and bottoms: Poor outlets	
	MWD	SWP	P	MWD	SWP	P	SWP	P
Loamy classes								
≥ Mod. slow	.9	.8		.9	.7	.4	.4	
Slow	.8	.5		.8	.5	.3	.3	.2
Very slow			.2					
Fine, mixed								
≥ Mod. slow	.8	.7		.8	.7			
Slow	.6	.4		.6	.4	.3		.2
Very slow		.3	.2					.1
Fine, mont.								
Slow						.2		.1
Very slow		.3			.3			.1
Very fine, mixed								
Slow								
Very slow		.1						
Very fine, mont.								
Very slow			.1			0		0
Clayey, mixed								
≥ Mod. slow	.7							
Slow	.6							
Very slow		.2						
Clayey, mont.								
Very slow		.1						

VIII. Corrections for amendments (lime and fertilizer)—evaluate *both* A and B

A. Corrections for nutrient deficiencies/physical root volume limitations—add back the apropriate number of points from each of the 7 categories below.

1. Orders

alf	+2 for Mollic intergrades
	+5 for all other subgroups
ent	+5
ept	+5 for Cumulic, Humic, Pachic, Ultic intergrades
	+10 for other subgroups
ert	+8
oll	0
ult	+15

2. Suborders

Alb	+5
And	all of earlier deduction
Psamm	+10

3. Great groups

Alb	⅓ of earlier deduction
And	all of earlier deduction
Dystr	½ of earlier deduction
Frag	⅓ of earlier deduction
Pale	⅓ of earlier deduction
Pell	+3
Psamm	+10
Vitr	½ of earlier deduction

4. Intergrades

Abruptic	⅓ of earlier deduction
Andic	all of previous deduction
Aquultic	+5, unless 5 already added back for pH ≥5.6
Dystric	½ of earlier deduction
Lithic	⅓ of earlier deduction
Ultic	+5, unless 5 already added back for pH ≥5.6

5. Families—particle size

Nonskeletal soils	
Sandy, coarse loamy, coarse silty	⅓ of earlier deduction
Skeletal soils	
Sandy-skeletal	+16
Loamy-skeletal	+6
Clayey-skeletal	+8

6. Families—other characteristics

Shallow	⅓ of earlier deduction
Acid	½ of earlier deduction, unless pH is ≥5.6 throughout

7. Series adjustments

Coarse fragments	
Nonskeletal soils	⅓ of earlier deduction
Skeletal soils	2/10 of earlier deduction
Rooting depth	⅓ of earlier deduction
Surface soil acidity	all of earlier deduction on slopes up to 30%, none on steeper slopes

B. Corrections for root volume limitations in wet soils (any soil less than well drained)—add back ⅓ of the balance of the total wetness penalty that remains *after* drainage corrections have been made, for soils that meet the following criteria:

1. Root depth <40″	any wet soil
2. Root depth 40–60″	poorly drained soils or Aquic suborders only
3. Root depth >60″	poorly drained soils only

IX. Corrections for irrigation—complete steps A and B

A. Determine the total penalty attributed to droughtiness by summing all the deductions made for any of the following reasons. Note that in many cases (e.g., Alb, Frag) the total value of the deduction may be attributed partly to nutrient deficiency and partly to droughtiness.

1. Orders

Vertisol	17

2. Suborders

Psamm	20
Xer	20

3. Great groups

Alb	10, unless all or part of the original -15 for abrupt textural change has been nullified by Argiaquic or by deep rooting
Fragi	10
Pale	⅔ of earlier deduction
Pello	⅔ of earlier deduction
Xer	20

4. Intergrades

Abruptic	⅔ of earlier deduction
Lithic	⅔ of earlier deduction
Vertic	20
Xeric	20

5. Family characteristics—particle size

Nonskeletal soils	
Sandy, coarse loamy, coarse silty	⅔ of earlier deduction
Skeletal soils	
Sandy-skeletal	44
Loamy-skeletal	24
Clayey-skeletal	34

6. Family characteristics—other

Shallow	⅔ of earlier deduction

7. Series adjustments

Coarse fragments	
Nonskeletal soils	⅔ of earlier deduction
Skeletal soils	8/10 of earlier deduction
Root depth	⅔ of earlier deduction

8. Wet soils—any soil less than well drained. Add back 2/3 of the balance of the total wetness penalty that remains *after* drainage corrections have been applied in the following situations.

Root depth <40	any wet soil
Root depth 40-60	poorly drained soils or Aquic suborders
Root depth >60	poorly drained soils only

B. Multiply the total penalty from part A by a coefficient taken from the bottom of table 6. Enter the product as a positive correction for productivity if the soil is irrigated.

To work through table 6, start at the top of column 1. If a soil meets the criteria for slope, move down. If it fails, move across until a column is reached that does fit. Then move down. In general, always work down as long as a soil's properties continue to fall within the permitted range for each parameter listed. Move across only when soil characteristics fall outside the permitted range. Always move down and to the right, never back up or to the left.

Table 6. Criteria for determining irrigation corrections

Parameter	Column 1	Column 2	Column 3	Column 4	Column 5
Slope	0-20%	0-20%	0-20%	0-20%	Any
Depth to bedrock	>40"	>40", *or* 20-40" *if* a) WD or MWD, and b) slope ≤12%	>20"	>12"	Any
Mineralogy	Mixed Medial	Mixed Medial Mont. No Vertic soils or Vertisols	Mixed Medial Mont. No Vertic soils or Vertisols	Any	Any
Particle size family	1. All loamy classes 2. Fine or clayey *if* WD or MWD	1. All loamy classes 2. Fine or clayey *if* a) WD-SWP, or b) PD if mixed & rooting >60" 3. Sandy, if <75% med. or coarser sand	1. All loamy classes 2. Fine or clayey *if* WD-PD 3. All sandy classes *except* lvcs, vcs	Any	Any
Coarse fragments	Nonskeletal soils with a. <10% coarse frag. in surface soil b. <35% coarse frag. in subsoil	1. Any nonskeletal soil 2. Skeletal soils, or soils with contrasting families over skeletal, *if* more than 20" non-skeletal soil overlie gravel	1. Any nonskeletal soil 2. Skeletal soils *if* surface soil coarse fragment name does not contain very or extremely	1. Any nonskeletal soil 2. Skeletal soils *if* surface soil coarse fragment name does not contain extremely	Any
Permeability	Mod. rapid to mod. slow	Rapid to slow	1. Very rapid to slow 2. Very slow if slope 0-3%	Very rapid to very slow	Any
Restrictive layers	None	Claypan, Fragipan, contrasting textures allowed *if* a. WD or MWD, b. Permeability at least slow, c. Slope ≤7%	Claypan, Fragipan, contrasting textures allowed *if* a. Pan below 12" b. WD-SWP c. PD on 0-3% slopes	Allowed	Allowed
Coefficient	1.0	0.8	0.5	0.2	0

Table 7. Sample Calculations for Woodburn Silt Loam, 0-3% Slopes

Map Unit Woodburn silt loam, 0-3%

Classification Fine-silty, mixed, mesic Aquultic Argixeroll

Order	oll	100
Suborder	xer	-20
G. Group	Argi	0
Subgroup	Aquultic	-35
Family		
temp.	mesic	0
mineral.	mixed	0
part. size	Fine-silty	0
other		
Series		
surface text.	silt loam	0
coarse frag.	none	0
drainage	Mod. well	+15
root depth	>60	0
acidity	≥5.6 thru	+5
flooding	none	0
rainfall	40-60"	0
droughtiness	already xeric	0
frost-free days	165-210	0
slope	0-3	0
Native Productivity		65
Corrections for		
Drainage	+8	
Amendments	+5	
Irrigation	+16	
Max. Dryland Productivity		78
Max. Irrigated Productivity		94

Permeability Slow

Corrections:

Drainage

Aqu -25
MWD +15
-10
x .8
+8

Amendments

Ultic +5

Irrigation

Xer -20
x .8
16

Table 8. Sample Calculations for Briedwell Stony Silt Loam, 7-12% Slopes

Map Unit Briedwell stony silt loam, 7-12%

Classification Loamy-skeletal, mixed, mesic Ultic Haploxeroll

Order	oll	100
Suborder	xer	-20
G. Group	Hap	0
Subgroup	Ultic	-10
Family		
temp.	mesic	0
mineral.	mixed	0
part. size	L-skel	-30
other		
Series		
surface text.	stony silt l.	-10
coarse frag.	>60% cobbles	-13
drainage	well dr.	0
root depth	skeletal	0
acidity	>5.6 thru	+5
flooding	none	0
rainfall	40-60"	0
droughtiness	already xeric	0
frost-free days	165-210	0
slope	7-12	-3
Native Productivity		19
Corrections for		
Drainage	0	
Amendments	+16	
Irrigation	+31	
Max. Dryland Productivity		35
Max. Irrigated Productivity		66

Permeability moderate

Corrections.

Drainage

none

Amendments

ultic	+5
.2 × L-skel	+6
.2 × Stony	+2
.2 × Coarse frag.	+3
	+16

Irrigation

Xer	20
.8 × L-skel	24
.8 × Stony	8
.8 × Coarse frag.	10
	62
	× .5
	31

Appendix B: Calibration of Productivity Ratings

Productivity ratings are designed to reflect both yield potential and diversity of crop choice. The numerical values assigned to each part of a soil name are arbitrary, but they must add up in such a way that soils capable of producing high yields on a number of crops consistently receive high ratings, whereas soils that can provide only low yields or that can be used for only a very few kinds of crops consistently receive low ratings.

In other words, the calculated productivity ratings must be validated by calibration with data from the actual yields of several different crops on several different soils.

Yield data used for calibration were the estimated yields published by the SCS. In the Willamette Valley, these data are available for Benton, Lane, Marion, Polk, Washington, and Yamhill counties. In addition, some yield data are reported on the OR-1 Soil Interpretation Sheets for Oregon. These seven sources, the six counties plus the OR-1's, provided the data used in the calibration.

Although some research data are available, most such data are for a specific crop on a specific soil. They don't provide adequate information on the yield of the same crop on different soils, or on the yield of a variety of crops on the same soil. For this reason, research data were not used in the calibration procedure. Later on, as more yield data are acquired on more soils, recalibration using proven yields will be a desirable thing to do.

Data were assembled for 23 soils that occur in three or more of the six counties used for calibration. The complete list is given in Tables 11 and 12. Crops used for the process were also those for which data were available in three or more of the calibration counties.

Calibration of dryland ratings was based on the yields of alfalfa, grass seed, wheat, barley, filberts, and cherries. Calibration of irrigated ratings was based on the yields of pasture, sweet corn, green beans, and strawberries.

Yield data from each source were always converted to the percent of the maximum for that source. This is because the estimated yields were not always the same, even though there is no reason to expect different yields of the same crop on the same soil in adjacent counties.

Wheat, for example, has maximum reported yields of 80 bushels (Benton Co.), 90 bushels (Yamhill Co.), 100 bushels (Lane, Polk, Washington counties and OR-1's), and 45 cwt (Marion Co.). Part of the reason for this variation may be the different times at which the estimates were made.

In any case, the variation shows why as many sources of data as possible were included in the calibration process. Expressing yields as percentages of maximums also has the advantage of putting calibration data on a 0 to 100 scale, which is the desired scale for the final productivity ratings.

The first step in the calibration process was to tabulate yields of each calibration crop on each calibration soil as listed in each of the seven calibration sources. Tables 9 and 10 illustrate this process for Marion County. Note that 20 of the 23 calibration soils occur in Marion County. Only the Briedwell, Coburg, and Cove soils are missing. Numbers in these tables are percentages of the maximum yield reported in the estimated yield table of the Marion County Soil Survey Report. Dashes mean simply that there were no data reported.

The next step was to calculate and tabulate (tables 11 and 12) the average percentage yield of each crop on each soil. If a given crop/soil combination occurred in five sources of information, five numbers went into the average. If it occurred in only one source, that number was recorded.

Zeroes were used only if none of the seven data sources gave yield estimates for a specific crop on a specific soil. Tables 11 and 12 list all 23 calibration soils and all 10 calibration crops. Each entry is the average percentage of maximum yield, followed in parentheses by the number of sources contributing to the average.

The third step was to calculate the weighted average percent yield. The weighting factors were the parenthesized numbers of data sources, except that each zero entry was weighted only with a one.

Incorporating zeroes in the average provides some penalty for lack of diversity. Weighting zeroes with sevens, however, would provide too severe a penalty, particularly because some sources have no information on a given crop yield only because the crop is not commonly grown on the soil in question, rather than because it's not adapted.

Further, if zeroes were weighted with sevens, then 100's reported from a single data source (e.g., alfalfa on Amity) should be weighted with sevens as well. The assumption made here was that only available data should be used and it was not appropriate to assume yields for crop/soil combinations for counties not reporting them explicitly.

Thus the calculation of the weighted average dryland rating on Concord soil would be:

$(0 \times 1 + 73 \times 3 + 67 \times 4 + 66 \times 4 + 0 \times 1 + 0 \times 1)/14 = 54.$

The final step was to scale the weighted average up so that the maximum value was

Table 9. Yield Data for Dryland Crops on Marion County Soils

	Percent of Maximum Yield					
Soil Series	Alfalfa	Seed	Wheat	Barley	Filberts	Cherries
Abiqua	100	100	93	100	100	100
Amity	100	89	87	100	62	80
Bashaw	—	67	—	55	—	—
Camas	—	—	47	42	—	—
Chehalis	100	100	93	100	100	100
Cloquato	100	100	100	100	77	100
Concord	—	89	80	63	—	—
Dayton	—	67	47	63	—	—
Holcomb	—	78	80	74	—	—
Jory	75	89	73	63	100	100
McAlpin	100	89	80	100	92	100
McBee	100	100	87	100	92	100
Nekia	75	89	73	63	77	91
Newberg	83	67	67	74	92	91
Salem	83	89	67	100	77	91
Salkum	75	89	71	63	77	91
Waldo	—	89	67	63	—	—
Wapato	—	89	80	63	—	—
Willamette	100	100	93	100	100	100
Woodburn	100	89	93	100	100	100

set equal to 100. For dryland crops, the maximum value of 97 was set at 100, and all other ratings were scaled upward accordingly. For irrigated crops, the maximum weighted average value was already 100, so no scaling was necessary. These scaled numbers, shown in the right hand columns of tables 11 and 12, were the final calibration scores used to validate the productivity ratings calculated from soil properties expressed through soil names.

Actually, the calibration scores were used as targets at which ratings derived from taxonomic calculations were aimed. The whole process of developing the system involved repetition: numbers were initially assigned to soil property effects arbitrarily, then continuously adjusted until the final calculated ratings for all 23 calibration soils came out as close to the calibration scores as possible.

Comparisons between calculated ratings and calibration scores are shown in table 13. In this table, calculated dryland scores have been adjusted upward by a factor of 1.25. This is because the calibration scale has a maximum value of 100, whereas the calculated rating for dryland productivity has a maximum value of 80.

Virtually all soils in the Willamette Valley are Xeric, which means that on a single scale of 0 to 100, they all lose 20 points for summer moisture stress under dryland management. Thus the calculated dryland scale runs from 0 to 80 and needs to be adjusted upward for comparison with a dryland calibration scale that runs from 0 to 100.

Ideally, all calculated ratings would match perfectly with the corresponding calibration score. Few do, but all of them are within 10 points. Some of the discrepancy is surely caused by imperfections in the rating scheme. The complexity inherent in natural soil variations is just too great to completely account for in a simplified system such as this. Subtle effects and interactions between two or more factors are probably not adequately represented.

Another reason for discrepancy surely lies in the calibration numbers themselves. The data used were only estimates, and the data set was incomplete in many respects, particularly in regard to zero yields. Overall, the agreement is good, and the ratings system

Table 10. Yield Data for Irrigated Crops on Marion County Soils

	Percent of Maximum Yield			
Soil Series	Beans	Corn	Pasture	Strawberries
Abiqua	100	100	100	100
Amity	92	100	100	83
Bashaw	—	—	57	—
Camas	—	—	57	—
Chehalis	100	100	100	100
Cloquato	100	100	100	100
Concord	83	75	86	—
Dayton	—	63	71	—
Holcomb	83	75	86	—
Jory	83	75	86	83
McAlpin	92	100	100	83
McBee	100	100	100	83
Nekia	83	75	86	83
Newberg	92	100	86	83
Salem	100	100	100	100
Salkum	83	75	86	83
Waldo	83	75	86	—
Wapato	83	75	86	—
Willamette	100	100	100	100
Woodburn	92	100	100	83

Table 11. Average Yields and Final Calibration Scores for 23 Primary Calibration Soils—Dryland Crops

	Average Percent Yield (number of data sources)							Scaled
Soil Series	Alfalfa	Seed	Wheat	Barley	Filberts	Cherries	Weighted Average	Calib. Score
Abiqua	94(2)	100(3)	86(5)	77(4)	91(3)	93(2)	89	92
Amity	100(1)	89(2)	88(2)	97(4)	70(2)	80(1)	89	92
Bashaw	0	64(4)	35(1)	59(4)	0	0	44	45
Briedwell	50(3)	65(2)	65(6)	50(4)	55(1)	0	54	56
Camas	0	67(1)	26(5)	37(4)	55(1)	0	31	32
Chehalis	93(4)	100(3)	96(5)	100(3)	91(3)	92(3)	95	98
Cloquato	93(4)	100(3)	100(3)	100(3)	82(4)	100(3)	95	98
Coburg	79(2)	95(2)	81(4)	86(1)	78(3)	71(1)	82	85
Concord	0	73(3)	67(4)	66(4)	0	0	54	56
Cove	0	44(1)	0	28(3)	0	0	16	16
Dayton	0	81(5)	47(1)	52(5)	0	0	51	53
Holcomb	0	89(2)	69(4)	66(3)	0	0	54	56
Jory	75(2)	89(2)	78(5)	63(2)	72(4)	100(1)	77	79
McAlpin	100(1)	89(3)	69(5)	88(4)	88(3)	86(2)	83	86
McBee	88(5)	93(5)	78(3)	81(5)	88(3)	86(2)	86	89
Nekia	63(2)	67(2)	66(4)	54(3)	65(3)	83(2)	65	67
Newberg	80(4)	67(2)	72(3)	66(3)	89(4)	89(2)	78	80
Salem	83(1)	89(2)	63(4)	79(2)	79(2)	81(2)	76	78
Salkum	75(1)	89(1)	70(3)	82(2)	70(3)	83(2)	76	78
Waldo	0	93(3)	60(3)	60(4)	0	0	54	56
Wapato	0	88(4)	65(4)	65(5)	0	0	59	61
Willamette	100(4)	96(3)	91(5)	100(3)	100(4)	100(2)	97	100
Woodburn	98(5)	89(3)	99(7)	100(3)	91(3)	100(2)	97	100

Table 12. Average Yields and Final Calibration Scores for 23 Primary Calibration Soils—Irrigated Crops

Soil Series	Average Percent Yield (number of data sources) Beans	Corn	Pasture	Strawberries	Weighted Average	Scaled Calib. Score
Abiqua	89(4)	100(5)	97(5)	92(4)	95	95
Amity	97(6)	96(5)	92(6)	80(3)	93	93
Bashaw	0	0	61(5)	0	38	38
Briedwell	75(2)	78(2)	82(6)	79(2)	80	80
Camas	54(4)	51(4)	61(5)	49(2)	55	55
Chehalis	95(7)	100(6)	98(6)	93(6)	96	96
Cloquato	100(5)	100(5)	100(4)	100(4)	100	100
Coburg	93(4)	100(4)	92(2)	71(3)	90	90
Concord	92(2)	71(2)	88(2)	0	72	72
Cove	0	46(3)	57(4)	0	41	41
Dayton	64(1)	63(2)	68(7)	0	61	61
Holcomb	80(3)	77(4)	90(4)	0	76	76
Jory	86(3)	86(4)	86(5)	79(4)	84	84
McAlpin	70(5)	89(5)	85(5)	63(3)	78	78
McBee	94(7)	100(5)	92(7)	59(3)	90	90
Nekia	75(2)	77(2)	82(4)	77(4)	78	78
Newberg	91(5)	100(5)	91(4)	89(4)	93	93
Salem	97(4)	97(4)	96(4)	85(4)	94	94
Salkum	83(3)	77(2)	90(3)	83(3)	84	84
Waldo	83(1)	70(3)	83(5)	0	71	71
Wapato	80(3)	70(5)	78(7)	0	71	71
Willamette	100(6)	100(5)	100(4)	95(5)	99	99
Woodburn	92(7)	100(6)	98(7)	81(5)	93	93

Table 13. Comparison of Calculated Ratings witb Calibration Scores for 23 Soils Used in Calibration

Soil series	Dryland Calc.	Dryland Calib	Dryland Δ	Irrigated Calc.	Irrigated Calib.	Irrigated Δ
Abiqua	94	92	+2	95	95	0
Amity	91	92	-1	93	93	0
Bashaw	39	45	-6	40	38	+2
Briedwell	53	56	-3	88	80	+8
Camas	24	32	-8	58	55	+3
Chehalis	96	98	-2	97	96	+1
Cloquato	94	98	-4	97	100	-3
Coburg	91	85	+6	93	90	+3
Concord	61	56	+5	70	72	-2
Cove	23	16	+7	31	41	-10
Dayton	45	53	-8	63	61	+2
Holcomb	61	56	+5	70	76	-6
Jory	79	79	0	83	84	-1
McAlpin	83	86	-3	82	78	+4
McBee	86	89	-3	89	90	-1
Nekia	64	67	-3	77	78	-1
Newberg	80	80	0	97	93	+4
Salem	84	78	+6	93	94	-1
Salkum	70	78	-8	78	84	-6
Waldo	48	56	-8	69	71	-2
Wapato	55	61	-6	73	71	+2
Willamette	100	100	0	100	99	+1
Woodburn	98	100	-2	94	93	+1

does approximate the calibration scores quite well.

Statistical evidence corroborates the conclusion above. Figures 8 and 9 are graphs of the relationships between the calculated ratings and the calibration scores for dryland and irrigated productivities, respectively. If all ratings matched the calibration scores perfectly, the equation of the line would be $Y = X$ and the correlation would be 1.00.

Regression shows that the slope is indeed very close to 1.0, the intercept is close to zero, and the correlation is very close to 1.00. The regression can also be expressed as an analysis of variance, and the results used in a joint statistical test[1] of the hypothesis that the slope equals 1.0 and the intercept equals 0 (Tables 14 and 15).

Because of uncertainties in the calibration scores themselves, the significance level is set at .99 so the hypothesis will not be rejected unless the probability is very high that it is not true. The F-values given in tables 14 and 15 fall well below the critical level, demonstrating the validity of the productivity ratings calculating procedure.

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[1]Ostle, B., *Statistics in Research* (Ames: The Iowa State University Press, 1963), page 175.

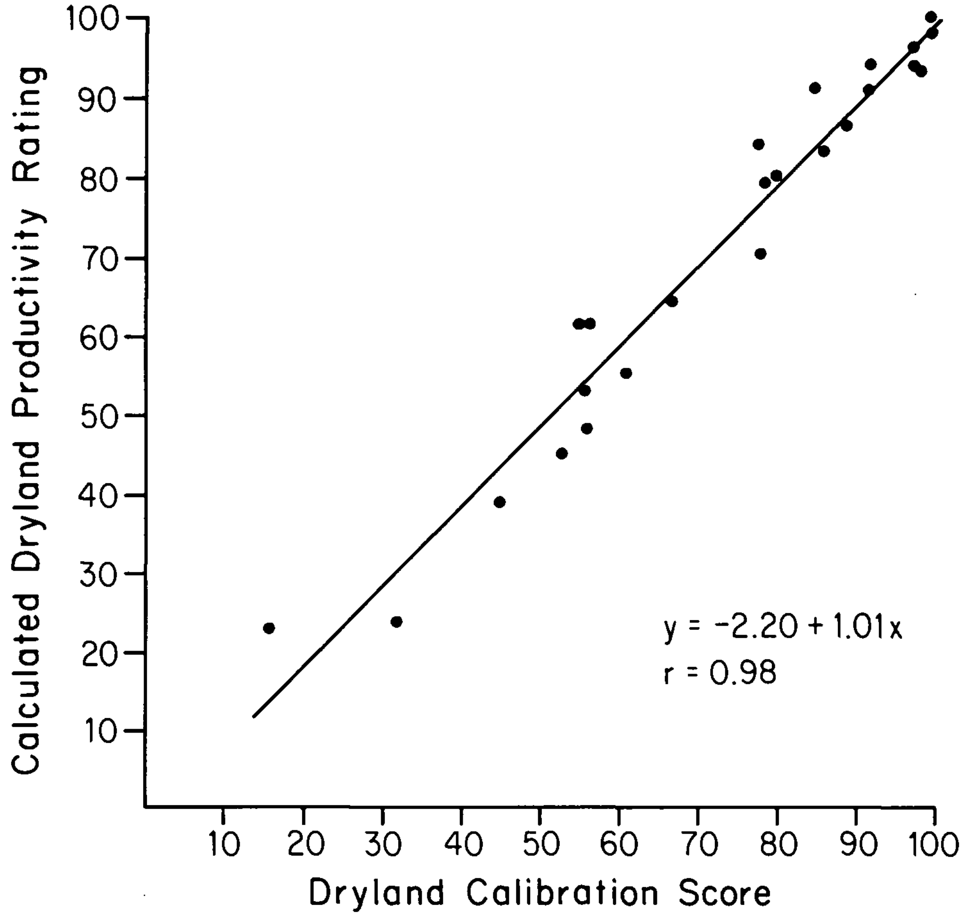

Figure 8: *Relationship between calculated ratings and calibration scores for dryland productivity.*

Table 14. Analysis of Variance of the Relationship Between Calculated Ratings and Calibration Scores for Dryland Productivity

Regression equation: $y = -2.20 + 1.01x$ $r = 0.98$

Source	d.f.	Sum of squares	Mean square
Mean (b_0)	1	113,963.52	
Regression (b_1)	1	11,786.90	
Residual	21	512.58	24.41
Total	23	126,263.00	

Calculated $F[H_0:\beta_0 = 0 \text{ and } \beta_1 = 1] = 1.05$

Tabulated $F_{.99,2,21} = 5.79$

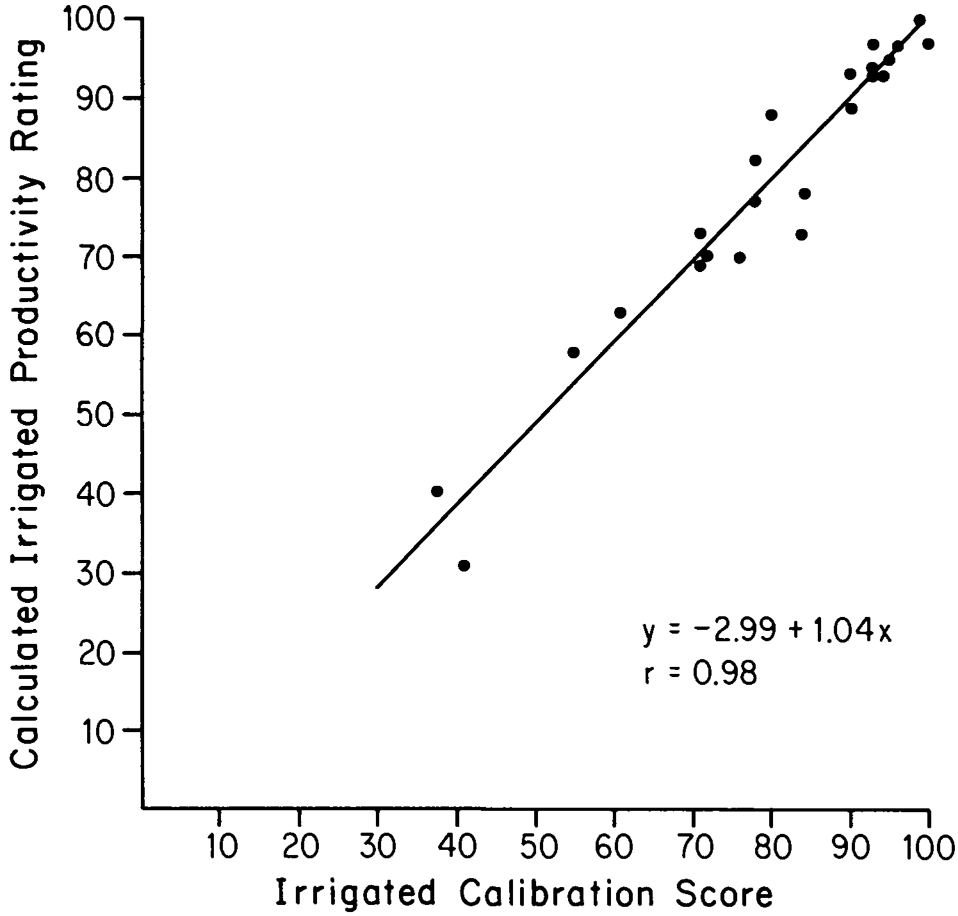

Figure 9: *Relationship between calculated ratings and calibration scores for irrigated productivity.*

Table 15. Analysis of Variance of the Relationship Between Calculated Ratings and Calibration Scores for Irrigated Productivity

Regression equation: $y = -2.99 + 1.04x$ $r = 0.98$

Source	d.f.	Sum of squares	Mean square
Mean (b_0)	1	145,604.35	
Regression (b_1)	1	7,192.74	
Residual	21	312.91	14.90
Total	23	153,110.00	

Calculated F [$H_0:\beta_0 = 0$ and $\beta_1 = 1$] = 0.39

Tabulated $F_{.99,2,21} = 5.79$

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