Agronomic Zones for the Dryland Pacific Northwest

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Extensive areas of eastern Oregon, eastern Washington, and Idaho are well suited to dryland production of small grains and legumes. Commonly, over this area, winter wheat is planted in rotation with either annual legumes or summer fallow.

Although farmland in this region is highly productive, growers frequently face production uncertainties and economic difficulties because of unpredictable fluctuations in seasonal weather conditions and infestations of weeds, diseases, and insects.

Over time, farming systems in this region have evolved to minimize the uncertainties in production. Unfortunately, those farming systems that tend to minimize uncertainties in production often result in excessive soil erosion. Growers and others in this region have recognized this difficulty and have continually sought to improve production practices and erosion control.

An important occurrence in this continuing effort was establishment of the STEEP (Solutions to Environment and Economic Problems) Program. It was launched in 1975 because of efforts of the wheat growers organizations in the three States, university faculty members, and personnel of the USDA-ARS.

STEEP is a tristate program involving Idaho, Washington, and Oregon. It is an interdisciplinary research program, designed to address the production and erosion problems of the region. A principal objective has been to develop and advance new conservation farming technologies within the region.

Research efforts have generated much-needed information and increased the type and number of cultural practices available to growers. However, transfer and integration of new technologies into current production systems have been slow.

Important factors that discourage adoption of new technologies are complexity of soils, weather conditions, and relief and topography over the region. Dryland farming practices that are successful at one locality often are not suitable at another location because of one or more of these factors.

Integration of new technologies into current farming systems requires producers to evaluate and test new techniques and practices under their own conditions. If growers are unfamiliar with conditions at research sites or if they know their conditions are different, they'll be reluctant to try new technologies.

In addition, researchers and Extension agents are often restricted in making recommendations because they don't know the real extent to which new technologies apply.

To improve this situation, we propose the following system of "agronomic zones." This system will allow scientists, agricultural professionals, and producers to more effectively communicate results of scientific investigations and to promote the transfer and adoption of new farming technologies.

We defined agronomic zones to allow delineation of areas that are agronomically similar for dryland production. Agronomic zones can be used as a reference for comparing, interpreting, and extrapolating research results; and they serve as a basis for implementating new technologies and improving management practices.

This publication has three parts:

- The criteria that define our six zones (page 3).
- Descriptions of the zones (page 6).
- Suggestions for using the zones (page 8).

The map on pages 4-5 shows the zones' distribution.

Defining criteria

Agronomic zones for the Pacific Northwest are defined from a combination of three criteria: annual precipitation, soil depth, and growing degree days.

Average annual precipitation and growing degree days are based on 30-year National Weather Service records. Information on soil depth was obtained through published soil surveys, Soil Conservation Service scientists, and our personal observations and knowledge.

Precipitation

This is the single most limiting factor to dryland crop production in the Pacific Northwest. Four classes of average annual precipitation are used to define agronomic zones:

1. **Moist**, over 16 inches (400 mm): This amount of annual precipitation is generally sufficient to recharge a 5-foot soil profile and support annual cropping.
2. **Moderately dry**, 14 to 16 inches (350 to 400 mm): Annual crop production in areas receiving precipitation in this range is marginal. In wetter years, annual cropping can be practiced; in drier years, it's better to summer-fallow.
3. **Dry**, 10 to 14 inches (250 to 350 mm): Crop production in areas receiving this range of annual precipitation is strongly influenced

(Text continues on page 6.)

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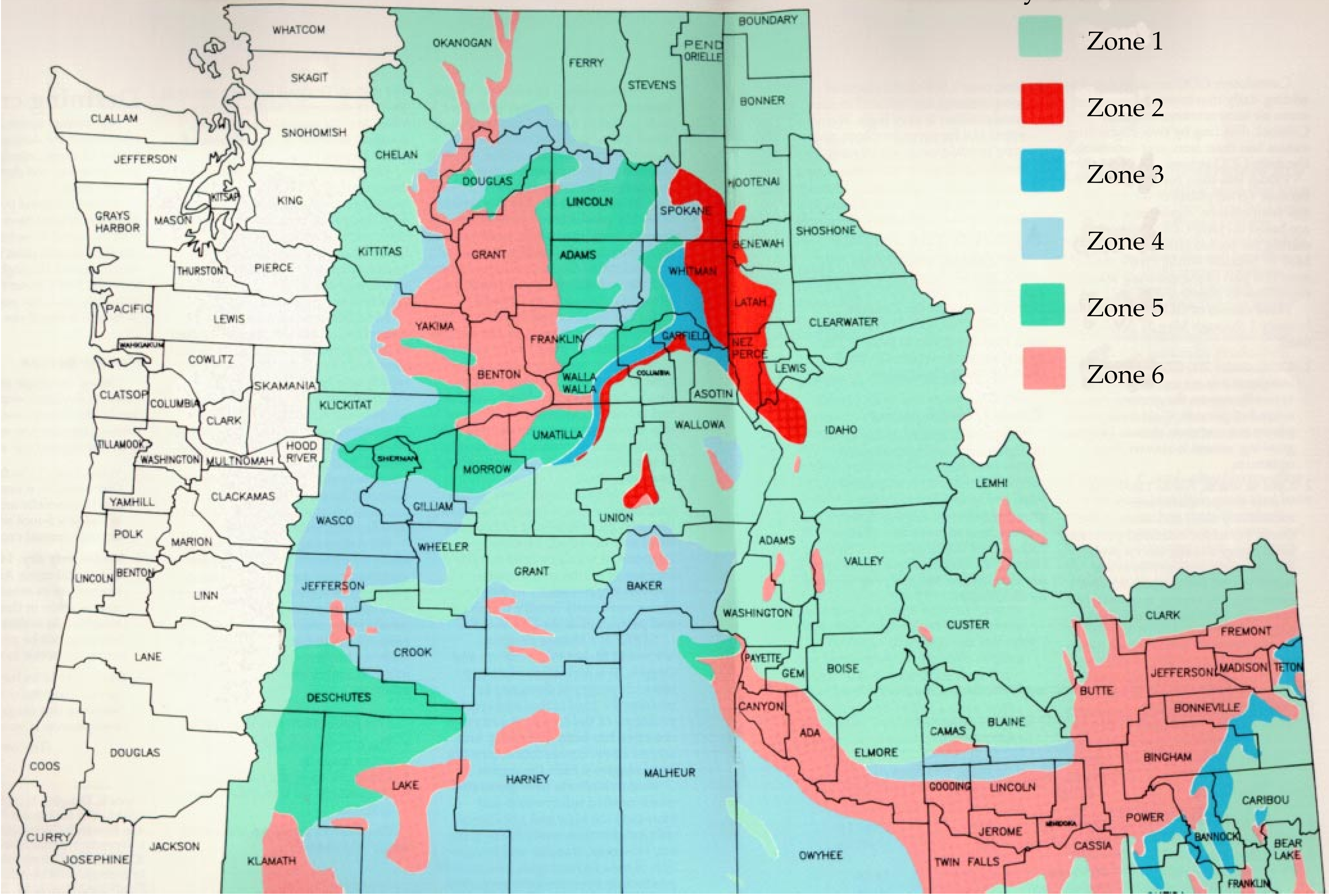

by soil depth. Deep soils with high water storage capacity can be summer-fallowed to maximize production and water use efficiency. Shallow soils or those with limited water-storage capacity recharge each year, and water use efficiency won't be improved by summer fallowing.

4. **Very dry**, under 10 inches (250 mm): This is the approximate limit of crop production without irrigation.

Soil depth

Dryland agricultural soils in the inland Pacific Northwest usually range in texture from silty clay loam to silt loam to fine sandy loam. These textures store approximately 1.6 to 2.0 inches of water per foot of soil.

Because of this narrow range, the potential water storage capacity of most soils is a function of depth to bedrock or root-restricting layer. Soil depth, along with crop season precipitation, is a reasonable indicator of plant-available water.

Two depth classes are used to define agronomic zones:

1. **Deep**, over 40 inches (100 cm) to bedrock or root restricting layer: Generally, annual precipitation must exceed 16 inches for soil profiles of this depth to fully recharge each year.
2. **Shallow**, under 40 inches (100 cm) to bedrock or root restricting layer: Generally, soils profiles of this depth recharge each year, even when annual precipitation is as low as 10 inches.

Growing degree days (GDD)

Growing degree days are a measure of heat available for plant growth. They're similar in concept to length of growing season, but they're more precise and can be used to predict rate of crop development.

Cumulative GDD are calculated by adding daily maximum and minimum air temperatures (degrees Celsius), dividing by two, discarding values less than zero, and summing the daily GDD values.

Values less than zero are discarded because cereal plants cease growth at this temperature. Agronomic zones are based on total GDD acquired during the period January 1 through May 31 because winter crops experience this part of the growing season, regardless of planting date.

Three classes of GDD, based on the January 1 through May 31 period, are used:

1. **Cold,** under 700 GDD: Winter temperatures are cold, and snow typically covers the ground for extended periods. Cold injury to plants is a common threat, and the growing season is shorter than optimum.
2. **Cool to warm**, 700 to 1,000 GDD: Winter temperatures aren't excessively cold, and snow cover doesn't exist for extended periods. Cold injury usually isn't a problem. Summer temperatures are warm to hot, but evaporation isn't excessive. This range is considered optimum for winter cereal production.
3. **Hot**, over 1,000 GDD: Summer temperatures are hot, and evapotranspiration is very high. Water stress is a frequent problem, and crop production is usually not feasible without irrigation.

Agronomic zones

Using annual precipitation, soil depth, and GDD, we have defined six agronomic zones for the Pacific Northwest east of the Cascade Mountains. The specific criteria for each zone are given in table 1. The following sections provide brief descriptions of these zones.

Zone 1, Cold-moist

This zone identifies those areas that generally receive sufficient winter precipitation to fill deep soil profiles (greater than 40 inches) each year, but have relatively short growing seasons. Although this is the most extensive zone, mountains, forests, and wilderness cover most of this region. Soils in these landscapes are too shallow, too steep, or too cold for cultivation.

Table 1.—Criteria that define agronomic zones for the Pacific Northwest east of the Cascade Mountains

		Criteria		
Zone	Description	Growing degree days (GDD)	Soil depth (in.)	Annual precipitation (in.)
1	Cold-moist	Under 700	All	Over 16
2	Cool-moist	700-1,000	All	Over 16
3	Cool-deep-moderately dry	700-1,000	Over 40	14-16
4	Cool-shallow-dry	Under 1,000	Under 40	10-16
5	Cool-deep-dry	Under 1,000	Over 40	10-14
6	Hot-very dry	Over 1,000	All	Under 10

Cultivated soils occupy only 10 to 15% of this landscape and occur in intermountain valleys or mountain foothills. Generally, cultivated land in this zone is above 3,200-feet elevation, and much of the precipitation falls as snow.

Cultivated areas often have snow cover for extended periods. Winter cereals frequently suffer damage from cold temperatures. Precipitation is sufficient to support annual cropping.

Zone 2, Cool-moist

Zone 2 identifies those areas that generally receive sufficient winter precipitation to fill deep (more than 40 inches) soil profiles each year and have a near-optimum growing season for winter crops. Landscapes in this zone are lower in elevation than those in zone 1, and 80 to 90% of land is under cultivation.

Winter temperatures aren't severely cold, and snow cover doesn't exist for extended periods. Usually, damage from cold isn't a problem. Summer heat isn't excessive, and evaporation is moderate.

The major landscapes in this zone are moderately to strongly sloping (10 to 40% slopes) with deep soil profiles. Minor areas include shallow soils or gently sloping areas with deep soils. Precipitation is adequate to support annual cropping in most years.

This zone represents some of the most productive land in the region.

Zone 3, Cool-deep-moderately dry

This zone identifies areas that have deep soils (more than 40 inches) and near-optimum growing seasons, where there's enough winter precipitation to recharge the soil profile in most years. With proper rotations and management techniques, annual cropping can be practiced in most years.

Summer fallowing in drier years is necessary to maximize production and water use efficiency. About 90% of this zone is cropland. Most landscapes in this zone are gently to strongly sloping (10 to 40%) with deep loess soils over basalt bedrock.

Zone 4, Cool-shallow-dry

This zone identifies areas that have shallow soils (less than 40 inches), near-optimum growing seasons, and low annual precipitation. Although the annual precipitation is low, the shallow soils fill with water each winter.

Summer fallowing has little advantage from the standpoint of water conservation or water use. Annual cropping provides the most efficient use of these soils.

A typical landscape for this zone consists of gently to steeply sloping (4 to 30%) loess soils over basalt or root-restricting layer at shallow depths. About 50% of this zone is cultivated.

Zone 5, Cool-deep-dry

Zone 5 identifies areas that have deep soils (more than 40 inches) and near-optimum growing seasons, but receive insufficient precipitation during the winter period to fill the soil profile. Because of these conditions, it's practical to increase production and water use efficiency by summer fallowing.

Typically, landscapes in this zone consist of gently to moderately sloping, deep, loess soils over basalt bedrock. About 90% of this zone is cultivated. Soils in this zone are low in organic matter, medium-textured, and susceptible to wind erosion. Landscapes are gently sloping to moderately steep.

Zone 6, Hot-very dry

This zone identifies areas that typically receive very low annual precipitation and have hot summers with high evaporative demands. These areas are unsuited for crop production unless irrigated.

Included in this zone are small areas that, without irrigation, would fall in zones 1 through 5. About 50% of this zone is cropland.

Soils in this zone are quite variable, with some tending to be coarse-textured or gravelly, which accentuates droughtiness.

Using agronomic zones

The map on pages 4-5 shows the distribution of agronomic zones. Each zone represents an area that's relatively uniform in agronomic characteristics for dryland production, and each provides a geographical base for applying or extrapolating research results or management recommendations.

Research conducted somewhere within a zone may be applied throughout that zone. Likewise, management practices that are valid for one location within a zone may be applied throughout that zone.

You must use the map cautiously—complex soil patterns can't be shown at this scale. For instance, a farm may include more than one agronomic zone, but only a large-scale map (too cumbersome for this publication) could accurately show this detail.

The importance of recognizing agronomic zones, however, isn't diminished. Although it's not possible to show every detail on a map, growers and others can identify the agronomic zone or zones that best fit their individual farms or fields.

Once agronomic zones for a field or farm are recognized, producers have a basis for applying research information and management recommendations.

The map on pages 4-5 was prepared by the Cartographic Service of Oregon State University.

Pacific Northwest cooperative Extension bulletins are joint publications of the three Pacific Northwest states—Oregon, Washington, and Idaho. Similar crops, climate, and topography create a natural geographic unit that crosses state lines. Since 1949 the PNW program has published more than 300 titles. Joint writing, editing, and production has prevented duplication of effort, broadened the availability of faculty specialists, and substantially reduced costs for the participating states.

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