AN ABSTRACT OF THE THESIS OF

Kelli Marie Camara for the degree of Master of Science in Soil Science presented on December 7, 1999. Title: Long-Term Effects of Tillage, Nitrogen, and Rainfall on Winter Wheat Yields.

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Abstract approved: William A. Payne

Winter wheat is commonly grown in dryland cropping systems in the Pacific Northwest region of semi-arid eastern Oregon. For agronomic, economic, and environmental reasons, it is important to understand the long-term sustainability of such dryland systems.

The objective of this study was to evaluate the long-term effects of tillage, nitrogen (N), soil depth, and the influence of precipitation on wheat yields in dryland cropping systems of eastern Oregon. Data were taken from the Tillage/Fertility or "Balenger" experiment, which was established in 1940 by a Soil Conservation employee, and is one of the oldest replicated research experiments in the western United States. The experiment consisted of a winter wheat-summer fallow rotation arranged in a randomized block design with three replications. The main plot consisted of three primary tillage treatments (moldboard plow, offset disk, and subsurface sweep) and subplots consisted of six nitrogen treatments that changed over time and most recently ranged from 0 to 180 kg ha $^{-1}$. Soil depth of individual plots ranged from 1.2- to 3.0-m. The study was divided into four main time periods (1940-1951, 1952-1961, 1962-1987, and 1988-1997) within which experimental treatments were consistently maintained.

The moldboard plow tillage treatment significantly increased yields by more than 300 kg ha^{-1} over the subsurface sweep tillage treatment in all four time periods. Yields with the moldboard plow system were significantly higher than with the offset disk system in time periods 3 and 4. The same trend was evident for mean yield in time periods 1 and 2, but differences were not statistically significant. In time periods 1, 2, and 3, mean yields were higher with the offset disk tillage treatment than the subsurface sweep tillage system, although the differences were not statistically significant. In time period 4, mean yield was higher for the subsurface sweep system than the offset disk treatment, but differences were not statistically significantly.

The optimum amount of N for winter wheat differed from year to year, within, and between experiment periods. This was apparently in response to rainfall patterns and improved management factors, specifically more N responsive semi-dwarf varieties. For time period 1, the maximum fertilizer rate was 11.2 kg N ha^{-1}, which tended to produce higher mean grain yields than an application rate of than 0 kg N ha^{-1}, regardless of the quantity or distribution of precipitation. For time period 2, the maximum fertilizer rate was 33.7 kg N ha^{-1}, which produced significantly higher grain yields than an application rate of than 0 kg N ha^{-1}, regardless of the quantity or distribution of precipitation. For time period 3 (1962-1987), which had below-normal annual and growing season precipitation, yield increased with the addition of 45 kg N ha^{-1}. For time period 4 (1988-1997), which had above-normal annual and growing season precipitation, yield increased with the addition of 90 kg N ha^{-1}. Yield increases at greater rates of N were insignificant. For time periods 3 and 4, maximum mean yield was obtained at an application rate of 135 kg N ha^{-1}. The response of wheat yield to N during dry years was greater for deep

(> 2.8 m) soils than for shallow soils. In addition to amount, rainfall distribution during the winter (October to March) and growing (April to June) season significantly affected yield.

Results demonstrate the importance of rainfall and nitrogen to winter wheat production in eastern Oregon, and that the most environmentally sound tillage systems are not necessarily the most profitable from farmers' point of view.

Long-Term Effects of Tillage, Nitrogen, and Rainfall
on Winter Wheat Yields

by

Kelli Marie Camara

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

Presented December 7, 1999
Commencement June 2000

Master of Science thesis of Kelli Marie Camara presented on December 7, 1999.

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Kelli Marie Camara, Author

ACKNOWLEDGMENT

I would like to express my sincere gratitude to Bill Payne for his guidance, encouragement, support, and friendship throughout my graduate studies at Oregon State University. I am extremely grateful for the opportunity he provided to further my education and am honored to have had such a distinguished scientist believe in me.

I am very grateful to the faculty members who served on my committee; Richard Dick, Jon Kimerling, and Fred Obermiller and appreciate all of their time and advice.

I would like to thank Paul Rasmussen, who "dug the data out of the attic" and whose previous efforts on the Balenger Experiment proved invaluable.

I would like to thank everyone at the Columbia Basin Agricultural Research Center for their friendliness, encouragement, and willingness to always help.

I appreciate the guidance and support of everyone in the Soil Science Department, faculty and fellow graduate students, and will always look fondly back at my studies at OSU.

Thank you to my "weeds" friends who accepted me into their circle-even if I do like soil! I'll always remember "approximately 120 ways to use potatoes"!

I want to thank my family for all of their love and support. Grandma Jo, who "loaned" me her house. Grandma and Grandpa, for their letters and phone calls which always kept me close to home. My mother, who has already supported my dreams and is my role model and best friend.

A special thanks to Nick Lasher, whose humor and love got me through the Oregon winters and support and encouragement, helped me dodge the avalanches. Thank you for always being there.

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Dedicated to my mother

who never told me I had limits

Long-Term Effects of Tillage, Nitrogen, and Rainfall on Winter Wheat Yields

INTRODUCTION

Despite years of research and development, tillage and cropping practices designed to conserve soil and water in the Pacific Northwest (PNW) have not achieved the goals of efficient water use and soil protection (Papendick and Miller, 1977). The inland PNW has some of the highest erosion rates in the USA (Young et al., 1994). There has been little economic incentive for farmers to use herbicides instead of tillage for weed control because tillage has been less expensive and more reliable. Farmers have been wary of accepting residue systems primarily due to management difficulties, including increased weed control problems (Bolton, 1983), inadequate tillage and planting equipment for operation in surface residues (Logan et al., 1987), and lower crop yields (Cosper, 1983). However, the successful development of equipment, chemicals, and management in the United States during the last 10 years has greatly increased the probability of achieving crop yields comparable to those obtained with conventional clean-tillage methods (Logan et al., 1987). Before reduced tillage systems will be accepted, however, specific problems such as reduced stands and plant vigor must be addressed (Cochran et al., 1977).

Concern over immediate farm profitability, long-term sustainability, and recent research indicating that cropland runoff is responsible for water pollution, has renewed interest in developing surface residue management systems to control soil erosion

(Cochran et al., 1977). From the standpoint of environmental quality, conservation of energy, and economics, it is important to maximize crop utilization of applied fertilizer N, while reducing stream and groundwater contamination (Olson and Swallow, 1984). Although dryland winter wheat has become increasingly responsive to N fertilization over the last 50 years, recommending optimum N rates is not an exact science (Rasmussen, 1981). To increase N uptake by the crop and minimize water pollution, records of past yield history, including information on wheat variety, seeding date, soil depth, available soil moisture, and disease and weed control practices are needed (Rasmussen, 1981).

Long-term studies provide such information. They are perhaps the only way to determine whether new agricultural practices will sustain or degrade the productive capability of the soil. They provide insight into historical trends in crop production, yield stability, and climatic and edaphic changes, as well as the effects of technological advancements in farming practices. Long-term experiments provide valuable information on the sustainability of agricultural systems and their effect on the environment.

The Columbia Basin Agricultural Research Center, near Pendleton, Oregon, was established in 1928 to develop farming systems east of the Cascade Mountains that would reduce soil erosion, sustain fertility of the land, and increase profit (Rasmussen et al., 1989a). In 1931, long-term studies on crop rotation, tillage, varietal improvement, and potential new crops were initiated. As tillage, crop residue management and fertility are major components of sustainable agricultural systems, long-term work in relation to these factors was needed to determine their effects on the sustainability and profitability of wheat-based farming systems of eastern Oregon. This study summarizes the results of one of the longest running experiments conducted at the Columbia Basin Agricultural Research Center. The experiment, which began in 1940, was initiated primarily to evaluate the effects of tillage and nitrogen application on the productivity of a winter wheat-summer fallow rotation system.

LITERATURE REVIEW

Wheat is the world's single most important food crop in terms of tons of grain produced each year. Since the population of the world continues to grow faster than the ability to feed it, maintenance of yield growth rate is considered critical for securing future global food supplies (Gooding and Davies, 1997). During the 20th century, wheat production has increased substantially, from 90 to 600 million tons. From 1903 to 1954, the increase in production, from 90 to 190 million tons, could be explained almost entirely by an increase in harvested area (Reynolds et al., 1996). Since then, however, most of the substantial increases in global food production have come from farming favorable areas more intensively (Reynolds et al., 1996). Oregon wheat yields have dramatically increased from approximately 1800 kg ha^{-1} in 1955 to 4800 kg ha^{-1} in 1997, while the area of production, although fluctuating due to grain price, has declined (USDA, 1999).

As the quantity of arable land continues to diminish, any increases in global wheat production will depend upon i) increased adoption of higher yielding, earlier maturing, modern varieties (Gooding and Davies, 1997); ii) increased dependence on chemical fertilizers (Borlaug and Dowsell, 1993); and iii) the introduction of new and more productive crop rotations (Gooding and Davies, 1997). This is especially true for the major regions of dryland wheat production located in semi-arid regions of the world, where soil moisture is the limiting factor to yield growth.

Dryland farming is practiced on approximately 40% of the world's land surface (Brady, 1988). Under dryland conditions, potential evapotranspiration exceeds precipitation, and precipitation is insufficient or so variable that soil water limits crop production. In dryland systems, the success of cereal crops, such as wheat, is uncertain. This is the case in the inland Pacific Northwest (PNW), which receives less than 380-mm of rainfall annually, and where approximately 70% of the precipitation occurs during the fall and winter (Schillinger, 1992). The PNW is well-adapted to winter annuals (Rasmussen et al., 1989a). It was largely because of seasonal temperatures and precipitation distribution that a winter wheat-summer fallow cropping system was adopted a little more than a century ago. The winter wheat-summer fallow rotation system is still widely practiced by growers today.

The winter wheat-summer fallow cropping system consists of a 14-month fallow cycle, which begins after harvest in July or August, and a 10-month crop cycle, which begins at planting in September or October. During the summer fallow phase of the crop rotation, no crop is grown and any weeds are controlled by cultivation or chemicals (Oram, 1980).

The advantages of summer fallow include storing moisture for the following crop (Schillinger, 1992; Rasmussen et al., 1989a; Smika, 1970), increased availability of nitrogen (Rasmussen et al., 1989a; Cantero-Martinez et al., 1995), and decreased weed and disease incidence (Rasmussen et al., 1989a). Summer fallow has become an accepted means for stabilizing yields and conserving natural resources in dryland wheat production (Good and Smika, 1978). During the winter wheat phase of the winter wheat-summer fallow rotation, winter wheat is planted in the fall and harvested the following summer. Two crucial management aspects that a grower must consider are tillage system and amount of nitrogen. The environmental factors which affect these management decisions include soil properties, specifically depth and nitrate availability, and the amount and distribution of rainfall. These two management aspects are now considered in more detail.

Tillage

In the PNW, winter wheat is traditionally planted during the fall into fallowed ground that has been heavily worked. To prepare the fallow, wheat stubble is usually moldboard plowed in the spring, inverting and pulverizing the upper soil profile and burying surface residues. Such methods of conventional tillage have been traditionally regarded as a necessary agricultural practice for preparation of a suitable seedbed, control of weed growth, encouragement of water and air movement and root growth, and incorporation of plant residue and fertilizer (Cosper, 1983).

However, soil erosion is often excessive with conventional tillage and the wheat-fallow cropping system. Papendick and Miller (1977) have reported an annual soil loss of 22 Mg ha $^{-1}$ under conventional tillage systems, which is unacceptable for adequate soil conservation and sustaining crop yields.

Attempts to control wind erosion caused by multiple tillage passes with the moldboard plow and disk led to the development of sweep and chisel "stubble mulch" plows. Rather than burying residues, these implements leave crop residues on the soil surface (Wiese and Allen, 1998), which is the most effective management practice for protecting soil from erosion during fallow. Adequate surface debris increases surface roughness and water infiltration (Good and Smika, 1978; Unger and McCalla, 1980;

Allmaras et al., 1985; Schillinger, 1992; Tucker et al., 1971). Based on research by Chepil and Woodruff (1954) at the USDA Wind Erosion Laboratory in Manhattan, Kansas, Fenster (1960) concluded that 1.0, 1.5, and 2.5 Mg ha^{-1} of residue could prevent wind erosion on fine, medium, and sandy soils, respectively. Zingg and Whitfield (1957), as cited by Harris (1963), reported that surface residues could reduce direct wind force at the soil surface by up to 99%, depending on the amount, size, and orientation of the residue. Young et al. (1994) have estimated that conservation tillage could reduce soil erosion by 35% in much of the inland Pacific Northwest.

Conservation tillage has been considered as an effective method of conserving soil water (Rao and Dao, 1996; Papendick and Miller, 1977). In the semi-arid PNW, where only 20 to 25% of the annual precipitation falls during the growing season, precipitation may be inadequate to meet the needs of a growing crop. Soil water is usually depleted before grain maturity (Legget, 1959; Papendick and Miller, 1977), and drought contributes to approximately 70% of wheat crop failures in eastern Oregon (Ramig and Ekin, 1991). Thus, tillage operations that maximize water retention during the fallow season may serve to provide essential soil water at the time of seeding (Oram, 1980).

Conservation techniques that encourage soil and water conservation have been available to farmers for years, but widespread adoption of these techniques has not occurred (Cosper, 1983). Although researchers agree that maintaining adequate surface residue is a valuable tool for controlling soil erosion, the effects of wheat stubble on germination, moisture storage, weed populations, N immobilization and mineralization, and grain yields, remain controversial.

Germination

Damage to wheat seedlings from the release of toxic compounds from surface residue is well-documented (Cochran et al., 1977; McCalla and Army, 1961; Papendick and Miller, 1977; Kimber, 1973). Part of the yield reduction from the sowing of winter wheat directly into large amounts of cereal residue in areas with winter rainfall has been attributed to the microbial production of acetic and butyric acids during the decomposition of surface straw (Cochran et al., 1977). The presence of mulch may stimulate the growth of microflora and fauna (de Boer et al., 1991; Kirkegaard et al, 1994) that may be pathogenic to the crop or compete for nutrients (Heenan and Chan, 1992). High residue may also reduce seed-soil contact, decreasing the amount of available water to the seed for germination and to the seedling for emergence (Chastain and Ward, 1992).

Kimber (1973) determined that close proximity of fresh wheat straw residues to sown wheat seed had a negative effect on germination, plant growth, and ultimately yield. In greenhouse studies, wheat germination was depressed under 7.5-cm of straw, which had decomposed on the soil surface for 0 to 18 days.

In Pendleton, Oregon, Chastain and Ward (1992) found that the emergence of wheat seedlings was more rapid in moderate residue plots (39%) than in high residue plots (49%). The presence of high residue levels in the seedbed resulted in poor water uptake by wheat seeds and reduced yields. In a long-term tillage trial at Moro, Oregon, Schillinger and Bolton (1993b) found that greater quantities of surface residue in the stubble-mulch treatment contributed to reduced germination and stand establishment because of poor seed-soil contact and less uniform seedbed conditions compared to plow tillage.

However, sowing winter wheat deeply into the prepared seedbed may lessen the toxic effects from the decomposing wheat straw under conservation tillage. The optimum sowing depth of wheat is a compromise and commonly ranges from 2.5- to 10-cm, depending on the nature of the soil, the climate, and the crop to be grown (Bear, 1953). At greater depths, surface frosts are less likely to damage the seedling roots, and the seed may experience less fluctuation in temperature. More importantly, in areas with low precipitation, the seed has a greater chance of remaining in contact with soil moisture at greater depths (Gooding and Davies, 1997). For the semi-arid regions of eastern Oregon, Rasmussen et al. (1989a) reported that deep plowing (228-mm) yielded approximately 5% more than shallow plowing (127-mm) at the Moro and Pendleton Experiments Stations from 1934 to 1955.

Moisture Storage

As insufficient seed zone water is a major limitation in the establishment of fall-sown wheat in the semi-arid PNW, small increases in seed zone water may result in increased yields (Schillinger and Bolton, 1992). Papendick and Miller (1977) report that wheat yields may be increased 20% with an additional 2-cm of water in a 25-cm precipitation zone. Depth of tilling may become less of an issue with the use of conservation tillage. Stubble-mulch systems which use a sweep or blade to cut below the soil surface, incorporate only 10 to 15% of tillage residue (Unger, 1994). The surface debris may minimize surface runoff and increase the amount of trapped snow and soil moisture (Blevins et al., 1971).

According to Greb et al. (1979), as the number of tillage operations was decreased in the central Great Plains, marked increases in water storage during the fallow periods and dramatic increases in yield were observed. The positive effects tended to accumulate because higher yields resulted in larger quantities of surface residue, which in turn resulted in greater water storage.

In a study conducted at Lind, Washington, Papendick and Miller (1977) reported that surface residues increased the over-winter water storage by decreasing evaporation. With 5000 kg ha^{-1} of straw, the surface was 50 to 60% shaded, resulting in a 2.9-cm increase in stored water and a 66% fallow efficiency. The surface was completely shaded with 11,000 kg ha^{-1} of straw, resulting in a 5.4-cm increase in water storage and an 81% fallow efficiency.

In a 4-year study conducted on two soils in northwest Victoria, Australia, O'Leary and Connor (1997) reported an increase in water supply, as well as improved water use efficiency, at both sites with the addition of surface residue. At the Dooen site, an average 0.6 Mg ha^{-1} increase in yield was observed in three of the four years. At the Walpeup site, a 0.5 Mg ha^{-1} increase in yield due to surface residue was significant in one of the four years. The response of wheat to the conservation tillage system was strongly affected by water availability, which tended to be higher under surface residue.

In an 8-year wheat-fallow rotation, Black and Siddoway (1979) found that increasing straw residue from 0 to 6730 kg ha^{-1} increased soil water availability from 14.5 to 18.0-cm in the Great Plains.

For three soils in southern Manitoba, Gauer et al. (1982) found that the soil moisture content was generally twice as much under conservation tillage systems than with conventional tillage. Lower soil temperatures were recorded when straw mulch was left on the surface than when it was incorporated with conventional tillage, confirming the findings of Van Wijk et al. (1959). However, when the straw was removed by raking, soil temperatures were often higher with conservation tillage than under conventional tillage because of reduced heat flow. Based on a study by Nakshabandi et al. (1965), Gauer indicated that the improved heat flow for the non-residue stubble-mulch plots may have been due to greater surface compaction. The Osborne clay loam had a bulk density of 1.07 g cm^{-3} under conservation tillage compared to a bulk density of 0.97 g cm^{-3} under conventional tillage system.

In a 4-yr study on tillage-crop rotation field plots near Moscow, Idaho, Hammel (1995) attributed reduced yields of stubble-mulch plots to a higher bulk density. After 10 years, winter wheat yields produced under conservation tillage management were 92% of the yield under a conventional tillage system.

Contrary to these findings, in a 14-year study, Krall et al. (1958), as cited by Weise and Allen (1988), reported that neither soil water storage nor subsequent yield of either winter or spring wheat at three locations in Montana was affected by the tillage system. Similarly, Ramig and Ekin (1991) found no differences in fallow efficiency between plow and stubble-mulch systems in a six-year study conducted at two locations in eastern Oregon. Massee and McKay (1979), as cited in Schillinger and Bolton (1992), reported that while stubble-mulching initially resulted in cooler soil temperatures and a lower initial water evaporation rate, the mulched soils, after sufficient drying time, dried to nearly the same water content as clean fallow.

Weed Populations

As winter wheat growers in the PNW have changed tillage practices to meet conservation compliance regulations for decreased erosion, increased levels of downy brome (*Bromus tectorum*) have been observed (Ball et al., 1994). Intensive tillage systems completely invert the soil and bury weed seeds to depths from which they cannot successively establish (Gooding and Davies, 1997). Conservation tillage systems, on the other hand, do not invert the soil or bury weed seeds as deeply. Furthermore, residue from conservation systems creates wetter soil conditions and cooler soil temperatures that can delay crop growth and thereby increase weed competitiveness (Black and Siddoway, 1979). Weeds, such as downy brome and volunteer wheat, can use up to 7.6-cm of stored water during fallow (Good and Smika, 1978), reducing the amount available to the subsequent wheat crop.

At the Central Great Plains Research Station near Akron, Colorado, Good and Smika (1978) reported that water conservation could increase wheat yield by an average of 13.2 kg ha^{-1} mm^{-1} of stored available. However, poor weed control under conservation tillage prevented the retention of this additional water for use by the crop in the following year.

In the northern Great Plains, Bond et al. (1971) found that a stubble-mulch tillage system resulted in lower spring wheat yields when compared to the moldboard plow system. This reduction in yield was attributed to weed populations, which were generally two to three times higher with conservation tillage than with a conventional system. Fenster et al. (1969) found that downy brome control on stubble-mulch tillage systems was not as consistent as with the one-way disk or moldboard plow. In a 38-cm rainfall zone of Nebraska, moderate and heavy infestations of downy brome reduced winter wheat yields by 30 and 80%, respectively. Following early summer tillage, downy brome populations for the plow, one-way disk, and sweep plow fallow treatments were 11, 22, and 24 plants m^{-2}, respectively. When plots were tilled in July and again in August, wheat yields were highest for the moldboard plow treatment followed by the one-way disk and sweep plow treatments. Downy brome populations were negatively correlated with wheat yield, with higher yields occurring on the moldboard plowed plots due to lower stands of downy brome.

Krall et al. (1958), as cited in Fenster (1969), suggested that the timing of tillage influenced weed control rather than the tillage system. The degree of stirring, temperature, soil moisture, type of weeds present, and stage of growth were responsible for the weed control attained with any implement.

Sewell and Gainey (1932) found long ago that the timeliness of tillage was one of the most important factors affecting yield of hard winter wheat region in central Kansas. Experiments extending over a 20-year period demonstrated that July plowing for fall-seeded winter wheat produced an average yield increase of 671 kg ha^{-1} compared to September plowing. This increase was attributed to the effective control of weeds, as well as the decomposition of crop residues. However, summer precipitation, which is not normally received in the PNW, would greatly influence both weed populations and residue decomposition.

Nitrogen Immobilization and Mineralization

When winter wheat is directly drilled into heavy residue, seedlings are often stunted and chlorotic, and grain yields may be 10 to 40% lower than under conventional seedbed conditions (Papendick and Miller, 1977). Lower yields under conservation tillage have been attributed to lower N availability (Rao and Dao, 1996), due to greater N immobilization (Rice and Smith, 1984), slower mineralization (Phillips et al., 1980), and increased leaching (McMahon and Thomas, 1976) volatilization, and surface runoff (Terman, 1979).

Soil microorganisms utilize NH_4^+ and NO_3^- in the soils to decompose straw and to provide adequate nutrients to the expanding microbial population. If N supply becomes insufficient, competition between plants and microbial populations for available N occurs. Immobilization of N by microbial populations occurs when the residue contains low nitrogen relative to carbon concentration. Immobilization may increase with conservation tillage systems due to the accumulation of soil organic matter (SOM) with a high carbon to nitrogen ratio, e.g. wheat straw (Tisdale et al., 1993).

Unlike conventional tillage systems, which bury plant residue, and thus increase SOM with depth, conservation tillage maintains at least 30% of plant residue at the soil surface. Rasmussen et al. (1989a) found that, after 50 years of stubble-mulch tillage, soils in eastern Oregon had one-third more SOM in the top 7.5-cm than soils that were conventionally plowed. If the decomposing SOM contains low N relative to C, the addition of low nitrogen straw will further perpetuate immobilization.

A laboratory study by Cochran et al. (1980) found that when straw was surface applied to a Walla Walla silt loam (coarse-silty, mixed, mesic Typic Haploxeroll), over 80% of the mineralized N was immediately immobilized under a stubble-mulch system due to the accumulation of SOM at the soil surface. Doran (1980) sampled soils from seven long-term experiments in the U.S. for microbial and biochemical characterization and found that the quantity of actinomycetes, aerobic microorganisms, facultative anaerobes, and denitrifiers in the surface 7.5-cm of stubble-mulch soils were 1.14, 1.58, 1.57, and 7.31 times higher, respectively, than in the surface of plowed soils. At 7.5- to 15-cm and 15- to 30-cm depth, however, this trend was reversed, and enzyme activities and organic C and N were the same or higher under conventional tillage. Doran (1980) concluded that the greater potential for immobilization under conservation tillage was due to large microbial populations at the soil surface.

Elliot et al. (1981) found that wheat residues decomposing on the soil surface did not significantly reduce winter wheat yields or decrease N uptake. However, when winter wheat straw (11mT ha^{-1}) was incorporated into the soil, significant reductions in yield and N uptake resulted due to N immobilization.

In many cases, immobilization can be reduced by the addition of N fertilizer, or the use of a suitable crop rotation (Kimber, 1973). Immobilization can also be alleviated by reducing fertilizer contact with residue (Soper et al., 1971; Toews and Soper, 1978; Tomar and Soper, 1981), or placing fertilizer N below the SOM concentrated at the soil surface (Cochran et al., 1980; Elliot et al., 1981).

N mineralization is basically the reverse of N immobilization and increases with rising temperatures and optimum oxygen and soil moisture supply (Tisdale et al., 1993). Conventional tillage accelerates net mineralization of soil organic N by increasing soil porosity and aeration, and exposing surface residues to soil microbial biomass (Schillinger and Bolton, 1993a). With conservation tillage systems, however, N mineralization can be reduced or delayed (Thomas and Ladewig, 1983; Lamb et al., 1985; Phillips et al., 1980; Kimber, 1973). This had been attributed to the insulating and shading effect of surface residues, which may lower soil temperature (Cassman and Munns, 1980; Van Wijk et al., 1959), reduce the supply of oxygen (Tisdale et al., 1993) and provide a large quantity of carbonaceous material (Smika et al., 1969).

In Sidney, Nebraska, Lamb et al. (1985) found that stubble-mulch tillage system soils accumulated only about 70% as much NO_3^--N as plowed soils at two sites. These results confirmed similar findings of McCalla and Army (1961), Winterlin et al. (1958), and Doran (1980). Smika et al. (1969) reported that wheat straw mulch rates greater than 3360 kg ha^{-1} significantly reduced soil NO_3^--N content during fallow at three Great Plain locations. Also in the Great Plains, Harris (1963) found soil NO_3^--N to be depressed under stubble-mulch tillage at seeding time. This was attributed to the slower rate of mineralization associated with residues that remain longer on the surface compared to those incorporated into the soil.

Other literature challenges the idea that stubble-mulch reduces N mineralization or crop yield and suggests that both actually increased with accumulation of surface residue. Lower soil temperatures and decreased radiation flux on the soil surface may decrease the evaporation rate and thus increase soil moisture. This would in turn create more favorable conditions for mineralization to occur. Doran (1980), for example, reported potentially 20 to 101 kg ha^{-1} more mineralizable N in the top 7.5-cm of the soil profile under minimum tillage systems, which corresponded to a higher microbial biomass and increased soil water content. Similarly, in the Palouse region, Hammel (1995) found significantly more available N present in the upper 30-cm of the soil profile in reduced-tillage systems compared to the conventional tillage treatment when sampled in spring. The increase in available N was attributed to increased moisture supply. In Texas, Franzluebbers et al. (1995) also reported that conservation tillage resulted in greater N mineralization than that did conventional tillage. The difference was ascribed to a more favorable environment for decomposition in the conservation tillage plots.

Nitrogen

Knowledge of the seasonal changes in soil N mineralization and immobilization is required to manage the delicate nutrient balance in the soil system. Nitrogen is a key element that can limit crop production when the inorganic supply is low and become toxic when it is excessive (Franzluebbers, 1995). Decline of SOM and N levels under conventional tillage systems have made N, by far, the most deficient plant nutrient in US agriculture (Rasmussen, 1981).

Initially, there was skepticism about whether N fertilization would benefit wheat yields in dryland farming regions of the Pacific Northwest (McGregor, 1982). It is now established that application of commercial fertilizer is one of the major technological improvements that wheat producers have adopted during the last several decades

(Pumphrey and Rasmussen, 1982). In the USA, the average rate of N fertilizer applied to winter wheat doubled from the mid-1970's to the early 1990's (Gooding and Davies, 1997). Without the addition of N fertilizer, wheat yields would have steadily declined in the PNW due to SOM depletion (Pumphrey and Rasmussen, 1982). Indeed, newer dryland wheat varieties have become increasingly responsive to N fertilization (Rasmussen, 1981). In the northeast mountain region of Oregon, Pumphrey and Rasmussen (1982) reported an average yield increase of 805 kg ha^{-1} with the addition of 45 kg ha^{-1} of early spring-applied N and an increase of 1141 kg ha^{-1} with 90 kg N ha^{-1}. Similarly, in Bozeman, Montana, Brown (1971) found that increasing N rates increased dryland winter wheat yields to 1610, 3090, and 3630 kg ha^{-1} for N rates of 0, 67, and 268 kg ha^{-1}, respectively.

Fertilizer recommendation for dryland wheat production is not an exact science (Rasmussen, 1981). Ideally, fertilizer should supply sufficient nitrogen to make up the difference between available soil N and the N required for maximum yields (Cassman and Munns, 1980). Nitrogen fertilizer application should compensate for N immobilization and decreased N mineralization. Inadequate N reduces tillering and yield, whereas excess N can over-stimulate vegetative growth, thereby increasing water stress and significantly reducing yields (Rasmussen, 1988; Brown, 1971; Luebs and Laag, 1969). Excessive N can also result in NO_3^--N movement below the root zone, causing not only economic loss but also environmental pollution. If progress in the efficient use of N fertilizer is to be made, the influence of factors such as soil depth, timing of application, weed populations, and disease, must be thoroughly understood (Tomar and Soper, 1981).

Soil Depth

Previous research on the influence of soil depth on wheat yield is deficient. However, Rasmussen (1981) has speculated that soil depth can have a significant impact on wheat yield and the amount of N needed for optimum yield by altering water use efficiency as well as water storage capacity. On shallow soils, early season soil water contents are higher in the zone of root activity. Consequently, early growth is more stimulated by N fertilization, increasing water use. Because of both reduced soil water storage capacity and accelerated root activity in the shallow soil, the wheat exhausts its water supply about the time of flowering, curtailing yield and N response (Rasmussen, 1981). In dry areas, deeper soils also have the potential to store greater quantities of precipitation, increasing the amount of available water to the crop later in the growing season (Rasmussen et al., 1989a).

For a long-term experiment at Pendleton, with identical tillage, variety, and fertilization practices, Rasmussen (1981) found that a 210-cm deep soil required 90 to 101 kg N ha^{-1} to produce a maximum yield of 5034 kg ha^{-1}, while a nearby 110-cm deep soil reached a maximum yield of 4026 kg ha^{-1} with 34 to 45 kg N ha^{-1}.

Timing of Fertilizer Application

Increased interest in N use efficiency and the potential for contaminating groundwater with NO_3^--N has created increased pressure on producers to use best management practices for fertilizer application (Stevens, 1997). A high recovery of applied N by crops, as well as proper timing of N fertilizer application for winter wheat forage and grain production systems, will decrease the quantity of NO_3^--N leaching below the crop root zone and entering the groundwater (Mahler et al., 1994; Boman et al., 1995). Timing of N fertilization can affect crop utilization by influencing N form, positional availability, and leaching or volatilization losses of N (Cochran et al., 1978; Huber et al., 1980; Reddy and Patrick, 1978; Robinson et al., 1979; Terman and Hunt, 1964). Thus, it is important that the timing of application coincide with the ability of the wheat plant to utilize the largest amounts of N efficiently (Gooding and Davies, 1997; Welch et al. 1966). The timing of fertilizer application can also influence the rate of application at which optimum yield is produced (Pumphrey and Rasmussen, 1982). Researchers have shown spring-applied N to be superior to fall-applied N in areas of high seasonal precipitation (Welch, et al., 1966; Doll, 1962). With greater than 650-mm of rainfall, less than 30% of the N is applied in the fall at planting (Mahler et al., 1994).

In a three-year study on a Cisne silt loam in Newton, Illinois, Welch et al. (1966) found that spring-applied N resulted in 145, 256, and 334 kg ha^{-1} greater wheat yields than fall-applied nitrogen at 22.5, 45, and 67.5 kg N ha^{-1}, respectively. In regions receiving spring and summer rainfall, early fertilizer application allowed the N to be positionally and chemically available for plant absorption at the proper time. In a study near Manhattan, Kansas, Olson and Swallow (1984) found that spring applications resulted in greater fertilizer N uptake and a higher N efficiency than fall applications in 4 out of 5 years. With spring application, approximately 30% of applied N fertilizer was removed by grain because the long period prior to rapid spring growth permitted immobilization of fall-applied N.

However, in areas receiving lower seasonal precipitation, fewer grain yield differences between fall- and spring-applied N have been reported (Ramig and Rhoades, 1963; Christensen and Meints, 1982). Current N management strategies for winter wheat in dryland areas of the PNW are based on research that suggests that all fertilizer can be applied to winter wheat in the fall when annual precipitation does not exceed 480-mm (Leggett, 1959; Koehler, unpublished data).

In Montana, Christensen and Meints (1982) reported little to no difference in grain yield due to time of N fertilizer application. Ramig and Rhoades (1962) found that although fall-applied nitrogen was superior to spring-applied nitrogen in 2 of 3 years, differences in yield due to time of application were small, averaging only 134 kg ha^{-1}. In Oklahoma, Boman et al. (1995) found that the date of application had no significant effect on winter wheat yield.

Weed Populations

Anderson (1991) suggested that variations in yields are not a result of fertilizer timing, but the influence of N application on weed populations. To determine the affect of downy brome interference on winter wheat, four application timings of NH_4NO_3 at 56 kg N ha^{-1} were compared: during fallow, near planting, during dormancy, or before winter wheat jointing. The application of N fertilizer increased winter wheat grain yields by more than 15% at all timings when downy brome was not present. However, applying N at any time during the crop season increased downy brome biomass and decreased grain yields. Downy brome was least responsive to N when applied in the spring of the fallow season.

Disease

In some instances, the increase in N fertilizer renders the crop more susceptible to most diseases due to changes in leaf nutrient status, canopy morphology and microclimate (Gooding and Davies, 1997). The most common management system for the PNW region, 90 kg N ha^{-1} and stubble incorporated by moldboard plowing, generally has the highest prevalence of disease (Smiley et al., 1994). Crops are particularly affected by wind-dispersed pathogens, such as powdery mildew (*Erysiphe graminis*) and the rusts (*Puccinia* spp), which have increased rates of sporulation as the N content of the leaves from which they extract nutrients is raised (Last, 1954). Strawbreaker foot rot, caused by the fungus *Pseudocercosporella herpotrichoides*, and Rhizoctonia root rot, caused by *Rhizoctonia solani*, become more apparent as the N rate is increased (Smiley et al., 1994).

Rainfall

A characteristic of semi-arid regions is that weather patterns vary markedly from year to year, from place to place, and within years at any one place. The element showing greatest uncertainty in agriculture is rainfall, and its unreliability is echoed in crop yields. To diagnose the constraints within farming systems, the uncertainty of crop yields as influenced by weather needs to be quantified, ideally by long-term studies.

In the northeast intermountain region of Oregon, winter wheat yields generally range from less than 2013 kg ha^{-1} to more than 8725 kg ha^{-1}. This large range reflects the effect of precipitation variation. Most of the low yields are associated with low rainfall and/or poor rainfall distribution (Pumphrey and Rasmussen, 1982). In the semi-arid climate of the PNW, precipitation is unreliable. Low precipitation and high evaporative potential limit dryland crop yields. Many studies report increased yields based solely on the quantity and occurrence of rainfall. In a study conducted in Moscow, Idaho, Mahler et al. (1994) reported that differences in yield between years were related to differences in total rainfall and rainfall distribution in the period October to June. The highest yield (8.6 Mg ha^{-1}) was recorded for the 1983-1984 growing season, which had the greatest quantity of precipitation. Corresponding decreases in winter wheat grain yields were observed as the quantity of precipitation decreased. In a long-term experiment in Spain, Lopez-Bellido et al. (1998) revealed a direct relationship between grain yield and the amount of rainfall during the vegetative period of wheat. The wettest growing season (1989-1990) produced much higher wheat yields than the driest growing season (1988-1989).

In a field study conducted at the USDA Conservation and Production Research Laboratory in Bushland, Texas, Unger (1994) reported that differences in mean water storage and yield were attributed to variable precipitation. For a 3-year winter wheat-fallow rotation, higher yields occurred in years of high rainfall and depressed yields occurred in years of below-average precipitation.

Hammel (1995) found significant differences in soft winter wheat yields among years in Moscow, Idaho, due to the amount and distribution of precipitation during the warm growing season. The lowest wheat yields occurred in 1985, which had the lowest growing season precipitation, and the highest yields were obtained in 1989, the year with the greatest growing season precipitation. Overall, annual average winter wheat yields were ranked as follows: 1987>1984>1986>1985, corresponding to the decreasing amount of growing season precipitation.

Interactions between Tillage, Nitrogen and Rainfall

Cereal yield in semi-arid regions is influenced not only by the amount of precipitation, but also its distribution (Henderson, 1979). Fluctuations in growing season precipitation have a strong impact on yield and utilization of applied N. Although winter wheat responds readily to fertilizer application throughout much of the PNW dryland cereal production area (Rasmussen and Goller, 1997), managing soil fertility for the most profitable crop production is enormously more complex in dryland farming than in areas where rainfall is more abundant and consistent (Tucker, 1988). Fertilizer response and recommended rates of application are strongly affected by adequacy of moisture and tillage system, as well as application timing and past fertilizer practices (Leggett, 1959; Rasmussen and Rohde, 1991; Fiez et al., 1994).

Adequacy of moisture

In years with low spring rainfall, yield is restricted and considerable N remains in the soil, where it is subject to leaching and denitrification (Rasmussen, 1997). In years of high precipitation, wheat is very responsive to N and a greater rate of applied N is required to meet optimal growth. Substantial reductions in yield occur when inadequate

N is applied (Rasmussen, 1997). The optimum N rate depends on the expected yield, which in turn depends on soil moisture present, as well as the expected precipitation (Lopez-Bellido et al., 1996).

In a study to determine the response of wheat to nitrogen and rainfall, Shimshi and Kafkafi (1978), as cited by Kafkafi (1988), determined that in areas receiving a total rainfall of 363-mm, application rates greater than 120 kg N ha^{-1} resulted in yield reductions. In areas receiving greater than 638-mm of water available, 180 kg N ha^{-1} produced as much as 6340 kg grain ha^{-1}.

In Montana, Brown and Campbell (1966) found that spring wheat yields were directly related to precipitation during the growing season. Yield responses to N fertilization were positive in years with adequate precipitation and yields were depressed in years with below-average precipitation. Excluding 1951, which had abnormally high yields, the average yield with 45 kg N ha^{-1} was 915.5 kg ha^{-1} in years with greater than 152-mm of growing season precipitation. In years receiving less than 152-mm of growing season precipitation, the average yield was 504 kg ha^{-1}.

In a 2-year fertility experiment conducted across four agroclimatic zones, with treatments consisting of N rates from 0 to 145 kg ha^{-1}, Rasmussen and Goller (1997) found that the optimum rate of N fertilization for winter wheat was strongly dependent on the amount of spring rainfall. In 1992, a year with low spring precipitation, N response was minimal in all agronomic zones, and higher rates of application decreased yield in some instances. In 1993, a year with above-normal spring precipitation, a nearly linear increase in yield with increasing rates of N was observed.

Results of other research indicate that the interaction between N application and precipitation on grain yield depends on the growth stage during which water stress occurs. According to Dimova (1960), if drought occurs during the critical period of heading, increased N availability intensifies the drought effect and can reduce yields.

At Riverside, California, Luebs and Laag (1967) found that increasing the rate of fertilization from 17 to 68 kg ha^{-1} decreased barley yields 200 kg ha^{-1} or 13 % when the crop was stressed for water at heading. The addition of 3.7-cm of water at heading increased the average barley grain yield by 64%.

Pumphrey and Rasmussen (1982) found that when moisture stress occurred during the later stages of growth, wheat fertilized with 45 kg N ha^{-1} produced 403 kg ha^{-1} more than non-fertilized wheat. However, wheat fertilized with 135 kg N ha^{-1} resulted in 120 kg ha^{-1} lower yields than the unfertilized wheat.

Tillage System

The uncertainty of yield and precipitation in the PNW can lead to possible N loss to surface or ground water because of the potential for over-application (Rasmussen et al., 1989a; Rasmussen and Rohde, 1991). Although conservation tillage has not changed the pattern of the wheat response to N from that of conventional tillage, 10 to 20% more N is required for maximum yield (Rasmussen, 1981). According to Pumphrey and Rasmussen (1982), this initial increase in N fertilizer is due to the slower rate of decomposition associated with surface residue. Fenster (1977) also found that additional soil N was required to maintain yields of winter wheat in stubble-mulch to compensate for N immobilization during residue decomposition.

Tillage method greatly effects soil biological, chemical, and physical properties, which in turn influence the amount of stored moisture, the rate of N mineralization and immobilization, erosion control, disease and weed control, wheat growth, and ultimately grain yield (Schillinger, 1992). However, the tillage system does not operate independently of N fertilization or precipitation, and the interaction between these variables is more complex and less understood. In eastern areas of the Great Plains, Winterlin et al. (1958) found soil NO_3^--N concentrations to be lower with stubble-mulch tillage, but the development of N deficiencies under conservation tillage could be overcome by the use of N fertilizer. In dry years, wheat yields were generally higher with conservation tillage due to greater moisture storage, even though soil NO_3^--N were lower., In wet years or where rainfall was high during the growing season, yields were usually higher with plowing due to greater NO_3^--N accumulation.

In northwestern Kansas, Harris (1963) reported that although stubble-mulch plots usually had less NO_3^--N than non-residue plots due to slower mineralization, applying fertilizer at a rate of 45 kg N ha^{-1} elevated the NO_3^--N content of the soil to approximately the same level obtained on unfertilized no-residue plots. Increased grain yields were also correlated with an increase in the amount of available water to the crop. For a winter wheat-fallow rotation, higher moisture content at seeding was found on the stubble-mulch plots than on the no-residue plots in 3 out of 6 years. These were years with high intensity precipitation or 4 to 6 consecutive days of precipitation. For the other 3 years, water storage for the two systems was equivalent.

In a 6-year study conducted at Lind, Washington, McCall (1925) reported that although surface residue prevented the loss of water already in the soil profile by decreasing evaporation, spring and summer rainfall events in the semi-arid PNW were seldom of sufficient magnitude to fill and penetrate through the residue. Under such conditions, the surface residue had an inhibitory effect on water absorption and could actually decrease soil moisture storage. However, in the PNW, infiltration is of relatively little concern during the period of high evaporation potential.

In Clovis, New Mexico, Christensen et al. (1994) reported that while N fertilizer significantly increased yield in wet or near normal years, tillage had no significant effect on yield. In dry years, neither tillage nor N fertilizer significantly affected yield. However, both N-fertilized and stubble-mulched treatments tended to have lower yields.

Time

Since 1965, wheat yields have risen at an enormous rate (USDA, 1999). Changes in farm operations, tillage and harvesting equipment, the development of improved crop varieties, and agricultural chemicals, most notably fertilizer and herbicides, have completely revolutionized farming as a way of life (Ridley and Hedlin, 1980). Long-term experiments offer a unique opportunity to determine whether new agricultural practices will sustain or degrade the productive capability of the soil. They provide insight into historical trends in crop production, yield stability, and climatic and edaphic changes, as well as the effects of technological advancements in farming practices.

In western Nebraska, Fenster (1988) reported that since the adoption of conservation tillage systems, yields of winter wheat more than doubled on an every-other-year basis and became stable even in years of low precipitation due mostly in part to improved water storage, but also due to improved varieties.

The additional water stored by conservation tillage systems and the addition of commercial N fertilizers have made it possible to more fully utilize the production potential of the new varieties of cereal crops that have been produced (Brady, 1988). The general pattern of varietal succession in Oregon has been from the tall varieties in the 1930's and 1940's (Kharkof, Rex, Rex-M1), to the medium-tall varieties in the 1950's (Elgin, Elmar, Omar), and finally to semi-dwarfs since the 1960's (Gaines, Nugaines, Hyslop, and Stephens) (Rasmussen et al., 1989b). The most rapid increases in yield occurred after 1960, reflecting the introduction of high yielding, N responsive semi-dwarf varieties of the green revolution into regional farming systems. The new varieties were less susceptible to lodging, disease, and drought stress than the older, tall varieties (Rasmussen et al., 1989a). Semi-dwarf wheats have improved yield capability approximately 50%, irrespective of the level of N input (Rasmussen, 1981), with an approximate 55 kg ha^{-1} increase in yield per year (Rasmussen et al., 1989b).

Rasmussen et al. (1989a) found that the yield of improved winter wheat varieties showed an almost linear yield increase over time when compared to the older varieties. However, higher yields require larger quantities of nutrients from the soil, and since their introduction, improved varieties have shown only a limited trend towards higher yields when not fertilized with N (Rasmussen et al. 1989a). The yield increase without N has been from 45 kg ha^{-1} in the 1930's to 53 kg ha^{-1} in the 1980's. When fertilized with N, the increase has been from 51 kg ha^{-1} in the 1930's to 93 kg ha^{-1} in the 1980's (Rasmussen et al., 1989a). Continued yield improvement has been contingent on both the development of new varieties and an adequate supply of N to meet corresponding yield level.

In a study on the Canadian Prairies, Ridely and Hedlin (1980) assessed the contribution of modern technology to the rapidly increasing yields since the 1950's. The general decline in grain yields until the mid-1930's was attributed to inclement weather, deterioration of soil quality and disease-susceptible cultivars. The increased use of N fertilizer had the most dramatic influence on increasing crop yields, while disease-resistant cultivars had a lesser effect.

After examining yield data for 80-yr-old dryland wheat rotations at Lethbridge, Alberta, Canadian researchers suggested that the main factor contributing to increased wheat yields since 1963 was chemical weed control (Freyman et al., 1982). Traditionally, tillage has been the main method of weed control in dryland farming. However, each disturbance of moist soil can cause 5- to 8-mm of evaporative water loss (Good and Smika, 1978). Recent reductions in herbicide costs and increasing efficiency have made it practical to manage weed populations with reduced tillage.

Summary

The conservation of soil and water resources is an important element in productive agriculture, and especially in dryland areas. Combined with increasing environmental concern for erosion and groundwater pollution, researchers and farmers have begun considering stubble-mulch tillage as an alternative to conventional methods. Tillage systems that maintain surface residue cover during the winter are recognized as important methods of controlling erosion. However, research to evaluate the effect of tillage systems on crop production has yielded contradictory results due to differences in climate, soil characteristics, and management practices. For optimizing crop yield and quality in conservation tillage systems, an in-depth understanding of the influences of tillage and residue management systems on the physical, chemical, and biological components of the plant-soil environment is essential. The current low profit margin for wheat will discourage wider adoption of conservation tillage systems unless perceptions of growth and yield reductions can be overcome.

It is also known that unfertilized soils can no longer provide adequate food for the world's expanding population. As the exploding population forces agriculture into less productive areas, improved technologies and systems are needed to maintain or increase productivity, while simultaneously ensuring the conservation of natural resources. However, the interpretation of crop responses to water and N treatments is often difficult in variable-rainfall environments because response to applied N is dependent on water supply. The significant effects of drought stress on crop yield and N response make it difficult to accurately access the quantity of fertilizer N to apply. Long-term data on past yield history, wheat variety and seeding date, soil depth, available soil moisture, and disease and weed control practices are needed for reliable fertilizer recommendations. Misuse of inputs may have both negative economic and environmental consequences.

The application of commercial fertilizer has substantially increased the yield potential of crops. Other practices that have increased productivity include the timely use of modern machinery, more effective weed control with herbicides, and improved varieties with drought-tolerance and greater N response. However, understanding the interactions of such variables is often difficult to interpret, and requires long-term data sets.

The objective of this study was to evaluate the long-term effect of tillage, nitrogen, soil depth, and the influence of precipitation on wheat yields in a semi-arid region of eastern Oregon.

OBJECTIVES

In 1940, Joseph Balenger, a Soil Conservation Service employee, established the Tillage/ Fertility or "Balenger" experiment. Today, it is one of the oldest replicated research experiments in the western United States. It was initiated for many reasons, of which the most important was to evaluate whether minimal amounts of nitrogen fertilizer (11.2 kg N ha^{-1}) could be profitably used in dryland wheat production. Today, the benefits of nitrogen fertilizer to crop yield are well-documented. However, at the time, local farmers were enormously skeptical about adding even such an insignificant amount of nitrogen.

The objectives of the Balenger experiment were originally to evaluate the effects of 1) three tillage systems, 2) tillage depth, 3) N fertilization rate, and 4) the timing of fertilizer application on the productivity and sustainability of a winter wheat-summer fallow cropping system. In 1952, as the positive influence of N fertilization on yields became known, the rate of N fertilization was increased. However, the objectives of the experiment remained the same.

In 1963, because of tremendous advances in technology since the study's inception, experimental treatments were modified to maintain relevance to contemporary agriculture. The new objectives were: 1) to determine the most economical rate of nitrogen for this rainfall zone; 2) to determine the rate of nitrogen at which yields of wheat on stubble-mulch fallow equal or surpass yields obtained by the moldboard plow; and 3) to study the yield response of wheat to different tillage practices and variable rates of nitrogen fertilization for plots with and without a history of sulfur application. In 1988, a control N treatment was introduced. However, the objectives remained unaltered.

Thus, the study can be divided into four main time periods within which experimental treatments were consistently maintained.

MATERIALS AND METHODS

Field Design

This experiment was conducted at the Columbia Basin Agricultural Research Center (Lat. 45' 43, Long. 118', Elev. 454 m) near Pendleton, Oregon (See Appendix B). The climate is characterized by cool, moist winters and hot dry summers. The mean annual precipitation is approximately 400-mm, with 70 % of the total received between September 1 and April 11. The soil was classified as a Walla Walla silt loam (coarse-silty, mixed mesic Typic Haploxeroll). The experiment consisted of a winter wheat-summer fallow rotation with one set of plots; thus yield was obtained only in odd years. The experiment was arranged in a randomized block split-plot design with three replications (See Appendix B). The main plot treatments were three primary tillage systems (moldboard plow, subsurface sweep, and offset disk) and six fertility subplots. The moldboard plow had a tillage depth of 230-mm and 7% residue cover at seeding (Rasmussen, unpublished data). The subsurface sweep had a tillage depth of 150-mm and 43% residue at seeding. The offset disk tills at a depth of 150-mm and had 34% residue cover at seeding. Individual plot size was 5.5 by 140.2 m.

Replication 1 had an average depth of 210-cm and was located on a slope of 3%; replication 2 had an average depth of 130-cm on a slope of 0 to 2%; and replication 3 had an average depth of 110-cm on slope of 2%.

Primary tillage operations were performed in April, after which the plots were smoothed 101- to 152-mm deep with a field cultivator and harrow. The plots were then rodweeded four to five times between April and October to control weeds and to maintain soil moisture. Nitrogen fertilizer was normally applied around October 1 and winter wheat seeded around October 10. Medium-tall soft white winter wheat was grown from 1940 to 1961. Semi-dwarf soft white winter wheat was introduced in 1962 and has been grown since.

The experimental design has remained relatively unaltered since inception, but the fertility treatments, timing, and tillage depth have been modified to maintain relevance to contemporary agriculture. Due to a lack of scientific personnel at the station during the Great Depression and World War II, data collected for 1941 and 1943 were considered unreliable. These were excluded from this study.

There are essentially four time periods in which treatments remained consistent, which will be described below. History of N fertilization history, tillage depth, and timing of N application can be found in Appendix C. A detailed description of each year (1961-1985) can be located in Appendix D.

<u>1944-1951</u>

Four of the six subplots received N in the form of ammonium sulfate at a rate of 11.2 kg N ha $^{-1}$. The N was applied to two of these plots at seeding and to the other two plots at plowing. The last two subplots received zero nitrogen. Two of the fertilized plots (one treated at seeding and the other at plowing) and one of the unfertilized plots, were tilled at a depth of 127-mm. The other three plots were tilled at a depth of 203 mm.

The experiment was seeded to the variety Rex M-1 in 1945, spring wheat in 1947, and Elgin in 1949 and 1951.

1952-1961

In 1952, the rate of ammonium sulfate was increased from 11.2 to 33.7 kg N ha^{-1}. The tillage methods and depths, and the timing of fertilizer application remained unaltered. The plots were seeded to the varieties Elgin in 1953, Elmar in 1955, and Omar from 1957 to 1961.

1962-1987

Important changes were made to the experimental design in 1962, reflecting the introduction of high yielding, N responsive semi-dwarf varieties of the green revolution into regional farming systems. The initial tillage treatments, including the moldboard plow, subsurface sweep, and offset disk continued. However, tillage depth was discontinued as a treatment, and all plots were tilled at a depth of 152-mm. The fertility treatments were also revised. The four plots that previously received 33.7 kg of ammonium sulfate per hectare (two plots at plowing and two plots at seeding), were fertilized only at seeding. Newly introduced fertilizer treatments were 45, 90, 135, and 180 kg N ha^{-1} as ammonium nitrate. The two plots, that had previously received no N treatment, began receiving 45 and 90 kg N ha^{-1}. The plots were seeded to Gaines from 1963 to 1967, Nugaines from 1969 to 1973, McDermid in 1975, Hyslop in 1977, and Stephens from 1979 to the present time.

1988-1997

In 1988, the subplot, which had received 0 kg N ha^{-1} from 1945 to 1961 and 45 kg N ha^{-1} from 1962 to 1987, was designated as the control, receiving 0 kg N ha^{-1}. The form of N changed from ammonium nitrate to urea ammonium nitrate (32-0-0). It was shanked 152-mm deep with 254-mm band spacing. All other plots remained unmodified.

Statistical Analysis

Analysis of variance was used to test the statistical significance of the main treatments and any interactive effects upon wheat yield. The main treatments were tillage treatment and fertilizer treatment. Analyses were made for individual years, and for all years within a particular time period. Analysis of covariance was also used to test the statistical significance of the environmental variables total precipitation, growing season precipitation, winter precipitation, and soil depth on yield. Statistical models were evaluated using SYSTAT's GLM module.

RESULTS AND DISCUSSION

Tillage

Table 1 shows the influence of tillage, fertilizer, and their interaction, on winter wheat yields. Tillage x fertilizer was insignificant for all years of study, except 1997, which allows the effect of the tillage and fertilizer treatments to be analyzed separately. Analysis of variance revealed that tillage was a significant variable ($p < 0.05$) in 9 of the 27 years of study. Since 1993, the influence of tillage has been remarkably significant ($p < 0.001$).

Mean yield was consistently greater (24 of the 27 years of study) for plots cultivated with the moldboard plow than plots cultivated with the offset disk or the subsurface sweep (Figure 1). The differences in yield, however, were only significant in 8 of these years (1949, 1951, 1955, 1959, 1965, 1975, 1985, and 1993) (Table 2). Mean yield was greater when tillage was performed with the moldboard plow than the offset disk in 20 of the 27 years, although differences in yield were only significant in 1949, 1985, 1993, 1995, and 1997. Mean yield was greater for plots tilled with the offset disk rather than the subsurface sweep in 19 of the 27 years, although significant differences were only found in 1949. Since 1993, plots cultivated with the subsurface sweep have produced significantly higher grain yields than plots cultivated with the offset disk.

When grouped into the four major time periods, the effect of the tillage treatment was significant for each time period. In all four time periods, the moldboard plow tillage treatment significantly increased yields by more than 300 kg ha^{-1} over the subsurface sweep tillage system (Figure 2). Winter wheat yields under conservation tillage

Table 1. Statistical significance of tillage and fertilizer treatments, and their interaction, on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Year	Tillage Treatment	Fertilizer Treatment	Tillage x Fertilizer
1945	NS	NS	NS
1947	NS	NS	NS
1949	***	NS	NS
1951	*	***	NS
1953	NS	***	NS
1955	*	***	NS
1957	NS	***	NS
1959	**	NS	NS
1961	NS	***	NS
1963	NS	***	NS
1965	*	***	NS
1967	NS	***	NS
1969	NS	***	NS
1971	NS	***	NS
1973	NS	NS	NS
1975	NS	NS	NS
1977	NS	*	NS
1979	NS	NS	NS
1981	NS	***	NS
1983	NS	***	NS
1985	***	NS	NS
1987	NS	**	NS
1989	NS	***	NS
1991	NS	*	NS
1993	***	***	NS
1995	***	***	NS
1997	***	***	*

*, **, *** Significant at the 0.05, 0.01, and 0.001 levels, respectively. NS = not significant.

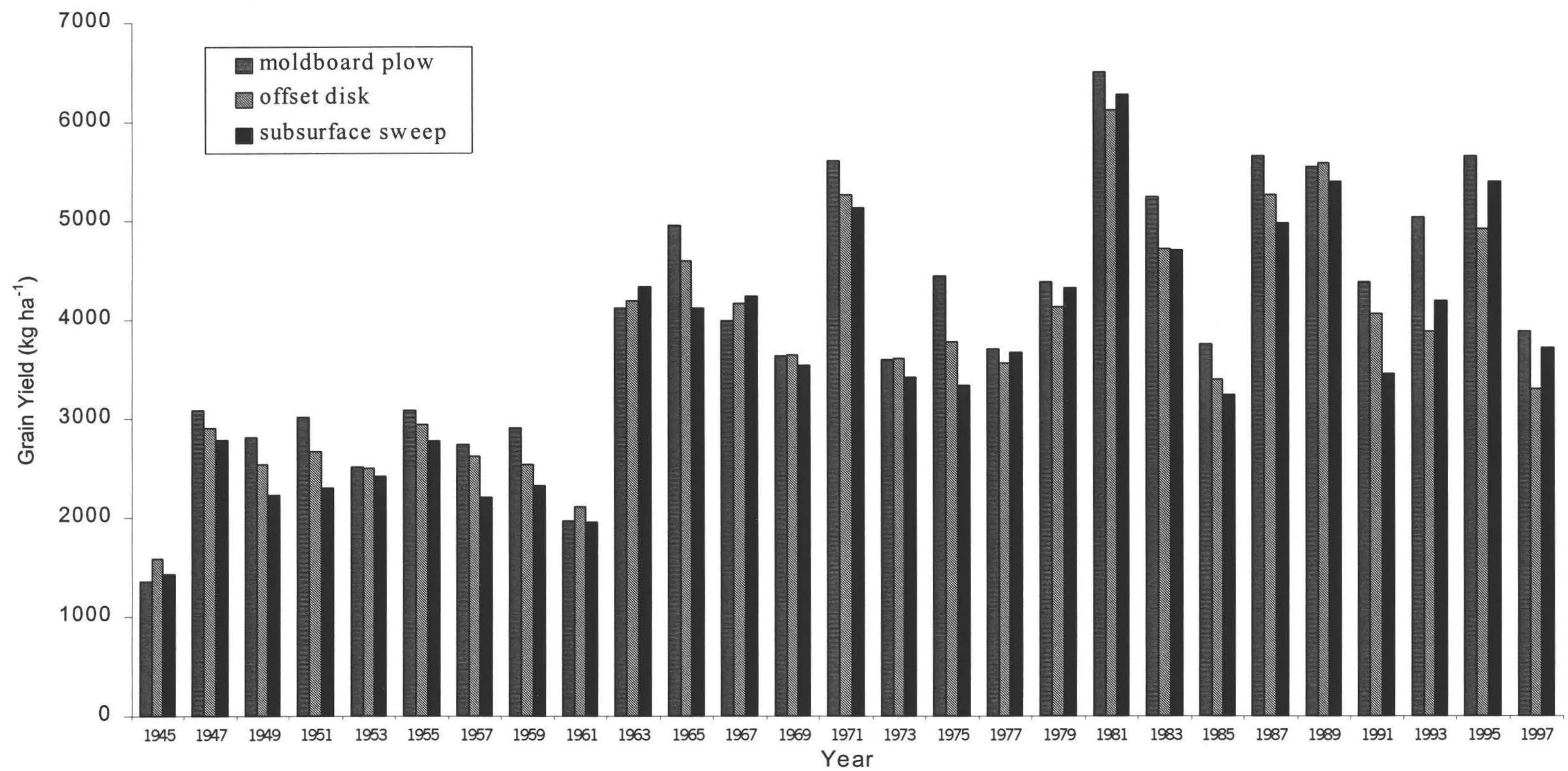

Figure 1. The influence of tillage on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Table 2. The influence of tillage on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1995.

	Tillage Treatment		
Year	Moldboard Plow	Offset Disk	Subsurface Sweep
	------------------- kg ha^{-1} -------------------		
1945	1362a	1581a	1425a
1947	3079a	2901a	2784a
1949	2814a	2537b	2223c
1951	3006a	2666ab	2303b
1953	2514a	2500a	2419a
1955	3082a	2939ab	2775b
1957	2733a	2614a	2208a
1959	2902a	2537ab	2322b
1961	1966a	2112a	1952a
1963	4116a	4187a	4338a
1965	4950a	4599ab	4119b
1967	3993a	4172a	4239a
1969	3635a	3645a	3534a
1971	5609a	5263a	5129a
1973	3592a	3605a	3418a
1975	4437a	3776ab	3332b
1977	3701a	3564a	3672a
1979	4386a	4127a	4321a
1981	6503a	6125a	6274a
1983	5238a	4720a	4707a
1985	3752a	3396b	3238b
1987	5656a	5262a	4981a
1989	5545a	5588a	5390a
1991	4380a	4064a	3457a
1993	5031a	3881b	4194c
1995	5657a	4918b	5390a

† Values within the same row accompanied by a common letter are not significantly different at the 0.05 probability level, according to Tukey's HSD.

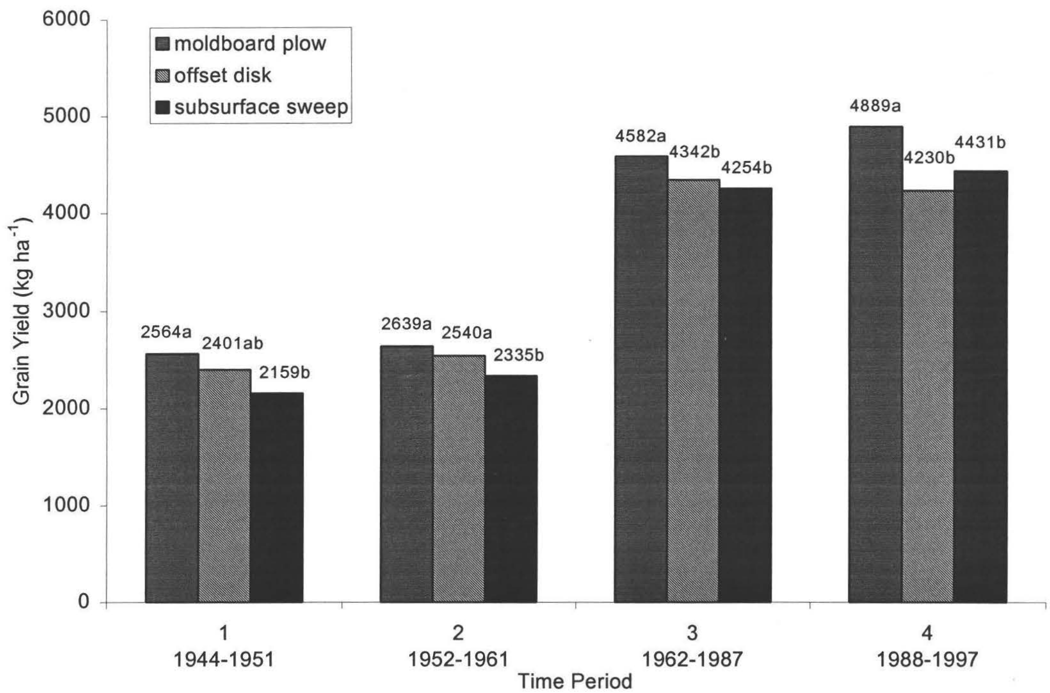

Figure 2. The influence of tillage on winter wheat for the four major time periods of the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997. Values without a letter in common are significantly different at the 0.05 probability level, according to Tukey's HSD.

management were consistently reduced compared to yields associated with conventional tillage practices, similar to the findings of others (Cochran et al., 1977; Papendick and Miller, 1977).

Reduced yields with the stubble-mulch systems could be attributed to greater stands of downy brome. Good and Smika (1978) have shown that weeds can use up to 7.6-cm of stored water during fallow, reducing the amount available to the subsequent wheat crop. Notes for the experiment (See Appendix D), dating back to 1961, repeatedly report severe downy brome infestations on plots tilled with the subsurface sweep, while weed populations were continually less severe on plots treated with the offset disk and negligible on plots tilled with the moldboard plow. In the northern Great Plains, Bond et al. (1971) found that a stubble-mulch tillage system resulted in lower spring wheat yields when compared to the moldboard plow system due the presence of weed populations, which were generally two to three times higher with conservation tillage than with a conventional system. In Nebraska, Fenster et al. (1969) found that downy brome control with stubble-mulch tillage systems was not as consistent as with the one-way disk or the moldboard plow. Downy brome populations for the moldboard plow, one-way disk, and sweep plow fallow treatments were 11, 22, and 24 plants m^{-2}, respectively. Heavy infestations of downy brome were found to reduce winter wheat yields by up to 80%.

Lower yields may also be attributed to lower NO_3^--N accumulations associated with the implementation of the subsurface sweep. According to the literature, (McCalla and Army, 1961; Winterlin et al., 1958; Harris, 1963), clean-tilled soils mineralize more N than soils under a conservation tillage system. In Sidney, Nebraska, Lamb et al. (1985) found that the stubble-mulch tillage system soils accumulated only about 70% as much

NO_3^--N as plowed soils at two sites. In the Great Plains, Harris (1963) found soil NO_3^--N accumulations to be depressed under stubble-mulch tillage at seeding time. This was attributed to the slower rate of mineralization associated with residues that remain longer on the surface compared to those incorporated into the soil.

There is also evidence that N immobilization may account for the differences in yield between conventional and conservation tillage systems. A laboratory study by Cochran et al. (1980) showed that over 80% of the mineralized N was immediately immobilized under a stubble-mulch system due to the accumulation of organic matter at the soil surface. Doran (1980) also reported greater potential for N immobilization under conservation tillage, which was due to large microbial populations associated with a high organic matter content at the soil surface.

Yields with the moldboard plow system were significantly higher than with the offset disk tillage treatment in time periods 3 (1964-1987) and 4 (1988-1997). The same trend was evident for mean yield in time periods 1 (1944-1951) and 2 (1952-1963), but differences were not statistically significant (Figure 2). Mean yields were higher, although not significantly, for plots tilled with the offset disk than plots tilled with the subsurface sweep, except in time period 4. In this period, mean yield was approximately 200 kg ha^{-1} greater for plots cultivated with the subsurface sweep than the offset disk. This may be attributed to increased moisture storage with the subsurface sweep. During period 4, the quantity of annual and growing season precipitation was above normal. Plots tilled with the subsurface sweep may have maintained higher infiltration rates, reducing erosion and increasing mean yield.

Tillage depth, which was discontinued as a treatment in 1961, did not significantly affect grain yield during time period 1 (1944-1951), when wheat received a maximum fertilization rate of 11.2 kg N ha^{-1}, or time period 2 (1952-1961), for which the maximum fertilization rate was 33.7 kg N ha^{-1} (Figure 3). However, there was a tendency for mean yield obtained with the 203-mm tillage depth to be slightly greater than mean yield obtained with the 127-mm tillage depth for both time periods.

Nitrogen

Fertilizer application affected wheat grain yield for 19 of the 27 years of the study (Table 1, Table 3). When annual grain yield data were pooled within the 4 time periods, fertilizer was a statistically significant variable for all periods except 1 (1944-1951), when the maximum fertilizer rate was a mere 11.2 kg N ha^{-1} (Table 4). Even at this low rate, however, there was a tendency for mean yield to increase compared to the unfertilized treatment (Figure 4). For time period 2 (1952-1961), grain yield increased significantly with the addition of 33.7 kg N ha^{-1} (Figure 5).

Timing of fertilizer application (at plowing or at seeding), which was initiated in 1944, for crops harvested in 1945, and discontinued in 1961, had no significant effect on grain yield for period 1 (1944-1951) or period 2 (1952-1961) (Figure 6). However, in time period 1, N applied at seeding tended to increase mean yields compared to application at plowing. No such trend was discernible for period 2, when the rate was increased to 33.7 kg N ha^{-1}.

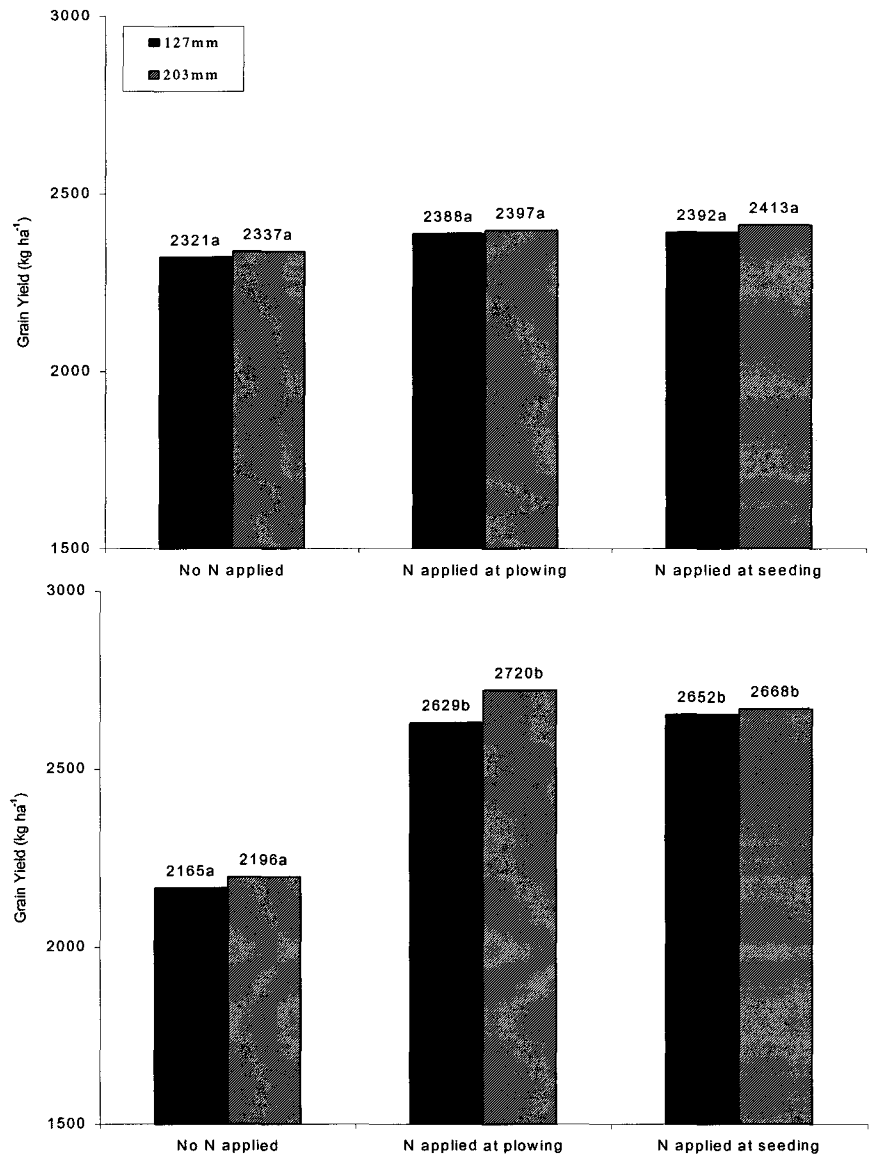

Figure 3. The influence of tillage depth on winter wheat for period 1 (1944-1951) and period 2 (1952-1961) for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997. Values without a letter in common are significantly different at the 0.05 probability level, according to Tukey's HSD. The history of tillage depth as a treatment is listed in Appendix C.

Table 3. The influence of N fertilization on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997. Nitrogen history of fertility subplots is listed in Appendix C.

Time Period	Year	Fertility Subplot 1	2	3	4	5	6
		Grain Yield					
		kg ha^{-1}					
1	1945	1565a	1498a	1397a	1408a	1427a	1441a
1	1947	3027a	2871a	2999a	2758a	2943a	2930a
1	1949	2492a	2530a	2513a	2544a	2499a	2572a
1	1951	2271a	2697ab	2652a	2911b	2788b	2631ab
2	1953	2251a	2619b	2227a	2536b	2627b	2606b
2	1955	2247a	3387b	2297a	3117b	3237b	3307b
2	1957	2259a	2682b	2193a	2739b	2638b	2600b
2	1959	2497a	2733a	2457a	2639a	2606a	2592a
2	1961	1728a	2177b	1651a	2112b	2232b	2159b
3	1963	4213a	4434a	4492a	4524a	4145ab	3473b
3	1965	3871a	4032b	4674b	4542b	5105c	5112c
3	1967	4113a	4303abe	4666bd	4556de	4032a	3137c
3	1969	3568ab	3595ab	4015c	3662ac	3522ab	3266b
3	1971	4434a	4906ab	5356bc	5618bc	5931c	5758c
3	1973	3581a	3522a	3548a	3452a	3611a	3516a
3	1975	4288a	4012a	3727a	3478a	3733a	3852a
3	1977	3619abc	3730abc	3527b	3596abc	3856c	3543ab
3	1979	4224a	4375a	4018a	4289a	4386a	4368a
3	1981	5323a	5701a	6395b	6757b	6799b	6837b
3	1983	3712a	4009a	4939b	5352bc	5538c	5779c
3	1985	3391a	3305a	3554a	3453a	3566a	3504a
3	1987	5056ab	4987b	5478ac	5299abd	5576cd	5402abd
4	1989	3446a	4969b	5994c	6127c	6220c	6289c
4	1991	3322a	3889ab	4038ab	4341b	4071ab	4142ab
4	1993	3291a	4165b	4565cd	4394bc	4822de	4974e
4	1995	3527a	5055b	5636c	5914c	5961c	5839c

† Values within the same row accompanied by a common letter are not significantly different at the 0.05 probability level, according to Tukey's HSD.

Table 4. The influence of N fertilization on winter wheat for the four major time periods of the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997. Nitrogen history of fertility subplots is listed in Appendix C.

Fertility Subplot	Time Period			
	1944-1951	1952-1961	1962-1987	1988-1997
	Grain Yield			
	------------kg ha^{-1}------------			
1	2337a	2196a	4107a	3193a
2	2397a	2720b	4224ab	4245b
3	2321a	2165a	4491b	4778c
4	2388a	2629b	4506b	4887c
5	2413a	2668b	4601b	5007c
6	2392a	2652b	4427ab	4990c

† Values within the same column accompanied by a common letter are not significantly different at the 0.05 probability level, according to Tukey's HSD.

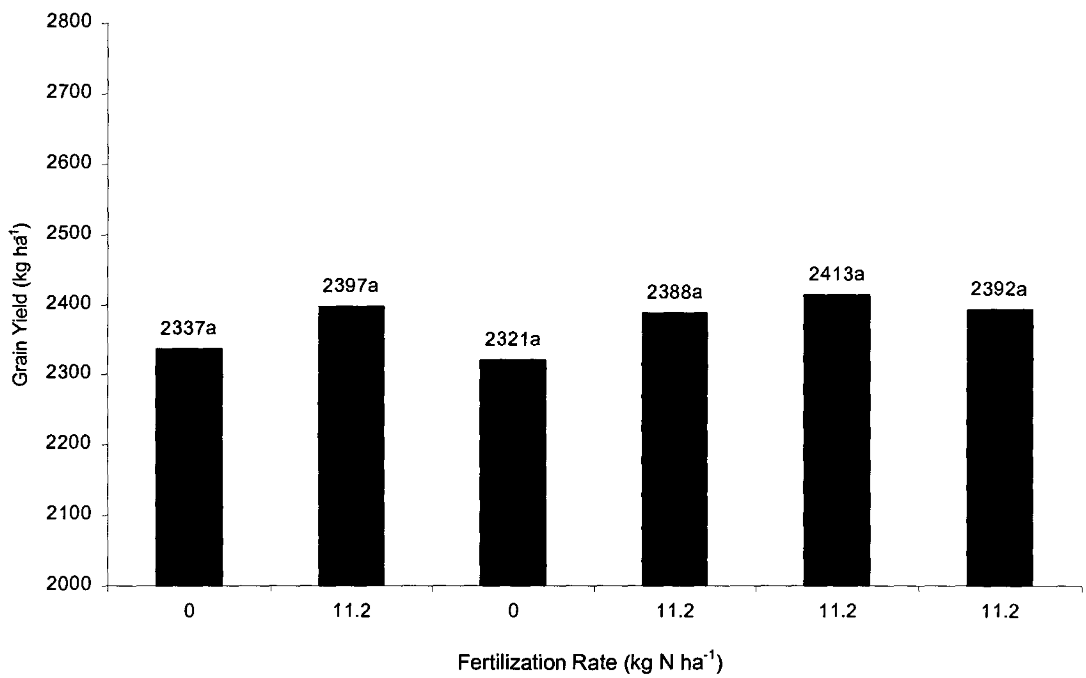

Figure 4. The influence of N fertilization, during period 1 (1944-1951), on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

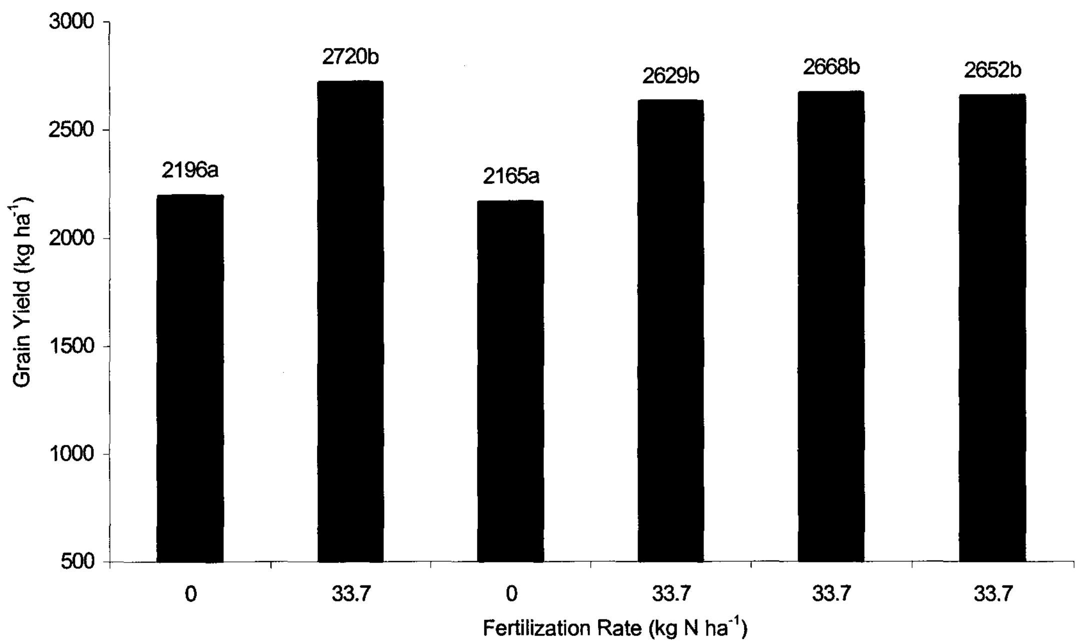

Figure 5. The influence of N fertilization, during period 2 (1952-1961), on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

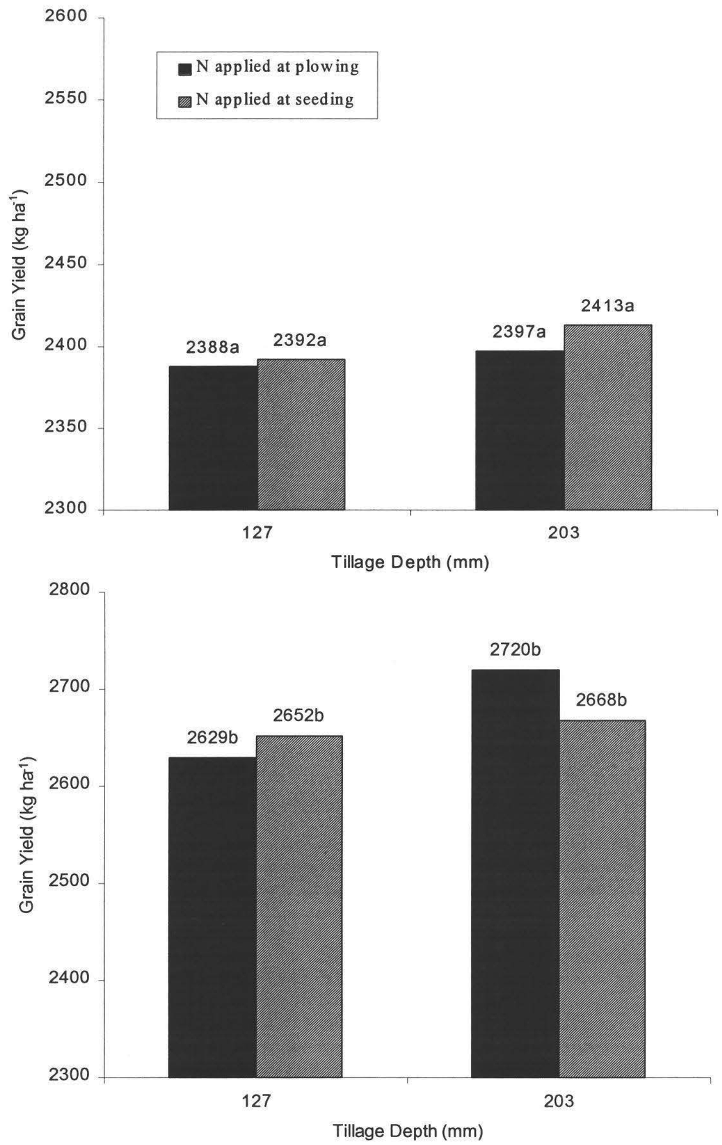

Figure 6. The influence of N application timing on winter wheat for period 1 (1944-1951) and period 2 (1952-1961) for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997. Values without a letter in common are significantly different at the 0.05 probability level, according to Tukey's HSD. The history N application timing as a treatment is listed in Appendix C.

For time period 3 (1962-1987), grain yield increased with the addition of 45 kg N ha^{-1}. However, yield increases at greater rates of N were insignificant. Maximum mean yield was obtained at an application rate of 135 kg N ha^{-1} (Figure 7).

The sulfur effects from ammonium sulfate, prior to 1962, did not significantly increase crop yields (Figure 7). In period 3, however, treatments that received sulfur had slightly greater mean yields than those without S for N rates of 45 kg N ha^{-1} and 90 kg N ha^{-1}.

For time period 4 (1988-1997), grain yield increased with the addition of 90 kg N ha^{-1}. However, yield increases at greater rates of N were insignificant. Maximum mean yield was obtained at an application rate of 135 kg N ha^{-1} (Figures 8).

Rainfall

Precipitation distribution patterns and total precipitation for the 1944 to 1997 period varied among years (See Appendix E). Precipitation means for individual time periods are listed in Table 5. Total precipitation was a significant ($p < 0.01$) covariate for all time periods except period 4 (1988-1997), which had slightly above-normal annual and growing season (April through June) rainfall (Table 6). Growing season and winter precipitation (October through March) were significant ($p < 0.01$) covariates for all time periods except period 1 (1944-1951), which had slightly above-normal growing season plus winter precipitation.

Regression analysis demonstrated that grain yield was positively correlated with annual precipitation (Figure 9) and with growing season plus winter precipitation (October through June) (Figure 10), as should be expected in dryland agriculture.

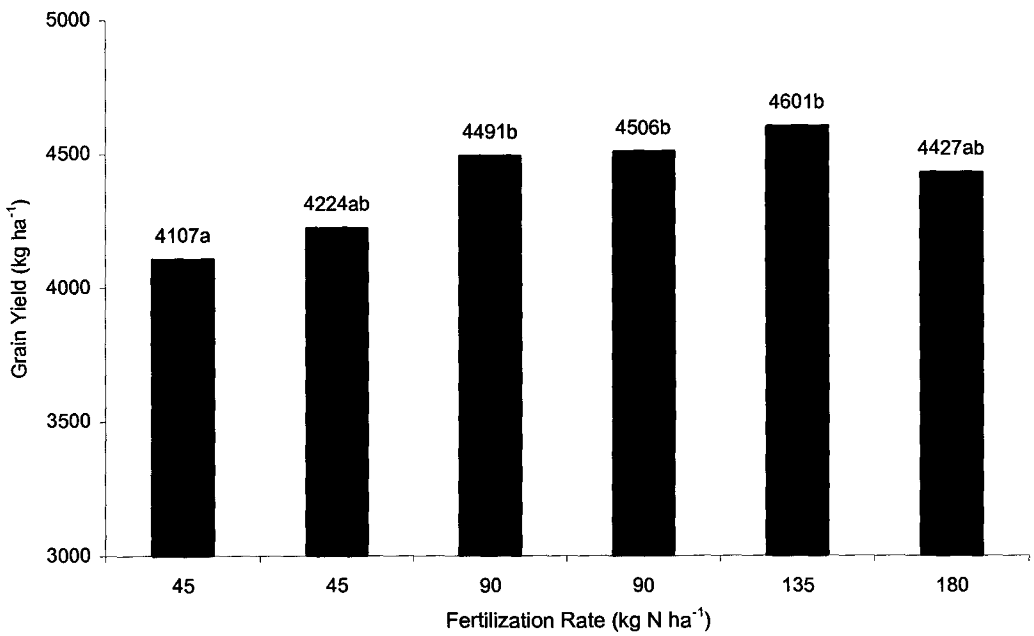

Figure 7. The influence of N fertilization, during period 3 (1962-1987), on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

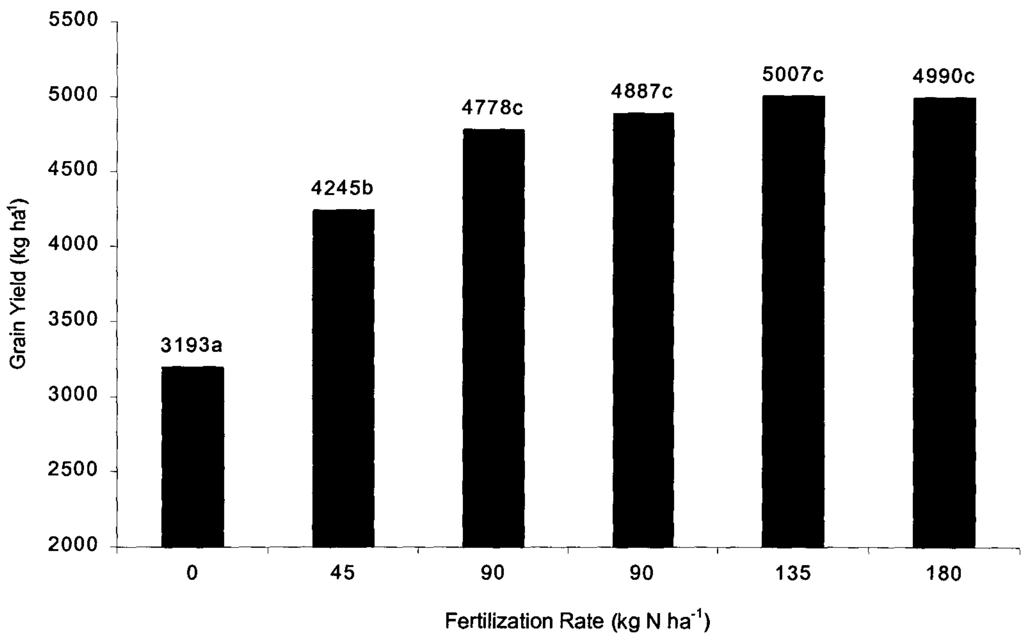

Figure 8. The influence of N fertilization, during period 4 (1988-1997), on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Table 5. Average annual, winter (October-March), and growing season (April-June) precipitation on winter wheat for the four major time periods of the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

	Time Period			
	1944-1951	1952-1961	1962-1987	1988-1997
	millimeters			
Annual Precipitation	426.02	424.23	421.76	429.01
Winter Precipitation	296.86	288.01	298.99	278.64
Growing Season Precipitation	117.35	117.45	93.83	126.16

Table 6. ANOVA results of the effects of annual precipitation and growing season plus winter (October-June) precipitation on winter wheat for the four major time periods of the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997. The distribution of annual precipitation is listed in Appendix E.

		Time Period			
Source of variation	df	1944-1951	1952-1961	1962-1987	1988-1997
		Analysis of Variance			
Annual Precipitation	1	**	***	***	NS
Tillage	2	**	***	***	***
Fertilizer	5	NS	***	***	***
Tillage x Fertilizer	10	NS	NS	NS	NS
		Analysis of Variance			
Growing season precipitation	1	NS	***	***	***
Winter precipitation	1	NS	***	***	**
Tillage	2	**	***	***	***
Fertilizer	5	NS	***	***	***
Tillage x Fertilizer	10	NS	NS	NS	NS

*, **, *** Significant at the 0.05, 0.01, and 0.001 levels, respectively. NS = not significant

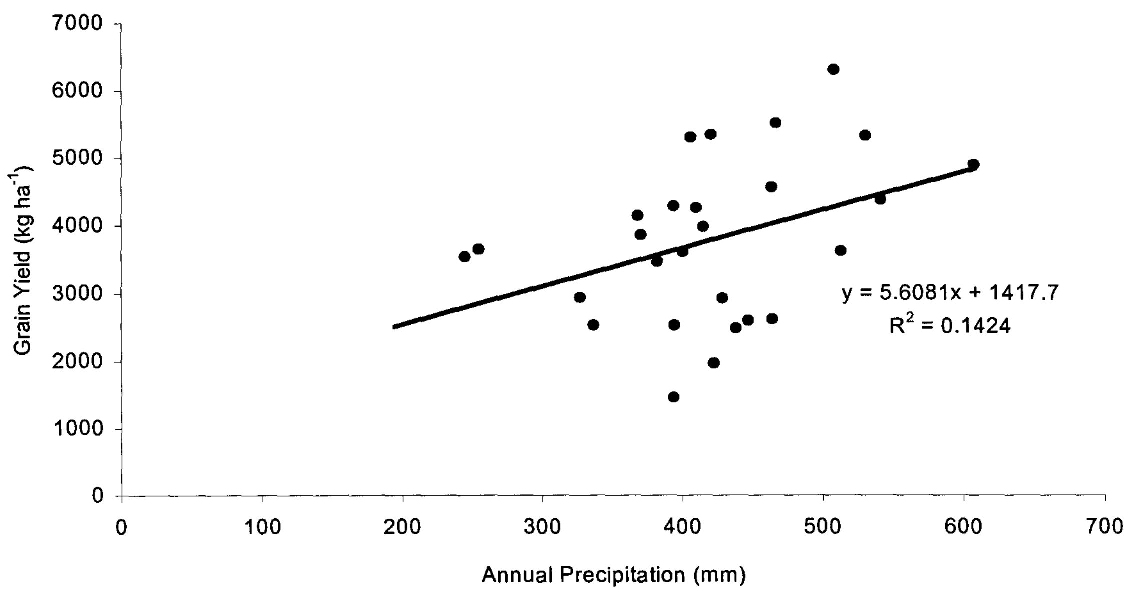

Figure 9. The influence of annual precipitation on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

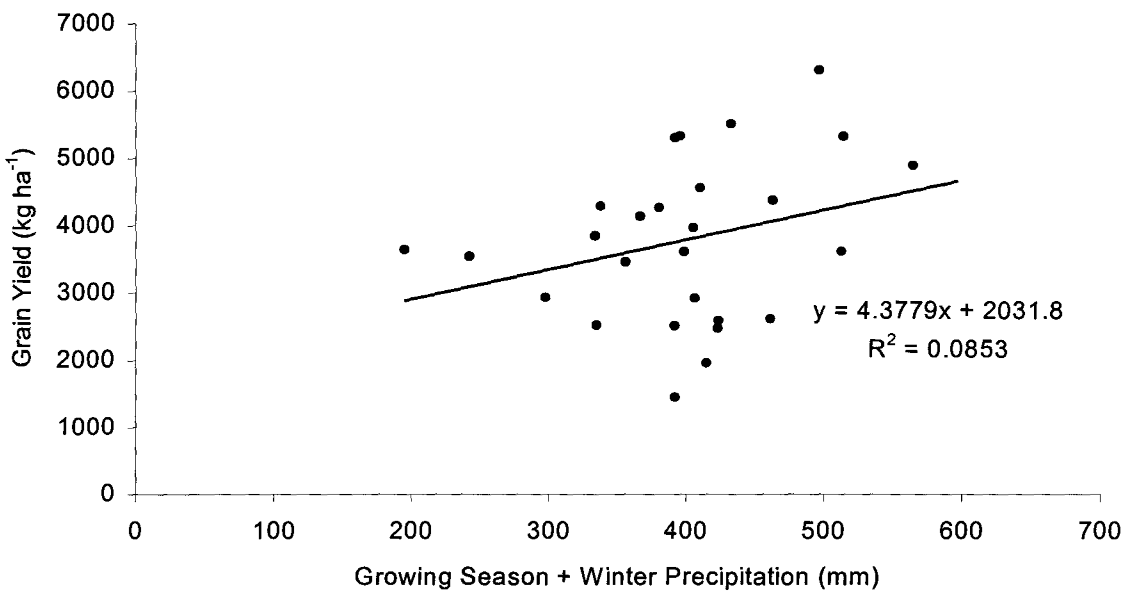

Figure 10. The influence of growing season plus winter (October-June) precipitation on winter wheat for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Interactions between Tillage, Nitrogen and Rainfall

There was a significant ($p < 0.01$) interaction between the covariates soil depth and total precipitation in all of the time periods, except the fourth (1988-1997), during which the annual and growing season precipitation was unusually high (Table 7). This constitutes quantitative evidence of the ameliorating effects of increased soil depth on yield of winter wheat-summer fallow rotations during crop years affected by drought.

The manner in which soil depth and annual precipitation interacted on winter wheat yield is illustrated in Figure 11. Relatively deep soils (> 2.8 m) tended to increase mean yield by more than 1000 kg ha^{-1} over shallow soils in very dry years. However, as the quantity of precipitation increased to more than 400-mm, the effect of soil depth was diminished. This confirms the findings of Rasmussen (1991) who found that grain yield was not affected by soil depth when growing season precipitation was above-normal, but 10 to 20% less when growing season precipitation was below-normal.

In dry areas, deeper soils have the potential to store greater quantities of precipitation, increasing the amount of available water to the crop later in the growing season (Rasmussen et al., 1989a). Rasmussen (1981) found that a 210-cm deep soil could produce a maximum yield of 5034 kg ha^{-1}, while a nearby 110-cm deep soil reached a maximum yield of only 4026 kg ha^{-1}. However, the deeper soil required a greater rate of fertilizer, 90 to 101 kg N ha^{-1}, while the shallow soil reached the maximum yield with 34 to 45 kg N ha^{-1}.

Table 7. ANOVA results of the effects of soil depth and annual precipitation on winter wheat for the four major time periods of the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

		Time Period			
Source of Variation	df	1944-1951	1952-1961	1962-1987	1988-1997
Soil Depth x Annual Precipitation	1	**	***	***	NS
Tillage	2	***	***	***	***
Fertilizer	5	NS	***	***	***
Tillage x Fertilizer	10	NS	NS	NS	NS

*, **, *** Significant at the 0.05, 0.01, and 0.001 levels, respectively. NS = not significant

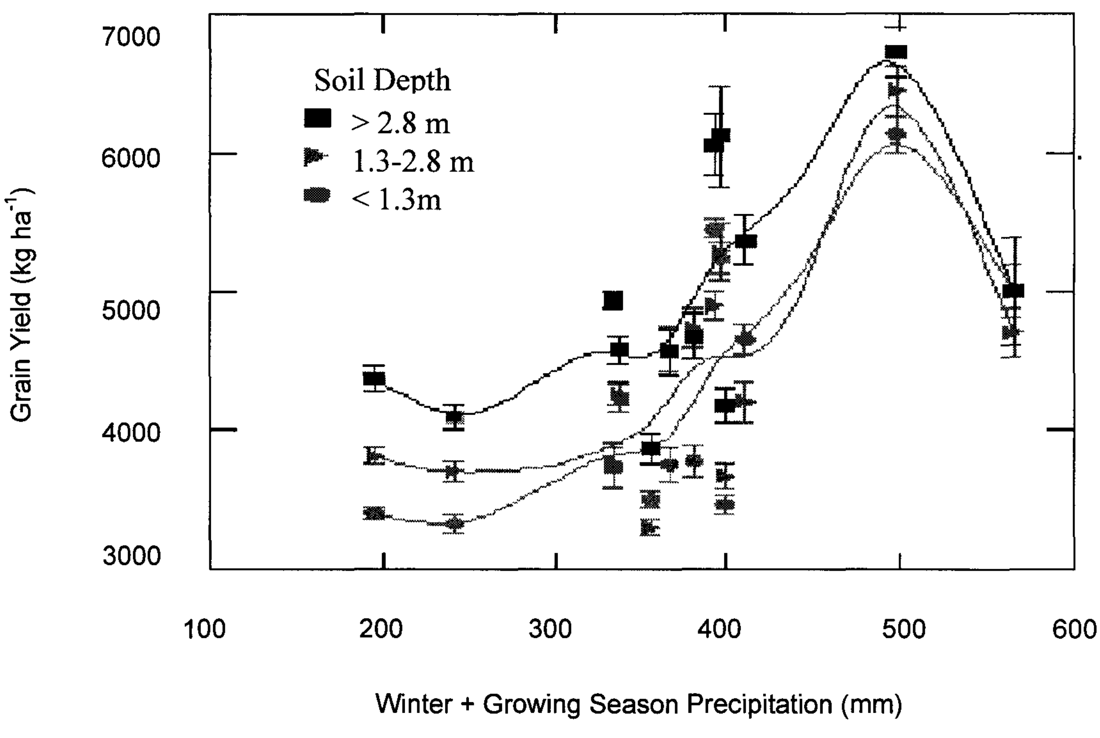

Figure 11. The influence of soil depth and winter plus growing season (October-June) precipitation of winter wheat, during time period 3 (1962-1987), for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997. The points represent the mean yield of individual plots. The bars indicate ± 1 standard error. Curves were generated using distance-weighted least squares.

Time

Figure 12 shows the five-year moving average of winter wheat yield from 1945 to 1997. The solid line represents the highest rate of N applied as a treatment. For time period 1 (1944-1951), this was 11.2 kg N ha^{-1}. For time period 2 (1952-1961), 33.7 kg N ha^{-1} was the maximum rate of fertilizer application. In time periods 3 (1962-1987) and 4 (1988-1997), the maximum fertilization rate was 180 kg N ha^{-1}. The dashed line represents the lowest rate of N fertilizer applied to the experiment. This was 0 kg N ha^{-1} for all time periods, except period 3 during which the lowest rate was 45 kg N ha^{-1}.

Since the experiment was initiated, wheat yields have increased over time. The increase in yield was gradual at first and then rapid after 1960 due primarily to the introduction of semi-dwarf varieties and the increasing rate of fertilizer application. The new semi-dwarf varieties were less susceptible to drought stress and more N responsive. According to Rasmussen (1981), the introduction of semi-dwarf varieties improved yield capability by about 50% irrespective of the level of N input, with an approximate 55 kg ha^{-1} increase in yield per year (Rasmussen et al., 1989b). However, higher yields require larger quantities of nutrients from the soil, and since their introduction, improved varieties have shown only a limited trend towards higher yields when not fertilized with nitrogen, as shown in Figure 12.

Rasmussen et al. (1989a) found that the yield increase without N has been from 45 kg ha^{-1} in the 1930's to 53 kg ha^{-1} in the 1980's. When fertilized with N, the increase has been from 51 kg ha^{-1} in the 1930's to 93 kg ha^{-1} in the 1980's.

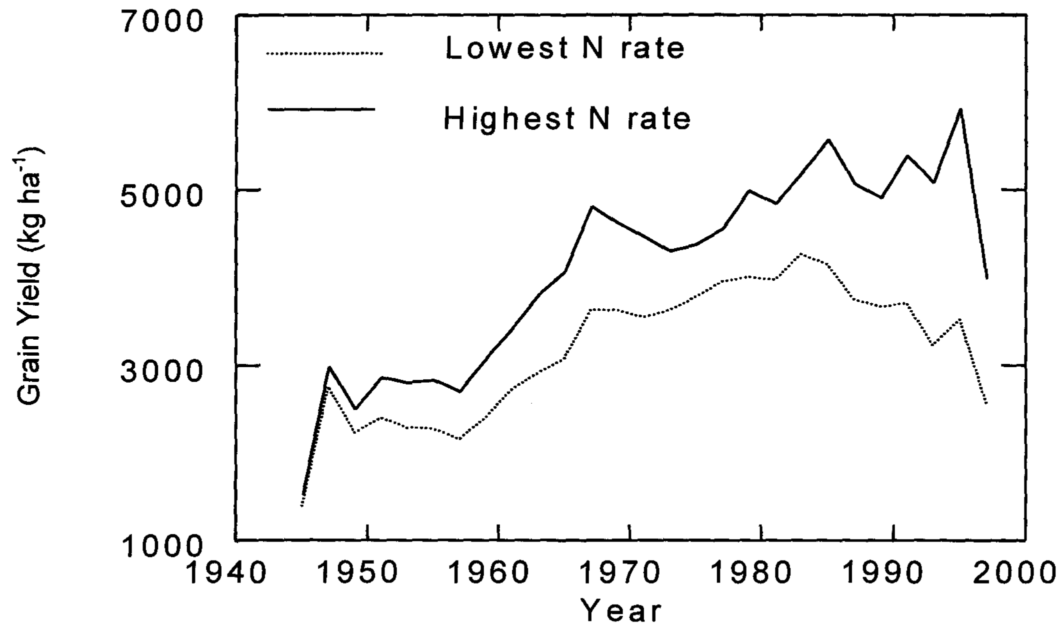

Figure 12. Five-year moving average of winter wheat yields for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

In a study on the Canadian Prairies, Ridely and Hedlin (1980) assessed the contribution of modern technology to the rapidly increasing yields since the 1950's. The increased use of N fertilizer had the most dramatic influence on increasing crop yields, while disease-resistant cultivars had a lesser effect.

Changes in farm operations and tillage and harvesting equipment have also contributed to increasing yields over time. In western Nebraska, Fenster (1988) reported that since the adoption of conservation tillage systems, yields of winter wheat more than doubled on an every-other-year basis and became stable even in years of low precipitation. After examining 80 years of data at Lethbridge, Alberta, researchers suggested that the main factor contributing to increased wheat yields since 1963 was chemical weed control (Freyman et al., 1982). Reductions in herbicide costs and increasing efficiency have made it practical to manage higher weed populations, which are associated with reduced tillage.

Although a dramatic increase in yields is observed after the introduction of semi-dwarf varieties, yield increases since 1975 have been less impressive, and since 1985, yields appear to be declining (Figure 12). If agricultural production in dryland areas is going to continue to be economically and environmentally feasible, the development of new technology is essential. It is likely to be contingent on the development of new varieties, an adequate supply of N to meet crop needs, increased reliance of chemical inputs, most notably fertilizers and herbicides, and the introduction of new and more productive crop rotations.

With current soil erosion rates in the PNW, long-term soil productivity and yield increase seems unlikely. The adoption of conservation systems which maintain surface residue minimize soil erosion, but if yields are reduced, the adoption of this tillage method will be limited. Further research is needed to understand the influence of surface residue on seed germination, N mineralization and immobilization, and weed populations.

CONCLUSIONS

Tillage

Tillage significantly influenced grain yields for all four time periods. Grain yields were consistently greater with a conventional tillage system (moldboard plow) than a conservation system (subsurface sweep), which was attributed to higher stands of downy brome associated with conservation tillage. Because of severe erosion rates on croplands in the Palouse region of the PNW, the implementation of conservation tillage systems would be ideal. However, as the quantity of arable land continues to diminish, reduced yields are unacceptable to both society, as well as farmers' financial survival. Conventional systems will continue to be relied upon until the specific problem of reduced yields under conservation tillage is resolved.

Nitrogen

Fertilizer was a statistically significant variable when greater than 33.7 kg N ha^{-1} was applied. For time period 3 (1962-1987), which had below-normal annual and growing season precipitation, grain yield increased with the addition of 45 kg N ha^{-1}. Because of lower moisture availability, lower rates of N were required to produce maximum yield. For time period 4 (1988-1997), which had an above-normal annual and growing season precipitation, grain yield increased with the addition of 90 kg N ha^{-1}. A greater quantity of N was required to obtain maximum yields. Yield increases at greater rates of N were insignificant, and the maximum mean yield for both time periods was obtained at an application rate of 135 kg N ha^{-1}.

Because N must be applied before the quantity of spring rainfall is known, it is difficult to predict the optimal application amount. When growing season rainfall is high, wheat is very responsive to N, and substantial reductions in yield are observed if inadequate N is applied. If growing season precipitation is low, yield is restricted and considerable N remains in the soil were it is subject to leaching, perpetuating the problem of groundwater contamination. Excessive N application in dry years will also result in economic loss due to over-fertilization, while in years with adequate rainfall, inadequate N application will result in economic loss due to lower grain yields. It is therefore vital to understand the optimal amount of N to apply based on predicted growing season precipitation.

Rainfall

Because soil water is usually depleted before grain maturity and drought is responsible for approximately 70% of wheat crop failures in eastern Oregon, the amount and distribution of rainfall is critical. Grain yield was positively correlated with annual precipitation and with growing season plus winter precipitation, as should be expected in dryland agriculture. However, as the quantity of precipitation increased, the influence of rainfall became less significant. Total precipitation was a significant ($p<0.01$) covariate for all time periods except period 4 (1988-1997), which had slightly above-normal annual and growing season rainfall. Growing season and winter precipitation were significant

($p<0.01$) covariates for all time periods except period 1 (1944-1951), which had slightly above-normal growing season plus winter precipitation.

Time

Improved tillage and harvesting equipment, the development of improved crop varieties, and increased reliance on agricultural chemicals, most notably fertilizer and herbicides, have completely modified farming. Before 1960, increases in yield were attributed to increases in acreage under agricultural productions. Since then, however, yields have continued to rise, while the area of land under cultivation has declined. The introduction of N responsive semi-dwarf wheat varieties in the early 1960's, coupled with the addition of commercial N fertilizers, have made it possible to more fully utilize the production potential of the new varieties and make land with lower fertility cultivable. Reductions in herbicide costs and increasing efficiency have made it practical to manage weed populations with reduced tillage. As the amount of arable land is finite, reliance on technology to maintain and increase agricultural production to feed a growing world is inevitable. The long-term maintenance of experiments such as this provide a perspective on the sustainability of N fertilization and tillage practices which often cannot be established when studies are conducted for a shorter time frame.

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APPENDICES

Appendix A. History of Oregon Wheat Yield

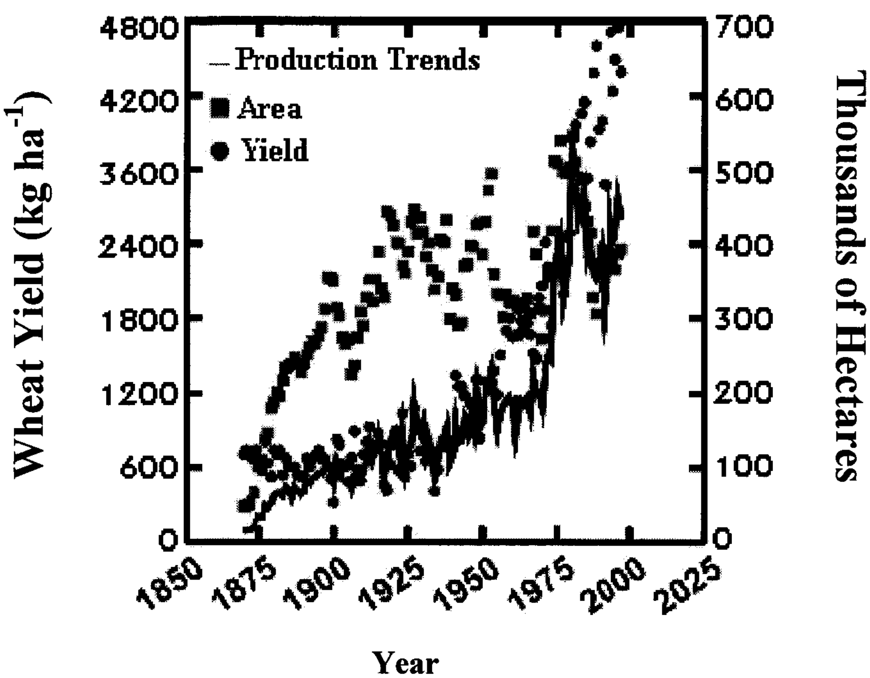

Figure A.1. Production trends, area under cultivation, and wheat yields for Oregon, 1869 to 1997 (adapted from USDA, 1999).

Appendix B. The Tillage/ Fertility Experiment

Figure B.1. Aerial photograph of the Columbia Basin Agricultural Research Center in Pendleton, Oregon. (Photograph compliments of Dr. Richard Smiley)

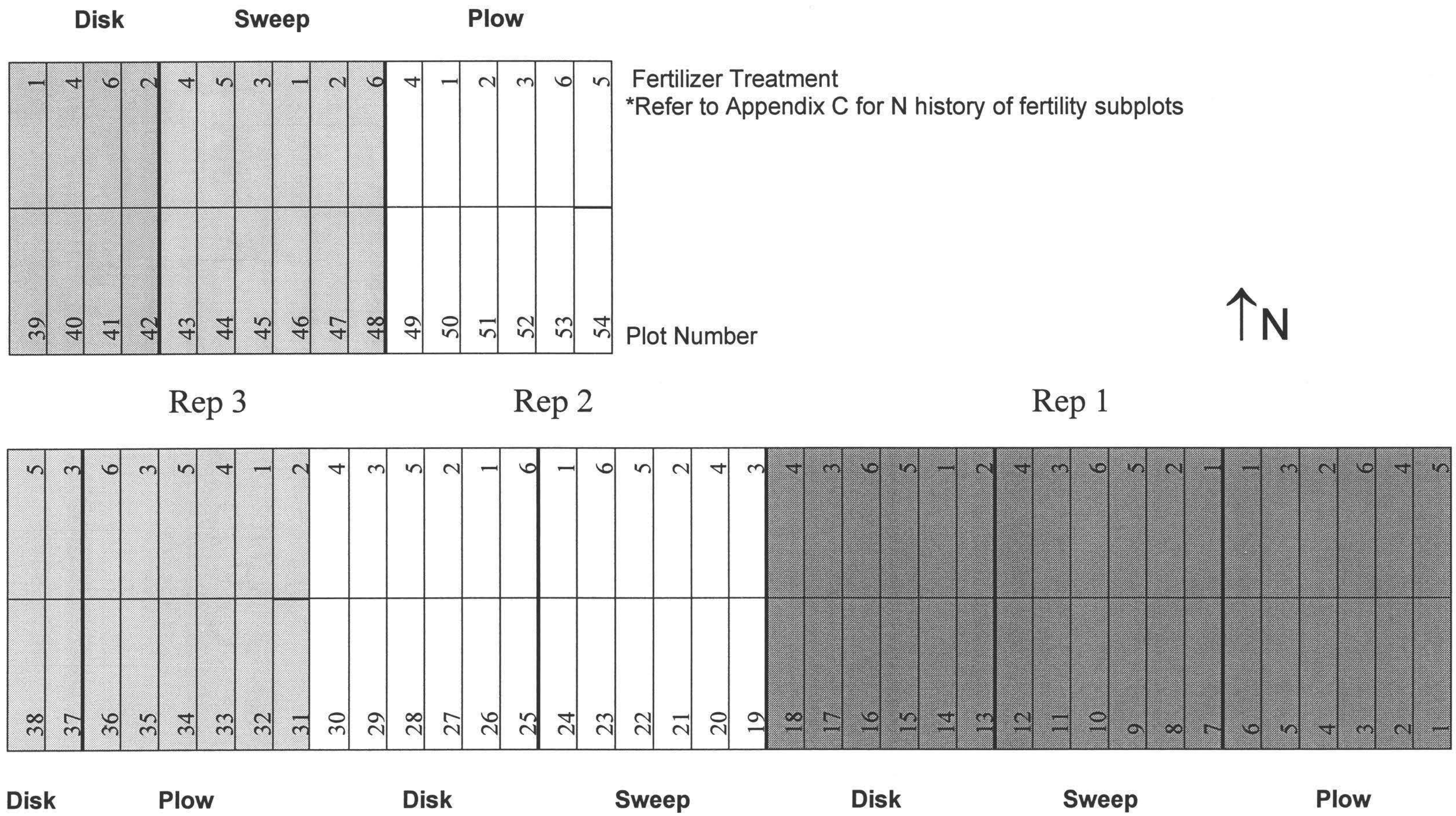

Figure B.2. The experimental design of the Tillage/ Fertility Experiment at Pendleton, Oregon.

Figure B.3. Tillage implements used for the Tillage/ Fertility Experiment at Pendleton, Oregon.
A- Moldboard Plow; B- Offset Disk; C- Subsurface Sweep; D- Rodweeder; E-Combine at Harvest; F- Field after Harvest

Appendix C. History of N fertilization, tillage depth, and timing of N application

Table C.1. Nitrogen history of fertility subplots for the four major time periods of the Tillage/Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Fertility Subplot	Period 1 (1944-1951)	Period 2 (1952-1961)	Period 3 (1962-1987)	Period 4 (1988-1997)
	Nitrogen Rate			
	kg ha^{-1}			
1	0 AS	0 AS	45 AN	0 URAN
2	11.2 AS	33.7 AS	45 AN	45 URAN
3	0 AS	0 AS	90 AN	90 URAN
4	11.2 AS	33.7 AS	91 AN	90 URAN
5	11.2 AS	33.7 AS	135 AN	135 URAN
6	11.2 AS	33.7 AS	180 AN	180 URAN

† AS = Ammonium sulfate; AN = Ammonium nitrate; URAN = Urea ammonium nitrate

Table C.2. Treatment history for tillage depth and timing of N application for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Fertility Subplot	Sulfur History	Nitrogen Treatment 1944-1951	Nitrogen Treatment 1952-1961	Application Timing	Tillage Depth
		kg ha^{-1}			mm
1	No	0 AS	0 AS	Plowing	203
2	Yes	11.2 AS	33.7 AS	-	203
3	No	0 AS	0 AS	Plowing	127
4	Yes	11.2 AS	33.7 AS	-	127
5	Yes	11.2 AS	33.7 AS	Seeding	203
6	Yes	11.2 AS	33.7 AS	Seeding	127

† AS = Ammonium sulfate

Appendix D. A detailed description of individual years

1961

Plots treated with the subsurface sweep were tilled twice prior to seeding for control of downy brome (Bromus tectorum). The experiment was seeded using a semi-deep furrow drill at 254-mm band spacing on October 15, 1960, at a rate of 56.1 kg ha^{-1}. The wheat seedlings had emerged by October 25, but were accompanied by another crop of downy brome. The entire area was sprayed with one pound of actual Semisin per acre in 75.7 liters of water, resulting in a clean stand of wheat, except for a minor amount of brome in the second replication of sweep plots. An infestation of stripe rust (Puccinia striiformis) affected all treatments in the experiment.

1963

Tillage was initiated in the spring of 1962 using a moldboard plow, offset disk, and 406.5-mm sweeps on a John Deere tool carrier. Following the initial tillage, plots treated with the moldboard plow were cultivated with a spring tooth harrow. Offset disk and subsurface sweep plots were treated with a skew treader. Weed infested plots were additionally treated with the rodweeder as needed.

In the fall of 1962, the plots were cultivated with the spring tooth harrow prior to seeding to kill downy brome seedlings, which were abundant on the plots tilled with the subsurface sweep and only slightly less abundant on areas treated with the offset disk. The entire area was fertilized with 45 kg N ha^{-1} using a Barber spreader, followed by individual plots receiving additional ammonium nitrate at the proposed rates.

The area was seeded to Gaines winter wheat at a rate of 50.5 kg ha^{-1} on October 2. Following the emergence of the wheat, stands of downy brome and fiddleneck tarweed (Amsinckia intermeida) were evident, especially on the plots tilled with the subsurface sweep. On November 21, the entire experiment was sprayed with 1.1 kg of atrazine [6-chloro-N-ethyl-N'-(1-methylethyl)$^{-1}$, 3, 5-triazine-2,4-diamine] per hectare, 80 percent material in 60.5 liters of water. Twelve meters across two series of plots, the atrazine rate was doubled.

1965

Tillage for the summer fallow in 1964 commenced in the early spring using a moldboard plow, an offset disk, and 406.5-mm sweeps on a John Deere tool carrier. Following the initial tillage, plots treated with the moldboard plow were cultivated with a spring tooth harrow. The offset disk and subsurface sweep plots were treated with a skew treader. Weed infested plots were additionally treated with the rodweeder as needed.

In the fall of 1964, the plots were cultivated with the spring tooth harrow just prior to seeding to kill germinating brome. Brome infestations were severe on the plots tilled with the subsurface sweep, less severe on areas treated with the offset disk, and negligible on areas tilled with the moldboard plow. The entire area was fertilized with 45 kg N ha^{-1} using a Barber spreader, followed by individual plots receiving additional ammonium nitrate at the proposed rates.

The area was seeded to Gaines winter wheat with a semi-deep furrow drill with 152-mm band spacing on October 21 at a rate of 55.1 kg ha^{-1}. By November 19, uniform wheat stands had established throughout the experiment. Following the wheat emergence, all plots were sprayed with 0.9 kg of (actual) atrazine per hectare to control the downy brome, which was the most severe on the plots tilled with the subsurface sweep.

In the spring of 1965, considerable herbicide damage to the wheat, especially on the sweep plots, was apparent.

1967

Tillage operations were performed early in the spring of 1966. The fertilizer treatments were applied on October 5, and the experiment was seeded to Gaines wheat on October 6. Good stands of wheat were apparent on all plots. However, a serious infestation of downy brome occurred, particularly on the sweep plots treated with high rates of nitrogen. The plots were sprayed with 1.1 kg of atrazine per hectare on November 7, which controlled much of the brome, but resulted in reduced yields on the plots treated with the subsurface sweep.

1969

Tillage operations were performed early in the spring of 1968, and fertilizer treatments were applied prior to seeding. The plots were seeded with Nugaines on

October 11 at a rate of 37 kg ha^{-1}. The first seeding was removed due to a heavy infestation of brome, which accompanied the wheat emergence. The skew treader was used to cultivate areas, which had been heavily infested with brome, and the experiment was reseeded to Nugaines on November 4. The plots were sprayed with 4.4 kg ha^{-1} of active ingredient of R111913-75W on February 18. Although the herbicide effectively controlled the brome, wheat damage was apparent, especially on plots treated with the subsurface sweep.

1971

Tillage was initiated early in the spring of 1970, and the fertilizer treatments were applied prior to seeding. The plots were initially seeded to Nugaines on October 5, but were retilled due to a heavy infestation of downy brome, as well as poor wheat seedling emergence. To control the brome, the plots were sprayed with 0.6 kg per hectare of atrazine.

1973

Tillage operations were performed early in the spring of 1972, and the fertilizer treatments were applied prior to seeding. It was necessary to rodweed the plots eight times for downy brome control.

1975

Tillage was initiated early in the spring of 1974, and the fertilizer treatments were applied prior to seeding. Stands of downy brome, which were severe on plots tilled with the subsurface sweep, moderately severe for disked plots, and negligible for the plow treatment, required the plots to be rodweeded on October 15 and November 5. This delayed seeding until November 8.

1977

Tillage operations were performed on April 22, 1982, and the plots were fertilized with Union 76 on October 5. Following the initial tillage, areas cultivated with the moldboard plow were spring-tooth harrowed. Plots tilled with the offset disk and the subsurface sweep were treated with a skew treader. Plots were additionally treated with the rodweeder on May 18, June 21, July 6, August 4, August 23, and August 26.

The plots were seeded to Stephens wheat on October 5 using an International drill at a 51-mm depth. The plots were sprayed with 0.35 liters of Roundup [(2,4-dichlorophenoxy) acetic acid] on March 22, 1983.

1985

Tillage operations were performed on April 22, 1984, and the plots were fertilized with Cenex on September 28. Following initial tillage, the moldboard plow plots were spring-tooth harrowed on May 25. Plots were rodweeded on May 30, June 28, August 1, August 28, and September 9. The plots were seeded to Stephens wheat on October 10 using an International drill at a 38.1-mm depth and at a rate of 75.2 kg ha^{-1}.

Appendix E. Distribution of annual precipitation

Table E.1. The distribution of annual precipitation at Pendleton, Oregon, 1944 to 1997.

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL	W	G	W + G
	------------	------------	------------	------------	------------	------------	------------	------------	-millimeters-	------------	------------	------------	------------	------------	------------	------------
1944	0.00	54.10	11.43	27.18	15.75	61.47	23.11	60.71	18.54	24.13	0.51	4.83	301.75	193.04	103.38	296.42
1945	28.19	11.94	31.24	19.81	55.12	58.17	73.66	43.18	58.42	12.45	0.00	1.78	393.95	278.13	114.05	392.18
1946	36.83	13.46	93.22	49.28	60.71	26.67	43.18	20.32	74.93	32.77	4.32	2.03	457.71	323.34	128.02	451.36
1947	17.53	59.69	48.26	50.55	28.96	12.45	32.77	58.17	19.05	79.50	16.00	6.10	429.01	250.19	156.72	406.91
1948	16.26	71.63	63.25	83.82	47.24	49.02	30.73	66.29	64.77	60.20	44.20	0.00	597.41	361.95	191.26	553.21
1949	18.80	17.27	44.20	93.47	8.64	61.98	40.89	10.41	34.04	5.84	1.02	0.00	336.55	285.24	50.29	335.53
1950	17.78	22.35	54.61	32.26	67.82	32.26	55.37	32.77	21.59	79.50	2.79	8.38	427.48	282.45	133.86	416.31
1951	4.32	106.68	70.61	72.90	62.23	37.34	46.48	17.78	11.94	31.50	2.54	0.00	464.31	400.56	61.21	461.77
1952	13.46	78.23	42.93	35.31	29.46	47.50	27.94	29.21	34.29	61.72	0.00	0.00	400.05	274.83	125.22	400.05
1953	13.97	3.05	12.95	60.20	94.23	51.05	59.18	38.35	57.91	32.77	0.00	14.73	438.40	294.64	129.03	423.67
1954	0.00	27.69	55.12	62.23	48.01	19.05	22.35	24.13	23.37	38.86	17.02	28.19	366.01	234.44	86.36	320.80
1955	15.49	25.65	32.00	38.10	33.02	18.54	33.27	55.37	34.29	12.45	29.21	0.00	327.41	196.09	102.11	298.20
1956	26.92	59.18	81.03	64.26	92.46	34.54	23.88	3.05	111.25	24.13	8.38	34.29	563.37	382.27	138.43	520.70
1957	1.52	49.53	16.51	41.66	44.70	42.93	85.34	21.08	70.87	18.03	0.76	1.52	394.46	282.19	109.98	392.18
1958	17.02	62.48	33.78	62.74	69.60	38.61	41.40	89.92	43.18	52.07	0.00	0.51	511.30	325.63	185.17	510.79
1959	10.41	4.57	61.21	87.63	75.18	58.42	40.13	21.59	36.07	28.96	4.32	18.80	447.29	337.57	86.61	424.18
1960	57.40	24.13	12.70	18.54	46.23	30.48	57.15	32.51	51.56	18.29	0.00	22.35	371.35	246.63	102.36	349.00
1961	20.83	39.37	72.14	22.10	18.03	83.06	50.29	40.39	41.66	27.18	2.29	5.33	422.66	305.82	109.22	415.04
1962	9.91	21.84	40.39	56.64	23.11	18.54	63.25	28.45	86.36	6.60	0.00	17.02	372.11	233.68	121.41	355.09
1963	29.97	68.58	51.82	45.47	29.21	47.75	25.65	59.69	15.75	6.86	14.48	14.73	409.96	298.45	82.30	380.75
1964	17.27	10.67	77.22	32.51	44.20	10.41	31.50	18.80	3.81	32.77	28.45	5.84	313.44	223.77	55.37	279.15
1965	15.49	31.50	45.97	112.52	97.54	11.94	5.33	29.46	26.16	34.80	19.05	33.78	463.55	320.29	90.42	410.72
1966	5.08	12.95	57.91	11.43	59.69	18.03	43.69	12.95	10.92	25.15	28.96	4.32	291.08	208.79	49.02	257.81
1967	11.68	27.94	58.42	72.64	71.12	8.13	38.35	40.64	24.13	13.97	1.02	0.00	368.05	288.29	78.74	367.03
1968	14.22	29.72	33.02	19.30	18.80	60.71	26.42	5.33	16.51	28.19	8.64	19.56	280.42	202.18	50.04	252.22
1969	21.08	34.54	68.83	67.31	66.55	19.81	10.92	58.67	32.00	19.05	1.52	0.00	400.30	289.05	109.73	398.78
1970	16.51	35.81	11.18	60.71	132.84	38.10	47.50	26.67	15.75	21.59	2.79	1.27	410.72	342.65	64.01	406.65
1971	25.91	35.56	56.39	25.91	36.58	19.56	32.51	41.91	42.16	79.76	16.00	8.38	420.62	232.41	163.83	396.24
1972	36.07	43.69	79.76	99.82	29.21	43.18	53.59	34.29	38.10	23.11	19.30	8.89	509.02	385.32	95.50	480.82
1973	12.45	16.76	28.96	62.74	22.61	22.61	32.26	14.73	26.16	3.05	0.00	2.29	244.60	198.37	43.94	242.32

† W = winter precipitation; G = growing season precipitation

Table E.1. The distribution of annual precipitation at Pendleton, Oregon, 1944 to 1997 (continued).

YEAR	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	TOTAL	W	G	W + G
	millimeters															
1974	44.96	31.50	148.84	111.76	32.77	50.80	38.10	92.46	9.65	8.38	33.02	0.00	602.23	458.72	110.49	569.21
1975	0.51	8.89	39.62	44.70	94.74	42.67	24.64	43.69	17.27	17.53	1.27	35.05	370.59	255.78	78.49	334.26
1976	0.00	54.86	37.34	86.36	54.10	27.69	42.93	41.91	30.73	14.73	1.02	65.53	457.20	303.28	87.38	390.65
1977	11.18	13.46	11.94	14.99	22.86	14.48	43.69	11.68	43.18	7.87	3.05	56.13	254.51	132.59	62.74	195.33
1978	39.12	17.53	45.47	81.03	57.66	43.43	35.56	88.90	20.57	32.26	14.99	34.80	511.30	319.79	141.73	461.52
1979	40.89	0.00	42.67	57.91	33.27	39.12	44.20	46.23	29.21	4.57	3.05	52.83	393.95	258.06	80.01	338.07
1980	4.32	65.02	58.67	26.67	72.39	39.37	53.85	30.48	62.23	36.07	5.84	4.57	459.49	320.29	128.78	449.07
1981	31.50	75.18	45.97	50.55	32.00	58.67	58.42	32.77	58.42	53.85	10.16	0.51	508.00	352.30	145.03	497.33
1982	38.35	41.15	61.21	83.06	66.29	47.24	50.55	39.12	12.19	28.45	25.91	12.70	506.22	387.86	79.76	467.61
1983	42.67	68.07	37.08	68.33	41.40	75.44	99.06	31.24	52.83	48.77	25.40	17.27	607.57	432.05	132.84	564.90
1984	20.83	23.11	70.87	87.38	25.15	65.02	82.04	60.20	53.59	52.07	1.27	31.75	573.28	374.40	165.86	540.26
1985	24.89	29.97	87.12	49.78	17.53	37.85	33.78	16.51	22.61	36.07	1.27	24.89	382.27	280.92	75.18	356.11
1986	39.12	34.04	67.56	32.26	60.45	77.22	49.28	21.08	45.47	2.29	15.49	4.83	449.07	359.92	68.83	428.75
1987	47.50	23.11	86.61	24.13	52.83	33.27	46.99	21.08	41.40	15.75	11.94	1.52	406.15	314.45	78.23	392.68
1988	1.02	0.00	36.58	40.89	66.04	8.13	41.91	65.79	45.47	23.88	0.00	0.00	329.69	194.56	135.13	329.69
1989	10.16	2.03	92.71	27.94	72.64	39.37	74.93	49.28	55.63	8.38	3.81	30.23	467.11	319.79	113.28	433.07
1990	6.10	25.40	41.91	12.45	36.32	16.00	48.01	44.96	54.36	17.78	9.40	19.30	331.98	186.18	117.09	303.28
1991	0.00	34.80	43.94	29.97	29.21	21.84	43.43	25.65	120.14	56.39	3.81	6.10	415.29	203.20	202.18	405.38
1992	0.76	22.61	106.17	24.64	24.38	34.04	21.59	32.77	5.08	22.86	44.20	19.81	358.90	234.19	60.71	294.89
1993	14.73	43.18	66.29	33.02	61.72	26.42	58.93	67.82	40.13	51.05	11.94	66.04	541.27	304.29	159.00	463.30
1994	0.00	7.62	12.45	48.51	60.45	42.42	13.21	29.97	73.15	19.05	8.38	1.78	316.99	184.66	122.17	306.83
1995	19.30	36.58	95.76	46.48	69.85	29.21	59.69	74.17	39.62	43.94	5.59	10.41	530.61	356.87	157.73	514.60
1996	23.62	34.29	74.93	60.20	70.87	62.23	37.85	59.18	50.80	9.91	0.00	1.27	485.14	363.98	119.89	483.87
1997	16.76	50.55	77.47	107.44	69.60	40.64	76.20	62.48	11.68	0.25	0.00	0.00	513.08	438.66	74.42	513.08

† W = winter precipitation; G = growing season precipitation

Appendix F. Tillage/ Fertility data used in the analysis

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1941	1	1	1	5	2600
1941	2	1	1	4	2291
1941	3	1	1	6	2291
1941	4	1	1	2	2600
1941	5	1	1	3	2291
1941	6	1	1	1	2600
1941	7	1	3	1	2452
1941	8	1	3	2	2452
1941	9	1	3	5	2399
1941	10	1	3	6	2399
1941	11	1	3	3	2399
1941	12	1	3	4	2452
1941	13	1	2	2	2493
1941	14	1	2	1	2587
1941	15	1	2	5	2493
1941	16	1	2	6	2587
1941	17	1	2	3	2493
1941	18	1	2	4	2587
1941	19	2	3	3	2452
1941	20	2	3	4	2399
1941	21	2	3	2	2452
1941	22	2	3	5	2452
1941	23	2	3	6	2399
1941	24	2	3	1	2399
1941	25	2	2	6	2493
1941	26	2	2	1	2587
1941	27	2	2	2	2587
1941	28	2	2	5	2493
1941	29	2	2	3	2493
1941	30	2	2	4	2587
1941	31	3	1	2	2291
1941	32	3	1	1	2600
1941	33	3	1	4	2291
1941	34	3	1	5	2600
1941	35	3	1	3	2291
1941	36	3	1	6	2600
1941	37	3	2	3	2493
1941	38	3	2	5	2493
1941	39	3	2	1	2587
1941	40	3	2	4	2493
1941	41	3	2	6	2587
1941	42	3	2	2	2587
1941	43	3	3	4	2452
1941	44	3	3	5	2399
1941	45	3	3	3	2399

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1941	46	3	3	1	2452
1941	47	3	3	2	2399
1941	48	3	3	6	2452
1941	49	2	1	4	2291
1941	50	2	1	1	2600
1941	51	2	1	2	2291
1941	52	2	1	3	2291
1941	53	2	1	6	2600
1941	54	2	1	5	2600
1943	1	1	1	5	3171
1943	2	1	1	4	3218
1943	3	1	1	6	3218
1943	4	1	1	2	3171
1943	5	1	1	3	3218
1943	6	1	1	1	3171
1943	7	1	3	1	2392
1943	8	1	3	2	2392
1943	9	1	3	5	2298
1943	10	1	3	6	2298
1943	11	1	3	3	2298
1943	12	1	3	4	2392
1943	13	1	2	2	2667
1943	14	1	2	1	2862
1943	15	1	2	5	2667
1943	16	1	2	6	2862
1943	17	1	2	3	2667
1943	18	1	2	4	2862
1943	19	2	3	3	2392
1943	20	2	3	4	2298
1943	21	2	3	2	2392
1943	22	2	3	5	2392
1943	23	2	3	6	2298
1943	24	2	3	1	2298
1943	25	2	2	6	2667
1943	26	2	2	1	2862
1943	27	2	2	2	2862
1943	28	2	2	5	2667
1943	29	2	2	3	2667
1943	30	2	2	4	2862
1943	31	3	1	2	3218
1943	32	3	1	1	3171
1943	33	3	1	4	3218
1943	34	3	1	5	3171
1943	35	3	1	3	3218
1943	36	3	1	6	3171

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1943	37	3	2	3	2667
1943	38	3	2	5	2667
1943	39	3	2	1	2862
1943	40	3	2	4	2667
1943	41	3	2	6	2862
1943	42	3	2	2	2862
1943	43	3	3	4	2392
1943	44	3	3	5	2298
1943	45	3	3	3	2298
1943	46	3	3	1	2392
1943	47	3	3	2	2298
1943	48	3	3	6	2392
1943	49	2	1	4	3218
1943	50	2	1	1	3171
1943	51	2	1	2	3218
1943	52	2	1	3	3218
1943	53	2	1	6	3171
1943	54	2	1	5	3171
1945	1	1	1	5	1162
1945	2	1	1	4	887
1945	3	1	1	6	887
1945	4	1	1	2	1277
1945	5	1	1	3	1377
1945	6	1	1	1	1377
1945	7	1	3	1	988
1945	8	1	3	2	1183
1945	9	1	3	5	1230
1945	10	1	3	6	1377
1945	11	1	3	3	1088
1945	12	1	3	4	1109
1945	13	1	2	2	1438
1945	14	1	2	1	1478
1945	15	1	2	5	1263
1945	16	1	2	6	1330
1945	17	1	2	3	1297
1945	18	1	2	4	1592
1945	19	2	3	3	1431
1945	20	2	3	4	1290
1945	21	2	3	2	1310
1945	22	2	3	5	1411
1945	23	2	3	6	1599
1945	24	2	3	1	1807
1945	25	2	2	6	1700
1945	26	2	2	1	1727
1945	27	2	2	2	1767

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1945	28	2	2	5	1653
1945	29	2	2	3	1579
1945	30	2	2	4	1801
1945	31	3	1	2	1747
1945	32	3	1	1	1700
1945	33	3	1	4	1337
1945	34	3	1	5	1418
1945	35	3	1	3	1263
1945	36	3	1	6	1317
1945	37	3	2	3	1532
1945	38	3	2	5	1552
1945	39	3	2	1	1767
1945	40	3	2	4	1633
1945	41	3	2	6	1660
1945	42	3	2	2	1700
1945	43	3	3	4	1633
1945	44	3	3	5	1680
1945	45	3	3	3	1680
1945	46	3	3	1	1633
1945	47	3	3	2	1633
1945	48	3	3	6	1572
1945	49	2	1	4	1391
1945	50	2	1	1	1613
1945	51	2	1	2	1431
1945	52	2	1	3	1330
1945	53	2	1	6	1532
1945	54	2	1	5	1478
1947	1	1	1	5	3017
1947	2	1	1	4	2842
1947	3	1	1	6	2889
1947	4	1	1	2	3111
1947	5	1	1	3	3017
1947	6	1	1	1	2909
1947	7	1	3	1	2641
1947	8	1	3	2	2641
1947	9	1	3	5	2909
1947	10	1	3	6	2741
1947	11	1	3	3	2567
1947	12	1	3	4	2762
1947	13	1	2	2	2842
1947	14	1	2	1	3138
1947	15	1	2	5	2997
1947	16	1	2	6	2762
1947	17	1	2	3	2909
1947	18	1	2	4	3017

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1947	19	2	3	3	3138
1947	20	2	3	4	2741
1947	21	2	3	2	2708
1947	22	2	3	5	2762
1947	23	2	3	6	2997
1947	24	2	3	1	3111
1947	25	2	2	6	3091
1947	26	2	2	1	3017
1947	27	2	2	2	2802
1947	28	2	2	5	2956
1947	29	2	2	3	3138
1947	30	2	2	4	3111
1947	31	3	1	2	3178
1947	32	3	1	1	3091
1947	33	3	1	4	2802
1947	34	3	1	5	3111
1947	35	3	1	3	3158
1947	36	3	1	6	3467
1947	37	3	2	3	2600
1947	38	3	2	5	2889
1947	39	3	2	1	2822
1947	40	3	2	4	2782
1947	41	3	2	6	2688
1947	42	3	2	2	2667
1947	43	3	3	4	2399
1947	44	3	3	5	2473
1947	45	3	3	3	3158
1947	46	3	3	1	3091
1947	47	3	3	2	2762
1947	48	3	3	6	2526
1947	49	2	1	4	2372
1947	50	2	1	1	3427
1947	51	2	1	2	3138
1947	52	2	1	3	3312
1947	53	2	1	6	3212
1947	54	2	1	5	3380
1949	1	1	1	5	3037
1949	2	1	1	4	2708
1949	3	1	1	6	2869
1949	4	1	1	2	3138
1949	5	1	1	3	2956
1949	6	1	1	1	3017
1949	7	1	3	1	1807
1949	8	1	3	2	1969
1949	9	1	3	5	2103

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1949	10	1	3	6	2372
1949	11	1	3	3	2298
1949	12	1	3	4	2331
1949	13	1	2	2	2513
1949	14	1	2	1	2331
1949	15	1	2	5	2258
1949	16	1	2	6	2372
1949	17	1	2	3	2473
1949	18	1	2	4	2493
1949	19	2	3	3	2331
1949	20	2	3	4	2197
1949	21	2	3	2	2278
1949	22	2	3	5	1949
1949	23	2	3	6	2237
1949	24	2	3	1	2419
1949	25	2	2	6	2741
1949	26	2	2	1	2547
1949	27	2	2	2	2641
1949	28	2	2	5	2782
1949	29	2	2	3	2493
1949	30	2	2	4	2741
1949	31	3	1	2	2842
1949	32	3	1	1	2741
1949	33	3	1	4	2620
1949	34	3	1	5	2641
1949	35	3	1	3	2667
1949	36	3	1	6	2782
1949	37	3	2	3	2600
1949	38	3	2	5	2620
1949	39	3	2	1	2600
1949	40	3	2	4	2600
1949	41	3	2	6	2526
1949	42	3	2	2	2352
1949	43	3	3	4	2641
1949	44	3	3	5	2150
1949	45	3	3	3	2063
1949	46	3	3	1	2150
1949	47	3	3	2	2258
1949	48	3	3	6	2473
1949	49	2	1	4	2567
1949	50	2	1	1	2822
1949	51	2	1	2	2782
1949	52	2	1	3	2741
1949	53	2	1	6	2782
1949	54	2	1	5	2956

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1951	1	1	1	5	3541
1951	2	1	1	4	3507
1951	3	1	1	6	3339
1951	4	1	1	2	3400
1951	5	1	1	3	2392
1951	6	1	1	1	2399
1951	7	1	3	1	1740
1951	8	1	3	2	2184
1951	9	1	3	5	2217
1951	10	1	3	6	2311
1951	11	1	3	3	2029
1951	12	1	3	4	2372
1951	13	1	2	2	2728
1951	14	1	2	1	2063
1951	15	1	2	5	2647
1951	16	1	2	6	2331
1951	17	1	2	3	*
1951	18	1	2	4	*
1951	19	2	3	3	*
1951	20	2	3	4	1740
1951	21	2	3	2	1969
1951	22	2	3	5	1848
1951	23	2	3	6	2184
1951	24	2	3	1	1969
1951	25	2	2	6	2681
1951	26	2	2	1	2103
1951	27	2	2	2	2620
1951	28	2	2	5	3017
1951	29	2	2	3	2479
1951	30	2	2	4	3212
1951	31	3	1	2	3339
1951	32	3	1	1	2600
1951	33	3	1	4	3279
1951	34	3	1	5	3386
1951	35	3	1	3	2573
1951	36	3	1	6	3124
1951	37	3	2	3	2231
1951	38	3	2	5	2661
1951	39	3	2	1	2466
1951	40	3	2	4	2943
1951	41	3	2	6	2788
1951	42	3	2	2	2802
1951	43	3	3	4	3057
1951	44	3	3	5	2547
1951	45	3	3	3	1908

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1951	46	3	3	1	1814
1951	47	3	3	2	2862
1951	48	3	3	6	2600
1951	49	2	1	4	3017
1951	50	2	1	1	3292
1951	51	2	1	2	2372
1951	52	2	1	3	2990
1951	53	2	1	6	2325
1951	54	2	1	5	3232
1953	1	1	1	5	2923
1953	2	1	1	4	2688
1953	3	1	1	6	2903
1953	4	1	1	2	2661
1953	5	1	1	3	2311
1953	6	1	1	1	2493
1953	7	1	3	1	2244
1953	8	1	3	2	2694
1953	9	1	3	5	2647
1953	10	1	3	6	2661
1953	11	1	3	3	2197
1953	12	1	3	4	2600
1953	13	1	2	2	2815
1953	14	1	2	1	2157
1953	15	1	2	5	2708
1953	16	1	2	6	2694
1953	17	1	2	3	2325
1953	18	1	2	4	2755
1953	19	2	3	3	2352
1953	20	2	3	4	2493
1953	21	2	3	2	2741
1953	22	2	3	5	2674
1953	23	2	3	6	2661
1953	24	2	3	1	2157
1953	25	2	2	6	2647
1953	26	2	2	1	2116
1953	27	2	2	2	2627
1953	28	2	2	5	2567
1953	29	2	2	3	2217
1953	30	2	2	4	2513
1953	31	3	1	2	2741
1953	32	3	1	1	2325
1953	33	3	1	4	2479
1953	34	3	1	5	2479
1953	35	3	1	3	2291
1953	36	3	1	6	2352

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1953	37	3	2	3	2231
1953	38	3	2	5	2553
1953	39	3	2	1	2432
1953	40	3	2	4	2896
1953	41	3	2	6	2291
1953	42	3	2	2	2459
1953	43	3	3	4	2137
1953	44	3	3	5	2600
1953	45	3	3	3	1969
1953	46	3	3	1	1969
1953	47	3	3	2	2237
1953	48	3	3	6	2526
1953	49	2	1	4	2264
1953	50	2	1	1	2372
1953	51	2	1	2	2600
1953	52	2	1	3	2157
1953	53	2	1	6	2721
1953	54	2	1	5	2493
1955	1	1	1	5	3689
1955	2	1	1	4	3050
1955	3	1	1	6	3292
1955	4	1	1	2	3151
1955	5	1	1	3	2049
1955	6	1	1	1	2419
1955	7	1	3	1	1982
1955	8	1	3	2	3454
1955	9	1	3	5	3017
1955	10	1	3	6	3588
1955	11	1	3	3	2204
1955	12	1	3	4	3064
1955	13	1	2	2	3655
1955	14	1	2	1	2237
1955	15	1	2	5	2950
1955	16	1	2	6	3622
1955	17	1	2	3	2473
1955	18	1	2	4	3084
1955	19	2	3	3	2318
1955	20	2	3	4	2929
1955	21	2	3	2	3151
1955	22	2	3	5	2674
1955	23	2	3	6	3151
1955	24	2	3	1	2204
1955	25	2	2	6	3057
1955	26	2	2	1	2278
1955	27	2	2	2	3017

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1955	28	2	2	5	3662
1955	29	2	2	3	2412
1955	30	2	2	4	3608
1955	31	3	1	2	3830
1955	32	3	1	1	2795
1955	33	3	1	4	2983
1955	34	3	1	5	3608
1955	35	3	1	3	2439
1955	36	3	1	6	3420
1955	37	3	2	3	2439
1955	38	3	2	5	2573
1955	39	3	2	1	2405
1955	40	3	2	4	3440
1955	41	3	2	6	2607
1955	42	3	2	2	3386
1955	43	3	3	4	2782
1955	44	3	3	5	3440
1955	45	3	3	3	2137
1955	46	3	3	1	1928
1955	47	3	3	2	2782
1955	48	3	3	6	3151
1955	49	2	1	4	3118
1955	50	2	1	1	1982
1955	51	2	1	2	4065
1955	52	2	1	3	2204
1955	53	2	1	6	3877
1955	54	2	1	5	3521
1957	1	1	1	5	3420
1957	2	1	1	4	3386
1957	3	1	1	6	2862
1957	4	1	1	2	3662
1957	5	1	1	3	2157
1957	6	1	1	1	2862
1957	7	1	3	1	2002
1957	8	1	3	2	2681
1957	9	1	3	5	2587
1957	10	1	3	6	2432
1957	11	1	3	3	1908
1957	12	1	3	4	2923
1957	13	1	2	2	2768
1957	14	1	2	1	2372
1957	15	1	2	5	3205
1957	16	1	2	6	2862
1957	17	1	2	3	2768
1957	18	1	2	4	3360

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1957	19	2	3	3	2157
1957	20	2	3	4	2278
1957	21	2	3	2	2157
1957	22	2	3	5	1908
1957	23	2	3	6	1942
1957	24	2	3	1	1881
1957	25	2	2	6	2956
1957	26	2	2	1	2278
1957	27	2	2	2	2681
1957	28	2	2	5	2311
1957	29	2	2	3	2251
1957	30	2	2	4	2493
1957	31	3	1	2	2923
1957	32	3	1	1	2466
1957	33	3	1	4	2741
1957	34	3	1	5	2647
1957	35	3	1	3	2251
1957	36	3	1	6	2896
1957	37	3	2	3	2372
1957	38	3	2	5	2493
1957	39	3	2	1	2372
1957	40	3	2	4	2708
1957	41	3	2	6	2587
1957	42	3	2	2	2217
1957	43	3	3	4	2399
1957	44	3	3	5	2063
1957	45	3	3	3	1814
1957	46	3	3	1	1848
1957	47	3	3	2	2466
1957	48	3	3	6	2311
1957	49	2	1	4	2372
1957	50	2	1	1	2251
1957	51	2	1	2	2587
1957	52	2	1	3	2063
1957	53	2	1	6	2553
1957	54	2	1	5	3111
1959	1	1	1	5	3292
1959	2	1	1	4	3111
1959	3	1	1	6	3171
1959	4	1	1	2	3272
1959	5	1	1	3	2513
1959	6	1	1	1	2768
1959	7	1	3	1	2278
1959	8	1	3	2	2634
1959	9	1	3	5	2466

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1959	10	1	3	6	2432
1959	11	1	3	3	2372
1959	12	1	3	4	2587
1959	13	1	2	2	2553
1959	14	1	2	1	2278
1959	15	1	2	5	2399
1959	16	1	2	6	2526
1959	17	1	2	3	2419
1959	18	1	2	4	2432
1959	19	2	3	3	2325
1959	20	2	3	4	1908
1959	21	2	3	2	2123
1959	22	2	3	5	1969
1959	23	2	3	6	1969
1959	24	2	3	1	2385
1959	25	2	2	6	2526
1959	26	2	2	1	2452
1959	27	2	2	2	2540
1959	28	2	2	5	2587
1959	29	2	2	3	2493
1959	30	2	2	4	2647
1959	31	3	1	2	3232
1959	32	3	1	1	2755
1959	33	3	1	4	2768
1959	34	3	1	5	2708
1959	35	3	1	3	2493
1959	36	3	1	6	2432
1959	37	3	2	3	2338
1959	38	3	2	5	2620
1959	39	3	2	1	2419
1959	40	3	2	4	3077
1959	41	3	2	6	2513
1959	42	3	2	2	2862
1959	43	3	3	4	2392
1959	44	3	3	5	2338
1959	45	3	3	3	2331
1959	46	3	3	1	2338
1959	47	3	3	2	2587
1959	48	3	3	6	2372
1959	49	2	1	4	2835
1959	50	2	1	1	2802
1959	51	2	1	2	2802
1959	52	2	1	3	2835
1959	53	2	1	6	3386
1959	54	2	1	5	3077

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1961	1	1	1	5	2479
1961	2	1	1	4	2029
1961	3	1	1	6	2137
1961	4	1	1	2	2177
1961	5	1	1	3	1492
1961	6	1	1	1	1787
1961	7	1	3	1	1512
1961	8	1	3	2	2110
1961	9	1	3	5	2049
1961	10	1	3	6	2157
1961	11	1	3	3	1633
1961	12	1	3	4	2184
1961	13	1	2	2	2278
1961	14	1	2	1	1754
1961	15	1	2	5	2264
1961	16	1	2	6	2264
1961	17	1	2	3	1740
1961	18	1	2	4	2096
1961	19	2	3	3	1539
1961	20	2	3	4	1881
1961	21	2	3	2	2123
1961	22	2	3	5	2029
1961	23	2	3	6	1908
1961	24	2	3	1	1646
1961	25	2	2	6	2116
1961	26	2	2	1	1740
1961	27	2	2	2	2116
1961	28	2	2	5	2116
1961	29	2	2	3	1787
1961	30	2	2	4	2231
1961	31	3	1	2	2184
1961	32	3	1	1	1814
1961	33	3	1	4	2002
1961	34	3	1	5	2096
1961	35	3	1	3	1586
1961	36	3	1	6	2170
1961	37	3	2	3	1814
1961	38	3	2	5	2493
1961	39	3	2	1	2049
1961	40	3	2	4	2553
1961	41	3	2	6	2251
1961	42	3	2	2	2358
1961	43	3	3	4	2258
1961	44	3	3	5	2338
1961	45	3	3	3	1686

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1961	46	3	3	1	1653
1961	47	3	3	2	2177
1961	48	3	3	6	2258
1961	49	2	1	4	1774
1961	50	2	1	1	1599
1961	51	2	1	2	2076
1961	52	2	1	3	1586
1961	53	2	1	6	2170
1961	54	2	1	5	2231
1963	1	1	1	5	4791
1963	2	1	1	4	4972
1963	3	1	1	6	4072
1963	4	1	1	2	4650
1963	5	1	1	3	4898
1963	6	1	1	1	4428
1963	7	1	3	1	3615
1963	8	1	3	2	4334
1963	9	1	3	5	5395
1963	10	1	3	6	4246
1963	11	1	3	3	4831
1963	12	1	3	4	5147
1963	13	1	2	2	4267
1963	14	1	2	1	4468
1963	15	1	2	5	5241
1963	16	1	2	6	4650
1963	17	1	2	3	5194
1963	18	1	2	4	6007
1963	19	2	3	3	5422
1963	20	2	3	4	5080
1963	21	2	3	2	4898
1963	22	2	3	5	5080
1963	23	2	3	6	3816
1963	24	2	3	1	4199
1963	25	2	2	6	3071
1963	26	2	2	1	4199
1963	27	2	2	2	4428
1963	28	2	2	5	3171
1963	29	2	2	3	4112
1963	30	2	2	4	3857
1963	31	3	1	2	4361
1963	32	3	1	1	4199
1963	33	3	1	4	3702
1963	34	3	1	5	2802
1963	35	3	1	3	3749
1963	36	3	1	6	2526

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1963	37	3	2	3	3884
1963	38	3	2	5	3366
1963	39	3	2	1	4031
1963	40	3	2	4	4018
1963	41	3	2	6	3138
1963	42	3	2	2	4267
1963	43	3	3	4	3763
1963	44	3	3	5	3077
1963	45	3	3	3	4099
1963	46	3	3	1	4193
1963	47	3	3	2	4307
1963	48	3	3	6	2587
1963	49	2	1	4	4172
1963	50	2	1	1	4589
1963	51	2	1	2	4401
1963	52	2	1	3	4246
1963	53	2	1	6	3158
1963	54	2	1	5	4388
1965	1	1	1	5	5469
1965	2	1	1	4	5617
1965	3	1	1	6	5778
1965	4	1	1	2	4717
1965	5	1	1	3	5261
1965	6	1	1	1	4636
1965	7	1	3	1	3380
1965	8	1	3	2	3689
1965	9	1	3	5	5167
1965	10	1	3	6	5167
1965	11	1	3	3	3742
1965	12	1	3	4	4031
1965	13	1	2	2	4031
1965	14	1	2	1	3742
1965	15	1	2	5	5429
1965	16	1	2	6	5389
1965	17	1	2	3	4287
1965	18	1	2	4	4327
1965	19	2	3	3	3837
1965	20	2	3	4	3709
1965	21	2	3	2	3292
1965	22	2	3	5	3837
1965	23	2	3	6	4616
1965	24	2	3	1	3561
1965	25	2	2	6	5698
1965	26	2	2	1	3998
1965	27	2	2	2	4267

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1965	28	2	2	5	5362
1965	29	2	2	3	5080
1965	30	2	2	4	4697
1965	31	3	1	2	4502
1965	32	3	1	1	4099
1965	33	3	1	4	4744
1965	34	3	1	5	4770
1965	35	3	1	3	4952
1965	36	3	1	6	4670
1965	37	3	2	3	5033
1965	38	3	2	5	5160
1965	39	3	2	1	3507
1965	40	3	2	4	4193
1965	41	3	2	6	4797
1965	42	3	2	2	3796
1965	43	3	3	4	4381
1965	44	3	3	5	4979
1965	45	3	3	3	4670
1965	46	3	3	1	3407
1965	47	3	3	2	3816
1965	48	3	3	6	4871
1965	49	2	1	4	5180
1965	50	2	1	1	4515
1965	51	2	1	2	4179
1965	52	2	1	3	5207
1965	53	2	1	6	5026
1965	54	2	1	5	5778
1967	1	1	1	5	4206
1967	2	1	1	4	4992
1967	3	1	1	6	4240
1967	4	1	1	2	4488
1967	5	1	1	3	4912
1967	6	1	1	1	4737
1967	7	1	3	1	4011
1967	8	1	3	2	4347
1967	9	1	3	5	5362
1967	10	1	3	6	3682
1967	11	1	3	3	5301
1967	12	1	3	4	5147
1967	13	1	2	2	4629
1967	14	1	2	1	4267
1967	15	1	2	5	5147
1967	16	1	2	6	3816
1967	17	1	2	3	5127
1967	18	1	2	4	5268

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1967	19	2	3	3	5456
1967	20	2	3	4	5207
1967	21	2	3	2	4932
1967	22	2	3	5	4240
1967	23	2	3	6	2929
1967	24	2	3	1	4179
1967	25	2	2	6	2338
1967	26	2	2	1	3897
1967	27	2	2	2	3897
1967	28	2	2	5	3037
1967	29	2	2	3	4347
1967	30	2	2	4	4267
1967	31	3	1	2	4206
1967	32	3	1	1	3978
1967	33	3	1	4	3447
1967	34	3	1	5	2956
1967	35	3	1	3	3897
1967	36	3	1	6	2587
1967	37	3	2	3	4320
1967	38	3	2	5	4072
1967	39	3	2	1	4401
1967	40	3	2	4	4569
1967	41	3	2	6	3353
1967	42	3	2	2	4347
1967	43	3	3	4	4099
1967	44	3	3	5	3319
1967	45	3	3	3	4320
1967	46	3	3	1	3622
1967	47	3	3	2	3709
1967	48	3	3	6	2452
1967	49	2	1	4	4011
1967	50	2	1	1	3931
1967	51	2	1	2	4179
1967	52	2	1	3	4320
1967	53	2	1	6	2842
1967	54	2	1	5	3957
1969	1	1	1	5	4011
1969	2	1	1	4	4246
1969	3	1	1	6	3877
1969	4	1	1	2	4159
1969	5	1	1	3	4582
1969	6	1	1	1	4246
1969	7	1	3	1	3380
1969	8	1	3	2	3333
1969	9	1	3	5	3978

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1969	10	1	3	6	2977
1969	11	1	3	3	4381
1969	12	1	3	4	3670
1969	13	1	2	2	3816
1969	14	1	2	1	3600
1969	15	1	2	5	4119
1969	16	1	2	6	3171
1969	17	1	2	3	4112
1969	18	1	2	4	4120
1969	19	2	3	3	4011
1969	20	2	3	4	3527
1969	21	2	3	2	3669
1969	22	2	3	5	3250
1969	23	2	3	6	3366
1969	24	2	3	1	3299
1969	25	2	2	6	3588
1969	26	2	2	1	3460
1969	27	2	2	2	3299
1969	28	2	2	5	3060
1969	29	2	2	3	4152
1969	30	2	2	4	4060
1969	31	3	1	2	3702
1969	32	3	1	1	3749
1969	33	3	1	4	3507
1969	34	3	1	5	3057
1969	35	3	1	3	3588
1969	36	3	1	6	2903
1969	37	3	2	3	4020
1969	38	3	2	5	3138
1969	39	3	2	1	3460
1969	40	3	2	4	3610
1969	41	3	2	6	3312
1969	42	3	2	2	3521
1969	43	3	3	4	3642
1969	44	3	3	5	3490
1969	45	3	3	3	3870
1969	46	3	3	1	3218
1969	47	3	3	2	3299
1969	48	3	3	6	3272
1969	49	2	1	4	2590
1969	50	2	1	1	3702
1969	51	2	1	2	3561
1969	52	2	1	3	3427
1969	53	2	1	6	2929
1969	54	2	1	5	3601

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1971	1	1	1	5	6968
1971	2	1	1	4	6390
1971	3	1	1	6	6652
1971	4	1	1	2	4992
1971	5	1	1	3	5570
1971	6	1	1	1	4938
1971	7	1	3	1	3749
1971	8	1	3	2	4246
1971	9	1	3	5	5442
1971	10	1	3	6	6336
1971	11	1	3	3	4750
1971	12	1	3	4	5751
1971	13	1	2	2	4408
1971	14	1	2	1	4011
1971	15	1	2	5	6121
1971	16	1	2	6	6121
1971	17	1	2	3	5678
1971	18	1	2	4	5987
1971	19	2	3	3	6229
1971	20	2	3	4	5489
1971	21	2	3	2	4891
1971	22	2	3	5	6437
1971	23	2	3	6	6336
1971	24	2	3	1	4347
1971	25	2	2	6	5536
1971	26	2	2	1	4327
1971	27	2	2	2	4347
1971	28	2	2	5	5859
1971	29	2	2	3	5516
1971	30	2	2	4	5711
1971	31	3	1	2	5597
1971	32	3	1	1	5086
1971	33	3	1	4	5597
1971	34	3	1	5	5167
1971	35	3	1	3	5812
1971	36	3	1	6	4488
1971	37	3	2	3	5147
1971	38	3	2	5	6067
1971	39	3	2	1	4697
1971	40	3	2	4	5442
1971	41	3	2	6	5362
1971	42	3	2	2	4408
1971	43	3	3	4	4488
1971	44	3	3	5	5039
1971	45	3	3	3	3857

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1971	46	3	3	1	3669
1971	47	3	3	2	5731
1971	48	3	3	6	5536
1971	49	2	1	4	5711
1971	50	2	1	1	5086
1971	51	2	1	2	5536
1971	52	2	1	3	5651
1971	53	2	1	6	5456
1971	54	2	1	5	6282
1973	1	1	1	5	4381
1973	2	1	1	4	4092
1973	3	1	1	6	4152
1973	4	1	1	2	3897
1973	5	1	1	3	3957
1973	6	1	1	1	4092
1973	7	1	3	1	3138
1973	8	1	3	2	3776
1973	9	1	3	5	3830
1973	10	1	3	6	3702
1973	11	1	3	3	3192
1973	12	1	3	4	3776
1973	13	1	2	2	3776
1973	14	1	2	1	3487
1973	15	1	2	5	4092
1973	16	1	2	6	4011
1973	17	1	2	3	3830
1973	18	1	2	4	3957
1973	19	2	3	3	3722
1973	20	2	3	4	3138
1973	21	2	3	2	3138
1973	22	2	3	5	3931
1973	23	2	3	6	3957
1973	24	2	3	1	3830
1973	25	2	2	6	3407
1973	26	2	2	1	3702
1973	27	2	2	2	3642
1973	28	2	2	5	3527
1973	29	2	2	3	3669
1973	30	2	2	4	3642
1973	31	3	1	2	3776
1973	32	3	1	1	3642
1973	33	3	1	4	2956
1973	34	3	1	5	2822
1973	35	3	1	3	3669
1973	36	3	1	6	2802

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1973	37	3	2	3	3507
1973	38	3	2	5	3796
1973	39	3	2	1	3333
1973	40	3	2	4	3252
1973	41	3	2	6	3010
1973	42	3	2	2	3252
1973	43	3	3	4	3037
1973	44	3	3	5	2903
1973	45	3	3	3	3057
1973	46	3	3	1	3527
1973	47	3	3	2	3037
1973	48	3	3	6	2849
1973	49	2	1	4	3218
1973	50	2	1	1	3487
1973	51	2	1	2	3407
1973	52	2	1	3	3333
1973	53	2	1	6	3763
1973	54	2	1	5	3218
1975	1	1	1	5	5066
1975	2	1	1	4	4972
1975	3	1	1	6	4891
1975	4	1	1	2	5012
1975	5	1	1	3	4750
1975	6	1	1	1	5261
1975	7	1	3	1	3897
1975	8	1	3	2	3460
1975	9	1	3	5	2607
1975	10	1	3	6	3252
1975	11	1	3	3	2903
1975	12	1	3	4	3749
1975	13	1	2	2	4246
1975	14	1	2	1	4267
1975	15	1	2	5	3171
1975	16	1	2	6	4152
1975	17	1	2	3	3957
1975	18	1	2	4	3218
1975	19	2	3	3	3037
1975	20	2	3	4	2822
1975	21	2	3	2	3749
1975	22	2	3	5	4542
1975	23	2	3	6	4616
1975	24	2	3	1	4327
1975	25	2	2	6	4992
1975	26	2	2	1	4488
1975	27	2	2	2	3897

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1975	28	2	2	5	3669
1975	29	2	2	3	3622
1975	30	2	2	4	3460
1975	31	3	1	2	4750
1975	32	3	1	1	4267
1975	33	3	1	4	3796
1975	34	3	1	5	3749
1975	35	3	1	3	4152
1975	36	3	1	6	3857
1975	37	3	2	3	4072
1975	38	3	2	5	4461
1975	39	3	2	1	3957
1975	40	3	2	4	3218
1975	41	3	2	6	2157
1975	42	3	2	2	2977
1975	43	3	3	4	2298
1975	44	3	3	5	1848
1975	45	3	3	3	2882
1975	46	3	3	1	3527
1975	47	3	3	2	3561
1975	48	3	3	6	2903
1975	49	2	1	4	3776
1975	50	2	1	1	4603
1975	51	2	1	2	4461
1975	52	2	1	3	4172
1975	53	2	1	6	3857
1975	54	2	1	5	4488
1977	1	1	1	5	4542
1977	2	1	1	4	4488
1977	3	1	1	6	4542
1977	4	1	1	2	4267
1977	5	1	1	3	4072
1977	6	1	1	1	4119
1977	7	1	3	1	3487
1977	8	1	3	2	3897
1977	9	1	3	5	4119
1977	10	1	3	6	3527
1977	11	1	3	3	3272
1977	12	1	3	4	4011
1977	13	1	2	2	3897
1977	14	1	2	1	3642
1977	15	1	2	5	4267
1977	16	1	2	6	3796
1977	17	1	2	3	3487
1977	18	1	2	4	3776

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1977	19	2	3	3	3957
1977	20	2	3	4	3897
1977	21	2	3	2	3702
1977	22	2	3	5	4072
1977	23	2	3	6	3796
1977	24	2	3	1	3857
1977	25	2	2	6	3487
1977	26	2	2	1	3642
1977	27	2	2	2	3642
1977	28	2	2	5	3702
1977	29	2	2	3	3588
1977	30	2	2	4	3427
1977	31	3	1	2	3749
1977	32	3	1	1	3588
1977	33	3	1	4	3118
1977	34	3	1	5	3118
1977	35	3	1	3	3487
1977	36	3	1	6	3057
1977	37	3	2	3	3171
1977	38	3	2	5	3588
1977	39	3	2	1	3218
1977	40	3	2	4	3218
1977	41	3	2	6	3333
1977	42	3	2	2	3272
1977	43	3	3	4	3380
1977	44	3	3	5	3527
1977	45	3	3	3	3380
1977	46	3	3	1	3460
1977	47	3	3	2	3622
1977	48	3	3	6	3138
1977	49	2	1	4	3057
1977	50	2	1	1	3561
1977	51	2	1	2	3527
1977	52	2	1	3	3333
1977	53	2	1	6	3218
1977	54	2	1	5	3776
1979	1	1	1	5	4381
1979	2	1	1	4	4811
1979	3	1	1	6	4710
1979	4	1	1	2	4697
1979	5	1	1	3	4327
1979	6	1	1	1	4811
1979	7	1	3	1	3897
1979	8	1	3	2	4697
1979	9	1	3	5	4461

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1979	10	1	3	6	4172
1979	11	1	3	3	3877
1979	12	1	3	4	4206
1979	13	1	2	2	4179
1979	14	1	2	1	4031
1979	15	1	2	5	4670
1979	16	1	2	6	3850
1979	17	1	2	3	4031
1979	18	1	2	4	4421
1979	19	2	3	3	4011
1979	20	2	3	4	4199
1979	21	2	3	2	3897
1979	22	2	3	5	4831
1979	23	2	3	6	5066
1979	24	2	3	1	4119
1979	25	2	2	6	4582
1979	26	2	2	1	4058
1979	27	2	2	2	3816
1979	28	2	2	5	4139
1979	29	2	2	3	3312
1979	30	2	2	4	4031
1979	31	3	1	2	4132
1979	32	3	1	1	3601
1979	33	3	1	4	3333
1979	34	3	1	5	2956
1979	35	3	1	3	4099
1979	36	3	1	6	3339
1979	37	3	2	3	3507
1979	38	3	2	5	4327
1979	39	3	2	1	4092
1979	40	3	2	4	4246
1979	41	3	2	6	4616
1979	42	3	2	2	4381
1979	43	3	3	4	4421
1979	44	3	3	5	4569
1979	45	3	3	3	3917
1979	46	3	3	1	4441
1979	47	3	3	2	4569
1979	48	3	3	6	4441
1979	49	2	1	4	4938
1979	50	2	1	1	4972
1979	51	2	1	2	5012
1979	52	2	1	3	5086
1979	53	2	1	6	4542
1979	54	2	1	5	5201

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1981	1	1	1	5	6840
1981	2	1	1	4	6941
1981	3	1	1	6	7230
1981	4	1	1	2	6390
1981	5	1	1	3	6229
1981	6	1	1	1	6181
1981	7	1	3	1	4972
1981	8	1	3	2	5778
1981	9	1	3	5	7102
1981	10	1	3	6	7209
1981	11	1	3	3	6806
1981	12	1	3	4	6968
1981	13	1	2	2	5201
1981	14	1	2	1	5147
1981	15	1	2	5	7048
1981	16	1	2	6	7048
1981	17	1	2	3	6786
1981	18	1	2	4	7418
1981	19	2	3	3	6968
1981	20	2	3	4	6262
1981	21	2	3	2	6417
1981	22	2	3	5	7391
1981	23	2	3	6	7082
1981	24	2	3	1	5751
1981	25	2	2	6	6840
1981	26	2	2	1	4992
1981	27	2	2	2	5281
1981	28	2	2	5	6181
1981	29	2	2	3	6121
1981	30	2	2	4	6020
1981	31	3	1	2	6229
1981	32	3	1	1	5859
1981	33	3	1	4	6632
1981	34	3	1	5	7001
1981	35	3	1	3	6726
1981	36	3	1	6	6679
1981	37	3	2	3	5751
1981	38	3	2	5	6806
1981	39	3	2	1	4797
1981	40	3	2	4	6712
1981	41	3	2	6	6598
1981	42	3	2	2	5516
1981	43	3	3	4	6712
1981	44	3	3	5	6067
1981	45	3	3	3	5678

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1981	46	3	3	1	4831
1981	47	3	3	2	5120
1981	48	3	3	6	5832
1981	49	2	1	4	7156
1981	50	2	1	1	5382
1981	51	2	1	2	5382
1981	52	2	1	3	6437
1981	53	2	1	6	7021
1981	54	2	1	5	6759
1983	1	1	1	5	5778
1983	2	1	1	4	5463
1983	3	1	1	6	5570
1983	4	1	1	2	3722
1983	5	1	1	3	4461
1983	6	1	1	1	3749
1983	7	1	3	1	3171
1983	8	1	3	2	3857
1983	9	1	3	5	4992
1983	10	1	3	6	5442
1983	11	1	3	3	4891
1983	12	1	3	4	4891
1983	13	1	2	2	3527
1983	14	1	2	1	3702
1983	15	1	2	5	5442
1983	16	1	2	6	5261
1983	17	1	2	3	5308
1983	18	1	2	4	5489
1983	19	2	3	3	5147
1983	20	2	3	4	4750
1983	21	2	3	2	4697
1983	22	2	3	5	5778
1983	23	2	3	6	5516
1983	24	2	3	1	4461
1983	25	2	2	6	5409
1983	26	2	2	1	3669
1983	27	2	2	2	4072
1983	28	2	2	5	5362
1983	29	2	2	3	4912
1983	30	2	2	4	5086
1983	31	3	1	2	4441
1983	32	3	1	1	3957
1983	33	3	1	4	5906
1983	34	3	1	5	6470
1983	35	3	1	3	5778
1983	36	3	1	6	6202

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1983	37	3	2	3	3897
1983	38	3	2	5	4616
1983	39	3	2	1	3622
1983	40	3	2	4	5456
1983	41	3	2	6	6020
1983	42	3	2	2	4119
1983	43	3	3	4	4636
1983	44	3	3	5	5227
1983	45	3	3	3	4408
1983	46	3	3	1	3333
1983	47	3	3	2	3722
1983	48	3	3	6	5812
1983	49	2	1	4	6491
1983	50	2	1	1	3749
1983	51	2	1	2	3931
1983	52	2	1	3	5651
1983	53	2	1	6	6786
1983	54	2	1	5	6181
1985	1	1	1	5	3588
1985	2	1	1	4	3978
1985	3	1	1	6	4172
1985	4	1	1	2	3642
1985	5	1	1	3	3957
1985	6	1	1	1	3978
1985	7	1	3	1	3118
1985	8	1	3	2	3353
1985	9	1	3	5	3507
1985	10	1	3	6	2822
1985	11	1	3	3	3460
1985	12	1	3	4	3118
1985	13	1	2	2	3171
1985	14	1	2	1	3427
1985	15	1	2	5	3669
1985	16	1	2	6	2903
1985	17	1	2	3	3427
1985	18	1	2	4	3192
1985	19	2	3	3	3380
1985	20	2	3	4	3299
1985	21	2	3	2	3057
1985	22	2	3	5	3138
1985	23	2	3	6	3407
1985	24	2	3	1	3427
1985	25	2	2	6	3783
1985	26	2	2	1	3272
1985	27	2	2	2	3252

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1985	28	2	2	5	3622
1985	29	2	2	3	3561
1985	30	2	2	4	3427
1985	31	3	1	2	3669
1985	32	3	1	1	3218
1985	33	3	1	4	3527
1985	34	3	1	5	3776
1985	35	3	1	3	3877
1985	36	3	1	6	3776
1985	37	3	2	3	3507
1985	38	3	2	5	3561
1985	39	3	2	1	3642
1985	40	3	2	4	3272
1985	41	3	2	6	3333
1985	42	3	2	2	3118
1985	43	3	3	4	3171
1985	44	3	3	5	3487
1985	45	3	3	3	3178
1985	46	3	3	1	2956
1985	47	3	3	2	2923
1985	48	3	3	6	3487
1985	49	2	1	4	4099
1985	50	2	1	1	3487
1985	51	2	1	2	3561
1985	52	2	1	3	3642
1985	53	2	1	6	3857
1985	54	2	1	5	3749
1987	1	1	1	5	6181
1987	2	1	1	4	6437
1987	3	1	1	6	6551
1987	4	1	1	2	5342
1987	5	1	1	3	5751
1987	6	1	1	1	5382
1987	7	1	3	1	4441
1987	8	1	3	2	4912
1987	9	1	3	5	5342
1987	10	1	3	6	5120
1987	11	1	3	3	5342
1987	12	1	3	4	5227
1987	13	1	2	2	4797
1987	14	1	2	1	4912
1987	15	1	2	5	5751
1987	16	1	2	6	4912
1987	17	1	2	3	5120
1987	18	1	2	4	4542

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1987	19	2	3	3	4690
1987	20	2	3	4	4267
1987	21	2	3	2	3957
1987	22	2	3	5	4690
1987	23	2	3	6	5227
1987	24	2	3	1	4542
1987	25	2	2	6	5698
1987	26	2	2	1	4750
1987	27	2	2	2	4750
1987	28	2	2	5	5651
1987	29	2	2	3	5288
1987	30	2	2	4	5288
1987	31	3	1	2	5442
1987	32	3	1	1	5227
1987	33	3	1	4	5442
1987	34	3	1	5	4972
1987	35	3	1	3	5859
1987	36	3	1	6	4797
1987	37	3	2	3	5798
1987	38	3	2	5	6081
1987	39	3	2	1	5651
1987	40	3	2	4	5180
1987	41	3	2	6	5382
1987	42	3	2	2	5180
1987	43	3	3	4	5342
1987	44	3	3	5	5442
1987	45	3	3	3	5550
1987	46	3	3	1	5012
1987	47	3	3	2	5066
1987	48	3	3	6	5489
1987	49	2	1	4	5966
1987	50	2	1	1	5590
1987	51	2	1	2	5442
1987	52	2	1	3	5906
1987	53	2	1	6	5442
1987	54	2	1	5	6081
1989	1	1	1	5	6094
1989	2	1	1	4	6014
1989	3	1	1	6	6659
1989	4	1	1	2	4764
1989	5	1	1	3	5375
1989	6	1	1	1	3635
1989	7	1	3	1	2916
1989	8	1	3	2	4616
1989	9	1	3	5	5825

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1989	10	1	3	6	5825
1989	11	1	3	3	6168
1989	12	1	3	4	6282
1989	13	1	2	2	4992
1989	14	1	2	1	3252
1989	15	1	2	5	6470
1989	16	1	2	6	6396
1989	17	1	2	3	6396
1989	18	1	2	4	6316
1989	19	2	3	3	6168
1989	20	2	3	4	5637
1989	21	2	3	2	5073
1989	22	2	3	5	6128
1989	23	2	3	6	5980
1989	24	2	3	1	3897
1989	25	2	2	6	6202
1989	26	2	2	1	3480
1989	27	2	2	2	5033
1989	28	2	2	5	6659
1989	29	2	2	3	5899
1989	30	2	2	4	6094
1989	31	3	1	2	5261
1989	32	3	1	1	3440
1989	33	3	1	4	6014
1989	34	3	1	5	6202
1989	35	3	1	3	6316
1989	36	3	1	6	6128
1989	37	3	2	3	5483
1989	38	3	2	5	6148
1989	39	3	2	1	3924
1989	40	3	2	4	5960
1989	41	3	2	6	6692
1989	42	3	2	2	5201
1989	43	3	3	4	6108
1989	44	3	3	5	6255
1989	45	3	3	3	5819
1989	46	3	3	1	3057
1989	47	3	3	2	5093
1989	48	3	3	6	6181
1989	49	2	1	4	6726
1989	50	2	1	1	3420
1989	51	2	1	2	4690
1989	52	2	1	3	6329
1989	53	2	1	6	6544
1989	54	2	1	5	6202

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected for 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1991	1	1	1	5	5489
1991	2	1	1	4	5012
1991	3	1	1	6	5704
1991	4	1	1	2	4650
1991	5	1	1	3	4965
1991	6	1	1	1	3595
1991	7	1	3	1	3010
1991	8	1	3	2	3803
1991	9	1	3	5	3430
1991	10	1	3	6	3060
1991	11	1	3	3	3750
1991	12	1	3	4	4226
1991	13	1	2	2	4011
1991	14	1	2	1	3326
1991	15	1	2	5	3860
1991	16	1	2	6	2750
1991	17	1	2	3	3380
1991	18	1	2	4	2640
1991	19	2	3	3	2220
1991	20	2	3	4	2160
1991	21	2	3	2	2160
1991	22	2	3	5	1740
1991	23	2	3	6	2220
1991	24	2	3	1	2856
1991	25	2	2	6	3857
1991	26	2	2	1	3326
1991	27	2	2	2	4011
1991	28	2	2	5	4596
1991	29	2	2	3	4757
1991	30	2	2	4	4858
1991	31	3	1	2	4757
1991	32	3	1	1	3487
1991	33	3	1	4	5389
1991	34	3	1	5	5389
1991	35	3	1	3	5073
1991	36	3	1	6	4910
1991	37	3	2	3	4757
1991	38	3	2	5	4757
1991	39	3	2	1	3595
1991	40	3	2	4	5073
1991	41	3	2	6	5227
1991	42	3	2	2	4388
1991	43	3	3	4	5073
1991	44	3	3	5	5174
1991	45	3	3	3	4965

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.1. Yield data collected 1941 to 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Yield
					kg ha^{-1}
1991	46	3	3	1	3326
1991	47	3	3	2	4172
1991	48	3	3	6	4912
1991	49	2	1	4	4650
1991	50	2	1	1	3380
1991	51	2	1	2	3060
1991	52	2	1	3	2480
1991	53	2	1	6	4650
1991	54	2	1	5	2220

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table F.2. Yield data collected for 1993 to 1997 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield
						kg ha^{-1}
1993	1	1	1	5	1	5308
1993	1	1	1	5	2	5308
1993	2	1	1	4	1	4797
1993	2	1	1	4	2	4623
1993	3	1	1	6	1	5476
1993	3	1	1	6	2	4797
1993	4	1	1	2	1	4448
1993	4	1	1	2	2	4965
1993	5	1	1	3	1	4797
1993	5	1	1	3	2	4448
1993	6	1	1	1	1	3595
1993	6	1	1	1	2	3595
1993	7	1	3	1	1	2567
1993	7	1	3	1	2	2224
1993	8	1	3	2	1	3937
1993	8	1	3	2	2	3427
1993	9	1	3	5	1	4797
1993	9	1	3	5	2	4112
1993	10	1	3	6	1	4623
1993	10	1	3	6	2	3937
1993	11	1	3	3	1	4448
1993	11	1	3	3	2	3937
1993	12	1	3	4	1	4280
1993	12	1	3	4	2	3595
1993	13	1	2	2	1	3769
1993	13	1	2	2	2	3252
1993	14	1	2	1	1	2909
1993	14	1	2	1	2	2741
1993	15	1	2	5	1	4623
1993	15	1	2	5	2	3937
1993	16	1	2	6	1	4623
1993	16	1	2	6	2	4280
1993	17	1	2	3	1	4112
1993	17	1	2	3	2	3769
1993	18	1	2	4	1	3769
1993	18	1	2	4	2	3595
1993	19	2	3	3	1	4623
1993	19	2	3	3	2	3937
1993	20	2	3	4	1	3937
1993	20	2	3	4	2	3427
1993	21	2	3	2	1	4448
1993	21	2	3	2	2	2399
1993	22	2	3	5	1	5651
1993	22	2	3	5	2	4448

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table F.2. Yield data collected for 1993 to 1997 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield
						kg ha^{-1}
1993	23	2	3	6	1	5819
1993	23	2	3	6	2	4623
1993	24	2	3	1	1	3769
1993	24	2	3	1	2	3252
1993	25	2	2	6	1	4797
1993	25	2	2	6	2	4448
1993	26	2	2	1	1	3427
1993	26	2	2	1	2	2909
1993	27	2	2	2	1	4448
1993	27	2	2	2	2	3769
1993	28	2	2	5	1	4280
1993	28	2	2	5	2	3937
1993	29	2	2	3	1	4448
1993	29	2	2	3	2	3937
1993	30	2	2	4	1	4448
1993	30	2	2	4	2	4112
1993	31	3	1	2	1	5133
1993	31	3	1	2	2	4797
1993	32	3	1	1	1	3595
1993	32	3	1	1	2	3084
1993	33	3	1	4	1	5308
1993	33	3	1	4	2	4623
1993	34	3	1	5	1	5819
1993	34	3	1	5	2	5476
1993	35	3	1	3	1	5651
1993	35	3	1	3	2	5476
1993	36	3	1	6	1	5476
1993	36	3	1	6	2	5993
1993	37	3	2	3	1	3937
1993	37	3	2	3	2	3769
1993	38	3	2	5	1	4112
1993	38	3	2	5	2	3769
1993	39	3	2	1	1	3084
1993	39	3	2	1	2	3427
1993	40	3	2	4	1	3937
1993	40	3	2	4	2	3427
1993	41	3	2	6	1	4448
1993	41	3	2	6	2	4280
1993	42	3	2	2	1	3595
1993	42	3	2	2	2	3595
1993	43	3	3	4	1	4448
1993	43	3	3	4	2	4623
1993	44	3	3	5	1	4797
1993	44	3	3	5	2	5308

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table F.2. Yield data collected for 1993 to 1997 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield
						kg ha^{-1}
1993	45	3	3	3	1	4623
1993	45	3	3	3	2	4623
1993	46	3	3	1	1	3252
1993	46	3	3	1	2	3595
1993	47	3	3	2	1	4623
1993	47	3	3	2	2	4448
1993	48	3	3	6	1	4797
1993	48	3	3	6	2	5651
1993	49	2	1	4	1	5993
1993	49	2	1	4	2	6161
1993	50	2	1	1	1	3937
1993	50	2	1	1	2	4280
1993	51	2	1	2	1	5133
1993	51	2	1	2	2	4797
1993	52	2	1	3	1	5993
1993	52	2	1	3	2	5651
1993	53	2	1	6	1	5993
1993	53	2	1	6	2	5476
1993	54	2	1	5	1	5993
1993	54	2	1	5	2	5133
1995	1	1	1	5	1	6732
1995	1	1	1	5	2	6524
1995	2	1	1	4	1	7015
1995	2	1	1	4	2	6551
1995	3	1	1	6	1	6652
1995	3	1	1	6	2	6188
1995	4	1	1	2	1	5463
1995	4	1	1	2	2	4616
1995	5	1	1	3	1	6511
1995	5	1	1	3	2	5463
1995	6	1	1	1	1	4179
1995	6	1	1	1	2	3615
1995	7	1	3	1	1	3554
1995	7	1	3	1	2	3044
1995	8	1	3	2	1	5207
1995	8	1	3	2	2	4092
1995	9	1	3	5	1	6417
1995	9	1	3	5	2	4629
1995	10	1	3	6	1	6444
1995	10	1	3	6	2	4361
1995	11	1	3	3	1	6181
1995	11	1	3	3	2	4784
1995	12	1	3	4	1	5792
1995	12	1	3	4	2	4697

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table F.2. Yield data collected for 1993 to 1997 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield
						kg ha^{-1}
1995	13	1	2	2	1	4918
1995	13	1	2	2	2	4166
1995	14	1	2	1	1	3454
1995	14	1	2	1	2	3003
1995	15	1	2	5	1	6302
1995	15	1	2	5	2	5483
1995	16	1	2	6	1	6208
1995	16	1	2	6	2	5557
1995	17	1	2	3	1	6396
1995	17	1	2	3	2	5839
1995	18	1	2	4	1	6544
1995	18	1	2	4	2	6390
1995	19	2	3	3	1	6907
1995	19	2	3	3	2	6383
1995	20	2	3	4	1	5832
1995	20	2	3	4	2	6766
1995	21	2	3	2	1	6437
1995	21	2	3	2	2	6363
1995	22	2	3	5	1	6034
1995	22	2	3	5	2	8170
1995	23	2	3	6	1	6141
1995	23	2	3	6	2	7136
1995	24	2	3	1	1	3635
1995	24	2	3	1	2	4576
1995	25	2	2	6	1	5248
1995	25	2	2	6	2	5274
1995	26	2	2	1	1	3386
1995	26	2	2	1	2	3312
1995	27	2	2	2	1	5113
1995	27	2	2	2	2	4656
1995	28	2	2	5	1	5241
1995	28	2	2	5	2	5234
1995	29	2	2	3	1	4179
1995	29	2	2	3	2	4475
1995	30	2	2	4	1	5006
1995	30	2	2	4	2	5416
1995	31	3	1	2	1	5678
1995	31	3	1	2	2	5973
1995	32	3	1	1	1	3480
1995	32	3	1	1	2	3279
1995	33	3	1	4	1	6141
1995	33	3	1	4	2	6114
1995	34	3	1	5	1	6195
1995	34	3	1	5	2	6692

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table F.2. Yield data collected for 1993 to 1997 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield
						kg ha^{-1}
1995	35	3	1	3	1	6061
1995	35	3	1	3	2	6470
1995	36	3	1	6	1	5637
1995	36	3	1	6	2	5691
1995	37	3	2	3	1	4085
1995	37	3	2	3	2	4737
1995	38	3	2	5	1	4865
1995	38	3	2	5	2	4435
1995	39	3	2	1	1	3695
1995	39	3	2	1	2	3642
1995	40	3	2	4	1	5207
1995	40	3	2	4	2	5825
1995	41	3	2	6	1	5315
1995	41	3	2	6	2	5772
1995	42	3	2	2	1	4314
1995	42	3	2	2	2	4381
1995	43	3	3	4	1	5328
1995	43	3	3	4	2	6007
1995	44	3	3	5	1	5402
1995	44	3	3	5	2	6067
1995	45	3	3	3	1	6061
1995	45	3	3	3	2	4811
1995	46	3	3	1	1	2916
1995	46	3	3	1	2	3460
1995	47	3	3	2	1	4361
1995	47	3	3	2	2	4992
1995	48	3	3	6	1	5127
1995	48	3	3	6	2	5960
1995	49	2	1	4	1	5456
1995	49	2	1	4	2	6370
1995	50	2	1	1	1	3373
1995	50	2	1	1	2	3884
1995	51	2	1	2	1	4959
1995	51	2	1	2	2	5315
1995	52	2	1	3	1	6242
1995	52	2	1	3	2	5879
1995	53	2	1	6	1	6141
1995	53	2	1	6	2	6262
1995	54	2	1	5	1	6370
1995	54	2	1	5	2	6517
1997	1	1	1	5	1	4764
1997	1	1	1	5	2	4768
1997	2	1	1	4	1	4383
1997	2	1	1	4	2	3924

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South

Table F.2. Yield data collected for 1993 to 1997 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield
						kg ha^{-1}
1997	3	1	1	6	1	4042
1997	3	1	1	6	2	4474
1997	4	1	1	2	1	3657
1997	4	1	1	2	2	3331
1997	5	1	1	3	1	4092
1997	5	1	1	3	2	3796
1997	6	1	1	1	1	2699
1997	6	1	1	1	2	2837
1997	7	1	3	1	1	2319
1997	7	1	3	1	2	1961
1997	8	1	3	2	1	3804
1997	8	1	3	2	2	3105
1997	9	1	3	5	1	4614
1997	9	1	3	5	2	3294
1997	10	1	3	6	1	3991
1997	10	1	3	6	2	2789
1997	11	1	3	3	1	4286
1997	11	1	3	3	2	3461
1997	12	1	3	4	1	4226
1997	12	1	3	4	2	3015
1997	13	1	2	2	1	3309
1997	13	1	2	2	2	2754
1997	14	1	2	1	1	2558
1997	14	1	2	1	2	1981
1997	15	1	2	5	1	4222
1997	15	1	2	5	2	3189
1997	16	1	2	6	1	4139
1997	16	1	2	6	2	3702
1997	17	1	2	3	1	4442
1997	17	1	2	3	2	3786
1997	18	1	2	4	1	4544
1997	18	1	2	4	2	4476
1997	19	2	3	3	1	5466
1997	19	2	3	3	2	5016
1997	20	2	3	4	1	4299
1997	20	2	3	4	2	5259
1997	21	2	3	2	1	4372
1997	21	2	3	2	2	4050
1997	22	2	3	5	1	4718
1997	22	2	3	5	2	5091
1997	23	2	3	6	1	4325
1997	23	2	3	6	2	4734
1997	24	2	3	1	1	2729
1997	24	2	3	1	2	3179

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table F.2. Yield data collected for 1993 to 1997 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield
						kg ha^{-1}
1997	25	2	2	6	1	3813
1997	25	2	2	6	2	4053
1997	26	2	2	1	1	2400
1997	26	2	2	1	2	2625
1997	27	2	2	2	1	3277
1997	27	2	2	2	2	3171
1997	28	2	2	5	1	3563
1997	28	2	2	5	2	3846
1997	29	2	2	3	1	3397
1997	29	2	2	3	2	3975
1997	30	2	2	4	1	3223
1997	30	2	2	4	2	3990
1997	31	3	1	2	1	3727
1997	31	3	1	2	2	3556
1997	32	3	1	1	1	2747
1997	32	3	1	1	2	2790
1997	33	3	1	4	1	3633
1997	33	3	1	4	2	3917
1997	34	3	1	5	1	4543
1997	34	3	1	5	2	4261
1997	35	3	1	3	1	3798
1997	35	3	1	3	2	4252
1997	36	3	1	6	1	4157
1997	36	3	1	6	2	3888
1997	37	3	2	3	1	2538
1997	37	3	2	3	2	2519
1997	38	3	2	5	1	2933
1997	38	3	2	5	2	2470
1997	39	3	2	1	1	2146
1997	39	3	2	1	2	2567
1997	40	3	2	4	1	3280
1997	40	3	2	4	2	3684
1997	41	3	2	6	1	3267
1997	41	3	2	6	2	3338
1997	42	3	2	2	1	2707
1997	42	3	2	2	2	2813
1997	43	3	3	4	1	3469
1997	43	3	3	4	2	3390
1997	44	3	3	5	1	3842
1997	44	3	3	5	2	3866
1997	45	3	3	3	1	3389
1997	45	3	3	3	2	3922
1997	46	3	3	1	1	2456
1997	46	3	3	1	2	2465

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table F.2. Yield data collected for 1993 to 1997 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield
						kg ha^{-1}
1997	47	3	3	2	1	2878
1997	47	3	3	2	2	2746
1997	48	3	3	6	1	3462
1997	48	3	3	6	2	3820
1997	49	2	1	4	1	4334
1997	49	2	1	4	2	5089
1997	50	2	1	1	1	2758
1997	50	2	1	1	2	3056
1997	51	2	1	2	1	3383
1997	51	2	1	2	2	3319
1997	52	2	1	3	1	4212
1997	52	2	1	3	2	3759
1997	53	2	1	6	1	4324
1997	53	2	1	6	2	4495
1997	54	2	1	5	1	*
1997	54	2	1	5	2	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Appendix G. Yield data collected for 1999 harvest

Table G.1. Data collected for the 1999 harvest for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield	Bundle Sample Area	Test weight
					kg ha^{-1}	m^2	kg m^{-3}
1	1	1	5	1	4940	28.3	773.5
1	1	1	5	2	4588	27.5	782.5
2	1	1	4	1	3739	27.4	779.9
2	1	1	4	2	4609	28.3	761.9
3	1	1	6	1	4739	28.0	781.2
3	1	1	6	2	4149	27.6	783.8
4	1	1	2	1	3540	27.3	786.4
4	1	1	2	2	3697	28.0	782.5
5	1	1	3	1	4087	28.4	783.8
5	1	1	3	2	3835	26.9	783.8
6	1	1	1	1	3049	27.2	787.6
6	1	1	1	2	4466	28.0	774.8
7	1	3	1	1	2351	28.3	774.8
7	1	3	1	2	2232	26.8	772.2
8	1	3	2	1	3072	26.8	785.1
8	1	3	2	2	3473	28.3	777.3
9	1	3	5	1	3380	28.4	781.2
9	1	3	5	2	3067	26.6	779.9
10	1	3	6	1	3110	26.6	763.2
10	1	3	6	2	3117	28.3	752.9
11	1	3	3	1	3724	28.0	767.1
11	1	3	3	2	3275	26.7	776.1
12	1	3	4	1	3515	26.6	749.0
12	1	3	4	2	3723	28.0	750.3
13	1	2	2	1	2911	28.2	763.2
13	1	2	2	2	2641	26.9	759.3
14	1	2	1	1	2370	27.1	779.9
14	1	2	1	2	2927	28.3	764.5

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history for fertility subplots

δ Location: 1 = North; 2 = South

Table G.1. Data collected for the 1999 harvest for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield	Bundle Sample Area	Test weight
					kg ha^{-1}	m^2	kg m^{-3}
15	1	2	5	1	3993	28.6	768.3
15	1	2	5	2	3064	26.8	768.3
16	1	2	6	1	3293	26.6	776.1
16	1	2	6	2	3867	28.7	768.3
17	1	2	3	1	3801	28.7	767.1
17	1	2	3	2	3677	26.8	774.8
18	1	2	4	1	3422	26.5	747.7
18	1	2	4	2	3718	28.8	745.2
19	2	3	3	1	4575	28.6	751.6
19	2	3	3	2	4190	26.8	747.7
20	2	3	4	1	3924	26.7	761.9
20	2	3	4	2	3636	28.7	774.8
21	2	3	2	1	3821	28.4	774.8
21	2	3	2	2	3496	26.8	785.1
22	2	3	5	1	4317	27.0	740.0
22	2	3	5	2	1647	28.3	743.9
23	2	3	6	1	4487	28.3	759.3
23	2	3	6	2	4255	26.9	755.5
24	2	3	1	1	2739	26.6	769.6
24	2	3	1	2	3067	28.6	777.3
25	2	2	6	1	3826	28.6	777.3
25	2	2	6	2	3465	27.0	781.2
26	2	2	1	1	2324	26.9	788.9
26	2	2	1	2	2604	28.7	786.4
27	2	2	2	1	3482	28.7	763.2
27	2	2	2	2	2989	27.0	759.3
28	2	2	5	1	3315	27.5	779.9
28	2	2	5	2	3964	28.5	764.5

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history for fertility subplots

δ Location: 1 = North; 2 = South

Table G.1. Data collected for the 1999 harvest for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield	Bundle Sample Area	Test weight
					kg ha^{-1}	m^2	kg m^{-3}
29	2	2	3	1	3415	28.7	769.6
29	2	2	3	2	3456	27.4	781.2
30	2	2	4	1	3290	27.1	776.1
30	2	2	4	2	3349	28.6	755.5
31	3	1	2	1	3980	28.6	765.8
31	3	1	2	2	3822	27.2	782.5
32	3	1	1	1	2912	27.1	759.3
32	3	1	1	2	3108	28.3	759.3
33	3	1	4	1	4018	28.7	785.1
33	3	1	4	2	4006	27.2	782.5
34	3	1	5	1	4218	26.9	782.5
34	3	1	5	2	4050	28.6	772.2
35	3	1	3	1	4239	28.3	783.8
35	3	1	3	2	4396	27.3	779.9
36	3	1	6	1	3599	34.9	774.8
36	3	1	6	2	3968	27.8	759.3
37	3	2	3	1	2774	27.8	764.5
37	3	2	3	2	2890	27.6	758.0
38	3	2	5	1	3036	27.4	750.3
38	3	2	5	2	3328	28.1	773.5
39	3	2	1	1	2789	28.5	750.3
39	3	2	1	2	2684	26.9	745.2
40	3	2	4	1	3723	27.1	761.9
40	3	2	4	2	3837	28.3	759.3
41	3	2	6	1	3490	28.3	779.9
41	3	2	6	2	3559	27.4	770.9
42	3	2	2	1	3181	27.4	751.6
42	3	2	2	2	3141	28.3	749.0

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history for fertility subplots

δ Location: 1 = North; 2 = South

Table G.1. Data collected for the 1999 harvest for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Yield	Bundle Sample Area	Test weight
					kg ha^{-1}	m^2	kg m^{-3}
43	3	3	4	1	3747	28.0	768.3
43	3	3	4	2	3674	27.7	768.3
44	3	3	5	1	3782	27.5	776.1
44	3	3	5	2	4049	28.0	768.3
45	3	3	3	1	3666	27.9	767.1
45	3	3	3	2	3769	27.5	774.8
46	3	3	1	1	2597	27.5	747.7
46	3	3	1	2	2698	27.7	745.2
47	3	3	2	1	3421	27.6	751.6
47	3	3	2	2	3134	27.8	747.7
48	3	3	6	1	3824	27.6	761.9
48	3	3	6	2	4151	27.5	774.8
49	2	1	4	1	5037	27.5	774.8
49	2	1	4	2	4601	27.6	785.1
50	2	1	1	1	3084	27.8	740.0
50	2	1	1	2	3026	27.2	743.9
51	2	1	2	1	3873	27.5	759.3
51	2	1	2	2	3586	27.8	755.5
52	2	1	3	1	4625	28.0	769.6
52	2	1	3	2	4266	27.4	777.3
53	2	1	6	1	4552	27.2	777.3
53	2	1	6	2	4806	28.3	781.2
54	2	1	5	1	4637	27.8	788.9
54	2	1	5	2	4923	27.4	786.4

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history for fertility subplots
δ Location: 1 = North; 2 = South

Appendix H. Additional data collected for the Tillage/ Fertility Experiment

Table H.1. Additional data collected for 1985 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
				g	g	g		
1	1	1	5	1048.9	524.7	524.2	1.999	0.999
2	1	1	4	1003.8	483.8	520.0	2.075	1.075
3	1	1	6	1164.9	540.2	624.7	2.156	1.156
4	1	1	2	1228.4	577.4	651.0	2.127	1.127
5	1	1	3	1221.9	571.3	650.6	2.139	1.139
6	1	1	1	1111.0	529.0	582.0	2.100	1.100
7	1	3	1	926.9	448.7	478.2	2.066	1.066
8	1	3	2	1019.0	483.9	535.1	2.106	1.106
9	1	3	5	1134.2	549.0	585.2	2.066	1.066
10	1	3	6	950.4	446.4	504.0	2.129	1.129
11	1	3	3	1084.6	528.9	555.7	2.051	1.051
12	1	3	4	1015.9	480.5	535.4	2.114	1.114
13	1	2	2	1002.0	482.2	519.8	2.078	1.078
14	1	2	1	1070.0	505.3	564.7	2.118	1.118
15	1	2	5	1145.3	540.7	604.6	2.118	1.118
16	1	2	6	1008.3	476.0	532.3	2.118	1.118
17	1	2	3	985.6	463.5	522.1	2.126	1.126
18	1	2	4	1060.8	515.1	545.7	2.059	1.059
19	2	3	3	1109.6	528.4	581.2	2.100	1.100
20	2	3	4	905.1	457.7	447.4	1.977	0.977
21	2	3	2	895.9	427.8	468.1	2.094	1.094
22	2	3	5	831.3	395.6	435.7	2.101	1.101
23	2	3	6	844.9	404.5	440.4	2.089	1.089
24	2	3	1	1063.8	480.9	582.9	2.212	1.212
25	2	2	6	925.9	435.3	490.6	2.127	1.127
26	2	2	1	1095.1	475.8	619.3	2.302	1.302
27	2	2	2	1004.7	456.4	548.3	2.201	1.201

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.1. Additional data collected for 1985 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
				g	g	g		
28	2	2	5	1083.2	498.0	585.2	2.175	1.175
29	2	2	3	1143.3	530.2	613.1	2.156	1.156
30	2	2	4	1045.6	460.9	584.7	2.269	1.269
31	3	1	2	1196.5	526.3	670.2	2.273	1.273
32	3	1	1	998.0	440.9	557.1	2.264	1.264
33	3	1	4	1182.4	523.6	658.8	2.258	1.258
34	3	1	5	1381.7	605.5	776.2	2.282	1.282
35	3	1	3	1184.7	528.4	656.3	2.242	1.242
36	3	1	6	1543.7	667.2	876.5	2.314	1.314
37	3	2	3	1152.8	538.9	613.9	2.139	1.139
38	3	2	5	1303.7	628.5	675.2	2.074	1.074
39	3	2	1	1078.8	481.2	597.6	2.242	1.242
40	3	2	4	1153.7	511.9	641.8	2.254	1.254
41	3	2	6	1195.8	519.3	676.5	2.303	1.303
42	3	2	2	974.0	442.2	531.8	2.203	1.203
43	3	3	4	1087.5	500.7	586.8	2.172	1.172
44	3	3	5	1180.3	518.6	661.7	2.276	1.276
45	3	3	3	1032.1	455.9	576.2	2.264	1.264
46	3	3	1	1000.7	436.8	563.9	2.291	1.291
47	3	3	2	936.9	396.3	540.6	2.364	1.364
48	3	3	6	1104.9	477.8	627.1	2.312	1.312
49	2	1	4	1386.1	595.9	790.2	2.326	1.326
50	2	1	1	1139.5	483.3	656.2	2.358	1.358
51	2	1	2	1126.7	501.5	625.2	2.247	1.247
52	2	1	3	1284.6	576.1	708.5	2.230	1.230
53	2	1	6	1342.0	608.6	733.4	2.205	1.205
54	2	1	5	1165.7	541.4	624.3	2.153	1.153

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.2. Additional data collected for 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
1	1	1	5	1	1.386	2136.3	956.3	1180.0	2.234	1.234
1	1	1	5	2	1.386	2152.6	898.2	1254.4	2.397	1.397
2	1	1	4	1	1.386	1860.8	817.2	1043.6	2.277	1.277
2	1	1	4	2	1.386	2005.2	920.8	1084.4	2.178	1.178
3	1	1	6	1	1.386	2091.2	896.8	1194.4	2.332	1.332
3	1	1	6	2	1.386	2124.2	920.3	1203.9	2.308	1.308
4	1	1	2	1	1.386	1601.3	697.9	903.4	2.294	1.294
4	1	1	2	2	1.386	1947.7	811.6	1136.1	2.400	1.400
5	1	1	3	1	1.386	1870.2	792.5	1077.7	2.360	1.360
5	1	1	3	2	1.386	2011.4	849.3	1162.1	2.368	1.368
6	1	1	1	1	1.386	1521.6	665.0	856.6	2.288	1.288
6	1	1	1	2	1.386	1581.2	688.7	892.5	2.296	1.296
7	1	3	1	1	1.386	1195.9	*	*	*	*
7	1	3	1	2	1.386	1517.3	647.2	870.1	2.344	1.344
8	1	3	2	1	1.386	1662.1	659.1	1003.0	2.522	1.522
8	1	3	2	2	1.386	1729.6	709.7	1019.9	2.437	1.437
9	1	3	5	1	1.386	1788.6	740.7	1047.9	2.415	1.415
9	1	3	5	2	1.386	1996.9	836.8	1160.1	2.386	1.386
10	1	3	6	1	1.386	1736.5	722.4	1014.1	2.404	1.404
10	1	3	6	2	1.386	1869.8	743.0	1126.8	2.517	1.517
11	1	3	3	1	1.386	1697.2	819.2	878.0	2.072	1.072
11	1	3	3	2	1.386	1761.2	773.3	987.9	2.278	1.278
12	1	3	4	1	1.386	1698.5	725.5	973.0	2.341	1.341
12	1	3	4	2	1.386	1803.9	778.4	1025.5	2.317	1.317
13	1	2	2	1	1.386	1471.5	639.6	831.9	2.301	1.301
13	1	2	2	2	1.386	1542.1	693.0	849.1	2.225	1.225
14	1	2	1	1	1.386	1618.7	677.2	941.5	2.390	1.390
14	1	2	1	2	1.386	1899.6	794.1	1105.5	2.392	1.392
15	1	2	5	1	1.386	1857.1	762.0	1095.1	2.437	1.437
15	1	2	5	2	1.386	2032.9	856.7	1176.2	2.373	1.373

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.2. Additional data collected for 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
16	1	2	6	1	1.386	1668.1	647.1	1021.0	2.578	1.578
16	1	2	6	2	1.386	1930.0	740.1	1189.9	2.608	1.608
17	1	2	3	1	1.386	1546.8	662.8	884.0	2.334	1.334
17	1	2	3	2	1.386	1917.7	832.1	1085.6	2.305	1.305
18	1	2	4	1	1.386	1741.3	660.3	1081.0	2.637	1.637
18	1	2	4	2	1.386	1530.9	655.8	875.1	2.334	1.334
19	2	3	3	1	1.386	1367.3	533.2	834.1	2.564	1.564
19	2	3	3	2	1.386	2136.0	873.7	1262.3	2.445	1.445
20	2	3	4	1	1.386	1699.9	676.9	1023.0	2.511	1.511
20	2	3	4	2	1.386	1559.3	636.6	922.7	2.449	1.449
21	2	3	2	1	1.386	1670.1	638.8	1031.3	2.614	1.614
21	2	3	2	2	1.386	1534.4	608.2	926.2	2.523	1.523
22	2	3	5	1	1.386	1560.8	543.8	1017.0	2.870	1.870
22	2	3	5	2	1.386	1624.9	584.0	1040.9	2.782	1.782
23	2	3	6	1	1.386	1717.6	601.6	1116.0	2.855	1.855
23	2	3	6	2	1.386	1448.2	541.7	906.5	2.673	1.673
24	2	3	1	1	1.386	1133.0	468.1	664.9	2.420	1.420
24	2	3	1	2	1.386	1331.4	507.3	824.1	2.624	1.624
25	2	2	6	1	1.386	2284.5	845.6	1438.9	2.702	1.702
25	2	2	6	2	1.386	1915.0	775.6	1139.4	2.469	1.469
26	2	2	1	1	1.386	1813.1	719.4	1093.7	2.520	1.520
26	2	2	1	2	1.386	1881.4	725.0	1156.4	2.595	1.595
27	2	2	2	1	1.386	1768.4	674.6	1093.8	2.621	1.621
27	2	2	2	2	1.386	1575.3	677.6	897.7	2.325	1.325
28	2	2	5	1	1.386	1984.1	798.9	1185.2	2.484	1.484
28	2	2	5	2	1.386	2140.4	828.3	1312.1	2.584	1.584
29	2	2	3	1	1.386	1862.7	774.2	1088.5	2.406	1.406
29	2	2	3	2	1.386	1534.7	679.6	855.1	2.258	1.258
30	2	2	4	1	1.386	1616.9	696.2	920.7	2.322	1.322
30	2	2	4	2	1.386	1755.0	780.2	974.8	2.249	1.249

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.2. Additional data collected for 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
31	3	1	2	1	1.386	1943.0	771.1	1171.9	2.520	1.520
31	3	1	2	2	1.386	2291.7	935.0	1356.7	2.451	1.451
32	3	1	1	1	1.386	1819.9	747.4	1072.5	2.435	1.435
32	3	1	1	2	1.386	1696.1	736.1	960.0	2.304	1.304
33	3	1	4	1	1.386	1956.0	720.6	1235.4	2.714	1.714
33	3	1	4	2	1.386	2084.5	813.3	1271.2	2.563	1.563
34	3	1	5	1	1.386	2150.7	664.8	1485.9	3.235	2.235
34	3	1	5	2	1.386	1919.8	659.4	1260.4	2.911	1.911
35	3	1	3	1	1.386	1973.6	767.3	1206.3	2.572	1.572
35	3	1	3	2	1.386	2147.3	872.0	1275.3	2.463	1.463
36	3	1	6	1	1.386	2151.8	595.6	1556.2	3.613	2.613
36	3	1	6	2	1.386	2542.6	892.7	1649.9	2.848	1.848
37	3	2	3	1	1.386	1924.2	784.9	1139.3	2.452	1.452
37	3	2	3	2	1.386	2211.3	943.7	1267.6	2.343	1.343
38	3	2	5	1	1.386	1860.8	701.0	1159.8	2.654	1.654
38	3	2	5	2	1.386	2272.3	913.2	1359.1	2.488	1.488
39	3	2	1	1	1.386	962.4	423.7	538.7	2.271	1.271
39	3	2	1	2	1.386	1044.1	462.2	581.9	2.259	1.259
40	3	2	4	1	1.386	1748.5	735.6	1012.9	2.377	1.377
40	3	2	4	2	1.386	1830.6	722.5	1108.1	2.534	1.534
41	3	2	6	1	1.386	1970.2	802.2	1168.0	2.456	1.456
41	3	2	6	2	1.386	1879.1	587.1	1292.0	3.201	2.201
42	3	2	2	1	1.386	1779.8	735.9	1043.9	2.419	1.419
42	3	2	2	2	1.386	1634.1	652.6	981.5	2.504	1.504
43	3	3	4	1	1.386	1964.2	784.3	1179.9	2.504	1.504
43	3	3	4	2	1.386	1984.3	803.4	1180.9	2.470	1.470
44	3	3	5	1	1.386	2092.2	816.7	1275.5	2.562	1.562
44	3	3	5	2	1.386	2050.7	815.2	1235.5	2.516	1.516
45	3	3	3	1	1.386	1731.9	671.7	1060.2	2.578	1.578
45	3	3	3	2	1.386	1902.9	797.9	1105.0	2.385	1.385

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.2. Additional data collected for 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
46	3	3	1	1	1.386	1822.9	736.6	1086.3	2.475	1.475
46	3	3	1	2	1.386	1576.3	578.5	997.8	2.725	1.725
47	3	3	2	1	1.386	1973.3	789.6	1183.7	2.499	1.499
47	3	3	2	2	1.386	1895.0	721.2	1173.8	2.628	1.628
48	3	3	6	1	1.386	2163.3	660.6	1502.7	3.275	2.275
48	3	3	6	2	1.386	2049.1	807.6	1241.5	2.537	1.537
49	2	1	4	1	1.386	2152.7	816.0	1336.7	2.638	1.638
49	2	1	4	2	1.386	2451.6	973.1	1478.5	2.519	1.519
50	2	1	1	1	1.386	1777.5	702.2	1075.3	2.531	1.531
50	2	1	1	2	1.386	1918.4	809.9	1108.5	2.369	1.369
51	2	1	2	1	1.386	2394.9	961.6	1433.3	2.491	1.491
51	2	1	2	2	1.386	1745.6	718.9	1026.7	2.428	1.428
52	2	1	3	1	1.386	1921.9	801.3	1120.6	2.398	1.398
52	2	1	3	2	1.386	2004.3	806.2	1198.1	2.486	1.486
53	2	1	6	1	1.386	2141.5	724.3	1417.2	2.957	1.957
53	2	1	6	2	1.386	1863.4	617.9	1245.5	3.016	2.016
54	2	1	5	1	1.386	2272.1	822.1	1450.0	2.764	1.764
54	2	1	5	2	1.386	1980.0	854.3	1125.7	2.318	1.318

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.3. Additional data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw: Grain Ratio
					m^2	g	g	g		
1	1	1	5	1	0.924	1725.8	594.5	1131.3	2.903	1.903
1	1	1	5	2	0.924	1950.1	579.2	1370.9	3.367	2.367
1	1	1	5	3	0.924	2026.9	625.4	1401.5	3.241	2.241
2	1	1	4	1	0.924	1855.0	676.6	1178.4	2.742	1.742
2	1	1	4	2	0.924	1945.7	609.8	1335.9	3.191	2.191
2	1	1	4	3	0.924	1764.1	567.6	1196.5	3.108	2.108
3	1	1	6	1	0.924	2050.9	724.2	1326.7	2.832	1.832
3	1	1	6	2	0.924	2252.7	723.3	1529.4	3.114	2.114
3	1	1	6	3	0.924	2171.2	726.1	1445.1	2.990	1.990
4	1	1	2	1	0.924	1555.8	511.2	1044.6	3.043	2.043
4	1	1	2	2	0.924	1655.1	604.8	1050.3	2.737	1.737
4	1	1	2	3	0.924	1400.2	466.0	934.2	3.005	2.005
5	1	1	3	1	0.924	1630.0	562.7	1067.3	2.897	1.897
5	1	1	3	2	0.924	2022.6	688.2	1334.4	2.939	1.939
5	1	1	3	3	0.924	1971.0	600.4	1370.6	3.283	2.283
6	1	1	1	1	0.924	1144.9	366.5	778.4	3.124	2.124
6	1	1	1	2	0.924	1134.6	342.6	792.0	3.312	2.312
6	1	1	1	3	0.924	1316.6	400.8	915.8	3.285	2.285
7	1	3	1	1	0.924	1077.7	334.5	743.2	3.222	2.222
7	1	3	1	2	0.924	999.2	296.2	703.0	3.373	2.373
7	1	3	1	3	0.924	866.8	266.6	600.2	3.251	2.251
8	1	3	2	1	0.924	1706.8	571.1	1135.7	2.989	1.989
8	1	3	2	2	0.924	1452.3	449.0	1003.3	3.235	2.235
8	1	3	2	3	0.924	1446.0	417.0	1029.0	3.468	2.468
9	1	3	5	1	0.924	2235.7	705.8	1529.9	3.168	2.168
9	1	3	5	2	0.924	2132.1	659.8	1472.3	3.231	2.231
9	1	3	5	3	0.924	2121.8	632.2	1489.6	3.356	2.356
10	1	3	6	1	0.924	1825.9	663.2	1162.7	2.753	1.753
10	1	3	6	2	0.924	1889.7	632.7	1257.0	2.987	1.987
10	1	3	6	3	0.924	2089.2	639.8	1449.4	3.265	2.265

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = Center; 3 = South

Table H.3. Additional data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
11	1	3	3	1	0.924	1963.3	707.2	1256.1	2.776	1.776
11	1	3	3	2	0.924	1819.8	592.7	1227.1	3.070	2.070
11	1	3	3	3	0.924	2059.5	689.6	1369.9	2.987	1.987
12	1	3	4	1	0.924	1625.3	606.2	1019.1	2.681	1.681
12	1	3	4	2	0.924	1913.5	693.2	1220.3	2.760	1.760
12	1	3	4	3	0.924	1655.1	614.2	1040.9	2.695	1.695
13	1	2	2	1	0.924	1466.1	518.2	947.9	2.829	1.829
13	1	2	2	2	0.924	1526.9	475.9	1051.0	3.208	2.208
13	1	2	2	3	0.924	1468.8	499.7	969.1	2.939	1.939
14	1	2	1	1	0.924	1213.8	365.9	847.9	3.317	2.317
14	1	2	1	2	0.924	1081.1	327.0	754.1	3.306	2.306
14	1	2	1	3	0.924	1137.9	345.4	792.5	3.294	2.294
15	1	2	5	1	0.924	2137.5	714.5	1423.0	2.992	1.992
15	1	2	5	2	0.924	2196.9	642.0	1554.9	3.422	2.422
15	1	2	5	3	0.924	1977.2	634.0	1343.2	3.119	2.119
16	1	2	6	1	0.924	2392.1	760.6	1631.5	3.145	2.145
16	1	2	6	2	0.924	2049.9	635.6	1414.3	3.225	2.225
16	1	2	6	3	0.924	2089.9	711.0	1378.9	2.939	1.939
17	1	2	3	1	0.924	1953.5	658.8	1294.7	2.965	1.965
17	1	2	3	2	0.924	1913.7	656.2	1257.5	2.916	1.916
17	1	2	3	3	0.924	1866.9	655.9	1211.0	2.846	1.846
18	1	2	4	1	0.924	1666.3	520.7	1145.6	3.200	2.200
18	1	2	4	2	0.924	1955.8	701.4	1254.4	2.788	1.788
18	1	2	4	3	0.924	2041.7	724.1	1317.6	2.820	1.820
19	2	3	3	1	0.924	1735.7	580.3	1155.4	2.991	1.991
19	2	3	3	2	0.924	1897.2	629.9	1267.3	3.012	2.012
19	2	3	3	3	0.924	2177.0	739.4	1437.6	2.944	1.944
20	2	3	4	1	0.924	1876.2	596.1	1280.1	3.147	2.147
20	2	3	4	2	0.924	1552.2	420.0	1132.2	3.696	2.696
20	2	3	4	3	0.924	1770.9	583.2	1187.7	3.037	2.037

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = Center; 3 = South

Table H.3. Additional data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
21	2	3	2	1	0.924	1520.6	447.4	1073.2	3.399	2.399
21	2	3	2	2	0.924	1570.2	507.9	1062.3	3.092	2.092
21	2	3	2	3	0.924	1702.8	576.2	1126.6	2.955	1.955
22	2	3	5	1	0.924	1977.6	680.3	1297.3	2.907	1.907
22	2	3	5	2	0.924	1699.5	478.5	1221.0	3.552	2.552
22	2	3	5	3	0.924	1535.7	571.1	964.6	2.689	1.689
23	2	3	6	1	0.924	2205.2	767.7	1437.5	2.872	1.872
23	2	3	6	2	0.924	2000.0	637.7	1362.3	3.136	2.136
23	2	3	6	3	0.924	1798.0	528.9	1269.1	3.400	2.400
24	2	3	1	1	0.924	1121.3	343.5	777.8	3.264	2.264
24	2	3	1	2	0.924	1145.9	386.2	759.7	2.967	1.967
24	2	3	1	3	0.924	1116.7	325.4	791.3	3.432	2.432
25	2	2	6	1	0.924	2049.1	740.4	1308.7	2.768	1.768
25	2	2	6	2	0.924	1904.2	589.4	1314.8	3.231	2.231
25	2	2	6	3	0.924	1796.1	551.5	1244.6	3.257	2.257
26	2	2	1	1	0.924	1260.0	376.4	883.6	3.348	2.348
26	2	2	1	2	0.924	1376.0	405.6	970.4	3.393	2.393
26	2	2	1	3	0.924	1063.6	336.7	726.9	3.159	2.159
27	2	2	2	1	0.924	1611.4	541.1	1070.3	2.978	1.978
27	2	2	2	2	0.924	1660.8	582.3	1078.5	2.852	1.852
27	2	2	2	3	0.924	1563.5	498.4	1065.1	3.137	2.137
28	2	2	5	1	0.924	1841.4	689.2	1152.2	2.672	1.672
28	2	2	5	2	0.924	1961.0	759.7	1201.3	2.581	1.581
28	2	2	5	3	0.924	1769.1	594.1	1175.0	2.978	1.978
29	2	2	3	1	0.924	1770.7	632.8	1137.9	2.798	1.798
29	2	2	3	2	0.924	1645.2	594.5	1050.7	2.767	1.767
29	2	2	3	3	0.924	1613.0	566.5	1046.5	2.847	1.847
30	2	2	4	1	0.924	1775.9	684.3	1091.6	2.595	1.595
30	2	2	4	2	0.924	1571.8	587.0	984.8	2.678	1.678
30	2	2	4	3	0.924	1666.3	626.9	1039.4	2.658	1.658

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = Center; 3 = South

Table H.3. Additional data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw: Grain Ratio
					m^2	g	g	g		
31	3	1	2	1	0.924	1612.0	567.8	1044.2	2.839	1.839
31	3	1	2	2	0.924	1548.7	554.1	994.6	2.795	1.795
31	3	1	2	3	0.924	1571.8	526.7	1045.1	2.984	1.984
32	3	1	1	1	0.924	1153.5	345.6	807.9	3.338	2.338
32	3	1	1	2	0.924	1109.3	326.8	782.5	3.394	2.394
32	3	1	1	3	0.924	1071.6	321.6	750.0	3.332	2.332
33	3	1	4	1	0.924	1761.5	597.5	1164.0	2.948	1.948
33	3	1	4	2	0.924	1602.4	550.5	1051.9	2.911	1.911
33	3	1	4	3	0.924	1653.3	552.8	1100.5	2.991	1.991
34	3	1	5	1	0.924	1713.4	550.1	1163.3	3.115	2.115
34	3	1	5	2	0.924	1844.0	619.3	1224.7	2.978	1.978
34	3	1	5	3	0.924	1674.3	566.9	1107.4	2.953	1.953
35	3	1	3	1	0.924	1874.3	628.4	1245.9	2.983	1.983
35	3	1	3	2	0.924	1669.1	561.5	1107.6	2.973	1.973
35	3	1	3	3	0.924	1976.2	686.1	1290.1	2.880	1.880
36	3	1	6	1	0.924	1899.2	556.6	1342.6	3.412	2.412
36	3	1	6	2	0.924	1802.9	568.1	1234.8	3.174	2.174
36	3	1	6	3	0.924	1933.0	597.0	1336.0	3.238	2.238
37	3	2	3	1	0.924	1572.9	544.8	1028.1	2.887	1.887
37	3	2	3	2	0.924	1647.1	572.6	1074.5	2.877	1.877
37	3	2	3	3	0.924	1860.0	618.2	1241.8	3.009	2.009
38	3	2	5	1	0.924	1640.0	546.3	1093.7	3.002	2.002
38	3	2	5	2	0.924	1709.1	621.5	1087.6	2.750	1.750
38	3	2	5	3	0.924	1767.8	607.0	1160.8	2.912	1.912
39	3	2	1	1	0.924	1115.8	368.2	747.6	3.030	2.030
39	3	2	1	2	0.924	1109.9	363.1	746.8	3.057	2.057
39	3	2	1	3	0.924	1222.5	423.8	798.7	2.885	1.885
40	3	2	4	1	0.924	1654.9	617.1	1037.8	2.682	1.682
40	3	2	4	2	0.924	1545.1	606.4	938.7	2.548	1.548
40	3	2	4	3	0.924	1702.1	714.0	988.1	2.384	1.384

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = Center; 3 = South

Table H.3. Additional data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw: Grain Ratio
					m^2	g	g	g		
41	3	2	6	1	0.924	1814.7	700.6	1114.1	2.590	1.590
41	3	2	6	2	0.924	1693.3	546.9	1146.4	3.096	2.096
41	3	2	6	3	0.924	1816.8	785.5	1031.3	2.313	1.313
42	3	2	2	1	0.924	1502.9	550.8	952.1	2.729	1.729
42	3	2	2	2	0.924	1429.3	540.7	888.6	2.643	1.643
42	3	2	2	3	0.924	1585.5	650.7	934.8	2.437	1.437
43	3	3	4	1	0.924	1608.7	493.9	1114.8	3.257	2.257
43	3	3	4	2	0.924	1481.5	567.4	914.1	2.611	1.611
43	3	3	4	3	0.924	1573.9	581.1	992.8	2.708	1.708
44	3	3	5	1	0.924	1657.3	614.9	1042.4	2.695	1.695
44	3	3	5	2	0.924	1675.3	616.5	1058.8	2.717	1.717
44	3	3	5	3	0.924	1911.0	706.6	1204.4	2.705	1.705
45	3	3	3	1	0.924	1573.1	555.8	1017.3	2.830	1.830
45	3	3	3	2	0.924	1448.6	462.6	986.0	3.131	2.131
45	3	3	3	3	0.924	1638.9	600.1	1038.8	2.731	1.731
46	3	3	1	1	0.924	826.7	278.1	548.6	2.973	1.973
46	3	3	1	2	0.924	1024.5	341.5	683.0	3.000	2.000
46	3	3	1	3	0.924	1022.5	304.5	718.0	3.358	2.358
47	3	3	2	1	0.924	1449.9	445.8	1004.1	3.252	2.252
47	3	3	2	2	0.924	1408.6	466.1	942.5	3.022	2.022
47	3	3	2	3	0.924	1597.2	542.9	1054.3	2.942	1.942
48	3	3	6	1	0.924	1721.9	512.0	1209.9	3.363	2.363
48	3	3	6	2	0.924	1849.1	630.0	1219.1	2.935	1.935
48	3	3	6	3	0.924	1985.7	693.5	1292.2	2.863	1.863
49	2	1	4	1	0.924	1944.5	717.5	1227.0	2.710	1.710
49	2	1	4	2	0.924	1681.6	511.8	1169.8	3.286	2.286
49	2	1	4	3	0.924	1975.4	747.8	1227.6	2.642	1.642
50	2	1	1	1	0.924	1082.5	280.8	801.7	3.855	2.855
50	2	1	1	2	0.924	1160.7	336.6	824.1	3.448	2.448
50	2	1	1	3	0.924	1128.1	361.3	766.8	3.122	2.122

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = Center; 3 = South

Table H.3. Additional data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Bundle Weight	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw: Grain Ratio
					m^2	g	g	g		
51	2	1	2	1	0.924	1200.3	365.3	835.0	3.286	2.286
51	2	1	2	2	0.924	1381.0	448.0	933.0	3.083	2.083
51	2	1	2	3	0.924	1467.5	483.6	983.9	3.035	2.035
52	2	1	3	1	0.924	1695.2	610.3	1084.9	2.778	1.778
52	2	1	3	2	0.924	1502.9	546.4	956.5	2.751	1.751
52	2	1	3	3	0.924	1677.1	593.0	1084.1	2.828	1.828
53	2	1	6	1	0.924	1858.5	659.4	1199.1	2.818	1.818
53	2	1	6	2	0.924	2102.4	729.4	1373.0	2.882	1.882
53	2	1	6	3	0.924	1558.2	493.3	1064.9	3.159	2.159
54	2	1	5	1	0.924	1389.1	492.0	897.1	2.823	1.823
54	2	1	5	2	0.924	1827.2	587.2	1240.0	3.112	2.112
54	2	1	5	3	0.924	2094.3	617.5	1476.8	3.392	2.392

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = Center; 3 = South

Table H.4. Additional data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
1	1	1	5	1	*	1925.0	774.2	1150.8	2.486	1.486
1	1	1	5	2	*	2020.0	771.5	1248.5	2.618	1.618
2	1	1	4	1	*	1970.0	737.2	1232.8	2.672	1.672
2	1	1	4	2	*	2040.0	813.8	1226.2	2.507	1.507
3	1	1	6	1	*	2045.0	761.7	1283.3	2.685	1.685
3	1	1	6	2	*	2205.0	818.3	1386.7	2.695	1.695
4	1	1	2	1	*	1795.0	627.6	1167.4	2.860	1.860
4	1	1	2	2	*	1825.0	631.8	1193.2	2.889	1.889
5	1	1	3	1	*	2315.0	738.4	1576.6	3.135	2.135
5	1	1	3	2	*	2170.0	715.2	1454.8	3.034	2.034
6	1	1	1	1	*	1630.0	530.6	1099.4	3.072	2.072
6	1	1	1	2	*	1445.0	451.8	993.2	3.198	2.198
7	1	3	1	1	*	1375.0	463.2	911.8	2.968	1.968
7	1	3	1	2	*	1290.0	440.8	849.2	2.926	1.926
8	1	3	2	1	*	1805.0	574.2	1230.8	3.144	2.144
8	1	3	2	2	*	1820.0	579.4	1240.6	3.141	2.141
9	1	3	5	1	*	1930.0	629.0	1301.0	3.068	2.068
9	1	3	5	2	*	2025.0	635.9	1389.1	3.184	2.184
10	1	3	6	1	*	2035.0	686.0	1349.0	2.966	1.966
10	1	3	6	2	*	1960.0	648.1	1311.9	3.024	2.024
11	1	3	3	1	*	2010.0	727.2	1282.8	2.764	1.764
11	1	3	3	2	*	1965.0	694.7	1270.3	2.829	1.829
12	1	3	4	1	*	1720.0	670.8	1049.2	2.564	1.564
12	1	3	4	2	*	1725.0	649.0	1076.0	2.658	1.658
13	1	2	2	1	*	1655.0	601.7	1053.3	2.751	1.751
13	1	2	2	2	*	1650.0	606.5	1043.5	2.721	1.721

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.4. Additional data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
14	1	2	1	1	*	1315.0	456.6	858.4	2.880	1.880
14	1	2	1	2	*	1295.0	441.0	854.0	2.937	1.937
15	1	2	5	1	*	1800.0	713.5	1086.5	2.523	1.523
15	1	2	5	2	*	1840.0	668.0	1172.0	2.754	1.754
16	1	2	6	1	*	2025.0	758.3	1266.7	2.670	1.670
16	1	2	6	2	*	1860.0	733.5	1126.5	2.536	1.536
17	1	2	3	1	*	1800.0	721.8	1078.2	2.494	1.494
17	1	2	3	2	*	1615.0	648.6	966.4	2.490	1.490
18	1	2	4	1	*	1655.0	694.8	960.2	2.382	1.382
18	1	2	4	2	*	1440.0	611.5	828.5	2.355	1.355
19	2	3	3	1	*	1465.0	600.2	864.8	2.441	1.441
19	2	3	3	2	*	1570.0	644.2	925.8	2.437	1.437
20	2	3	4	1	*	1670.0	634.5	1035.5	2.632	1.632
20	2	3	4	2	*	1770.0	653.5	1116.5	2.708	1.708
21	2	3	2	1	*	1375.0	523.7	851.3	2.626	1.626
21	2	3	2	2	*	1565.0	611.8	953.2	2.558	1.558
22	2	3	5	1	*	1760.0	685.6	1074.4	2.567	1.567
22	2	3	5	2	*	1565.0	568.4	996.6	2.753	1.753
23	2	3	6	1	*	1410.0	569.0	841.0	2.478	1.478
23	2	3	6	2	*	1675.0	649.3	1025.7	2.580	1.580
24	2	3	1	1	*	1285.0	466.2	818.8	2.756	1.756
24	2	3	1	2	*	1320.0	480.8	839.2	2.745	1.745
25	2	2	6	1	*	1685.0	699.9	985.1	2.407	1.407
25	2	2	6	2	*	1790.0	709.1	1080.9	2.524	1.524
26	2	2	1	1	*	1570.0	494.9	1075.1	3.172	2.172
26	2	2	1	2	*	1500.0	483.2	1016.8	3.104	2.104

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South

Table H.4. Additional data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
27	2	2	2	1	*	1865.0	707.8	1157.2	2.635	1.635
27	2	2	2	2	*	1615.0	557.7	1057.3	2.896	1.896
28	2	2	5	1	*	1770.0	741.5	1028.5	2.387	1.387
28	2	2	5	2	*	1825.0	771.5	1053.5	2.366	1.366
29	2	2	3	1	*	1575.0	603.1	971.9	2.612	1.612
29	2	2	3	2	*	1605.0	605.5	999.5	2.651	1.651
30	2	2	4	1	*	1730.0	694.2	1035.8	2.492	1.492
30	2	2	4	2	*	1750.0	750.3	999.7	2.332	1.332
31	3	1	2	1	*	1770.0	673.1	1096.9	2.630	1.630
31	3	1	2	2	*	1960.0	724.5	1235.5	2.705	1.705
32	3	1	1	1	*	1380.0	500.6	879.4	2.757	1.757
32	3	1	1	2	*	1310.0	456.5	853.5	2.870	1.870
33	3	1	4	1	*	1860.0	728.2	1131.8	2.554	1.554
33	3	1	4	2	*	1900.0	744.0	1156.0	2.554	1.554
34	3	1	5	1	*	1910.0	775.6	1134.4	2.463	1.463
34	3	1	5	2	*	1840.0	748.6	1091.4	2.458	1.458
35	3	1	3	1	*	1825.0	729.8	1095.2	2.501	1.501
35	3	1	3	2	*	1925.0	798.6	1126.4	2.410	1.410
36	3	1	6	1	*	2085.0	886.1	1198.9	2.353	1.353
36	3	1	6	2	*	2160.0	856.7	1303.3	2.521	1.521
37	3	2	3	1	*	1670.0	633.7	1036.3	2.635	1.635
37	3	2	3	2	*	1820.0	648.2	1171.8	2.808	1.808
38	3	2	5	1	*	1830.0	675.1	1154.9	2.711	1.711
38	3	2	5	2	*	2000.0	810.2	1189.8	2.469	1.469
39	3	2	1	1	*	1240.0	450.0	790.0	2.756	1.756
39	3	2	1	2	*	1320.0	463.2	856.8	2.850	1.850

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.4. Additional data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
40	3	2	4	1	*	1745.0	763.3	981.7	2.286	1.286
40	3	2	4	2	*	1640.0	696.8	943.2	2.354	1.354
41	3	2	6	1	*	1805.0	762.4	1042.6	2.368	1.368
41	3	2	6	2	*	1865.0	714.1	1150.9	2.612	1.612
42	3	2	2	1	*	1605.0	626.1	978.9	2.563	1.563
42	3	2	2	2	*	1585.0	608.1	976.9	2.606	1.606
43	3	3	4	1	*	1705.0	678.2	1026.8	2.514	1.514
43	3	3	4	2	*	1775.0	699.2	1075.8	2.539	1.539
44	3	3	5	1	*	1955.0	784.0	1171.0	2.494	1.494
44	3	3	5	2	*	1885.0	764.6	1120.4	2.465	1.465
45	3	3	3	1	*	1795.0	743.3	1051.7	2.415	1.415
45	3	3	3	2	*	1820.0	727.7	1092.3	2.501	1.501
46	3	3	1	1	*	1315.0	463.0	852.0	2.840	1.840
46	3	3	1	2	*	1410.0	483.0	927.0	2.919	1.919
47	3	3	2	1	*	1610.0	577.3	1032.7	2.789	1.789
47	3	3	2	2	*	1735.0	647.3	1087.7	2.680	1.680
48	3	3	6	1	*	2010.0	814.8	1195.2	2.467	1.467
48	3	3	6	2	*	1685.0	698.8	986.2	2.411	1.411
49	2	1	4	1	*	1860.0	800.4	1059.6	2.324	1.324
49	2	1	4	2	*	1880.0	820.1	1059.9	2.292	1.292
50	2	1	1	1	*	1465.0	494.6	970.4	2.962	1.962
50	2	1	1	2	*	1205.0	412.8	792.2	2.919	1.919
51	2	1	2	1	*	1645.0	586.2	1058.8	2.806	1.806
51	2	1	2	2	*	1515.0	534.3	980.7	2.835	1.835
52	2	1	3	1	*	1775.0	715.7	1059.3	2.480	1.480
52	2	1	3	2	*	1890.0	756.9	1133.1	2.497	1.497

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South

Table H.4. Additional data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
53	2	1	6	1	*	2050.0	856.8	1193.2	2.393	1.393
53	2	1	6	2	*	2020.0	833.2	1186.8	2.424	1.424
54	2	1	5	1	*	1915.0	773.9	1141.1	2.474	1.474
54	2	1	5	2	*	1935.0	826.1	1108.9	2.342	1.342

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.5. Additional data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
1	1	1	5	1	0.507	640.0	241.4	398.6	2.651	1.651
1	1	1	5	2	0.507	730.0	279.9	450.1	2.608	1.608
2	1	1	4	1	0.507	835.0	351.4	483.6	2.376	1.376
2	1	1	4	2	0.507	920.0	385.5	534.6	2.387	1.387
3	1	1	6	1	0.507	790.0	323.0	467.0	2.446	1.446
3	1	1	6	2	0.507	780.0	312.5	467.5	2.496	1.496
4	1	1	2	1	0.507	850.0	343.6	506.4	2.474	1.474
4	1	1	2	2	0.507	920.0	366.5	553.6	2.511	1.511
5	1	1	3	1	0.507	820.0	334.5	485.5	2.452	1.452
5	1	1	3	2	0.507	885.0	330.9	554.1	2.675	1.675
6	1	1	1	1	0.507	960.0	396.4	563.6	2.422	1.422
6	1	1	1	2	0.507	900.0	341.5	558.5	2.636	1.636
7	1	3	1	1	0.507	605.0	240.4	364.6	2.516	1.516
7	1	3	1	2	0.507	640.0	230.6	409.4	2.775	1.775
8	1	3	2	1	0.507	695.0	293.5	401.5	2.368	1.368
8	1	3	2	2	0.507	735.0	273.7	461.3	2.685	1.685
9	1	3	5	1	0.507	880.0	350.4	529.6	2.511	1.511
9	1	3	5	2	0.507	745.0	264.2	480.9	2.820	1.820
10	1	3	6	1	0.507	865.0	356.6	508.4	2.426	1.426
10	1	3	6	2	0.507	800.0	283.5	516.5	2.822	1.822
11	1	3	3	1	0.507	960.0	406.5	553.5	2.362	1.362
11	1	3	3	2	0.507	770.0	290.4	479.7	2.652	1.652
12	1	3	4	1	0.507	910.0	367.8	542.2	2.474	1.474
12	1	3	4	2	0.507	845.0	320.0	525.0	2.640	1.640
13	1	2	2	1	0.507	965.0	400.7	564.3	2.408	1.408
13	1	2	2	2	0.507	770.0	301.5	468.5	2.554	1.554

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.5. Additional data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
14	1	2	1	1	0.507	765.0	294.3	470.7	2.600	1.600
14	1	2	1	2	0.507	905.0	342.2	562.8	2.644	1.644
15	1	2	5	1	0.507	810.0	323.1	486.9	2.507	1.507
15	1	2	5	2	0.507	820.0	300.9	519.1	2.725	1.725
16	1	2	6	1	0.507	920.0	369.8	550.2	2.488	1.488
16	1	2	6	2	0.507	855.0	327.6	527.4	2.610	1.610
17	1	2	3	1	0.507	715.0	303.8	411.2	2.353	1.353
17	1	2	3	2	0.507	770.0	308.9	461.1	2.492	1.492
18	1	2	4	1	0.507	820.0	349.9	470.1	2.344	1.344
18	1	2	4	2	0.507	855.0	375.0	480.0	2.280	1.280
19	2	3	3	1	0.507	825.0	350.2	474.8	2.356	1.356
19	2	3	3	2	0.507	1065.0	455.4	609.6	2.339	1.339
20	2	3	4	1	0.507	865.0	359.5	505.5	2.406	1.406
20	2	3	4	2	0.507	710.0	293.2	416.8	2.421	1.421
21	2	3	2	1	0.507	895.0	379.3	515.7	2.360	1.360
21	2	3	2	2	0.507	695.0	298.2	396.9	2.331	1.331
22	2	3	5	1	0.507	900.0	360.9	539.1	2.494	1.494
22	2	3	5	2	0.507	925.0	373.2	551.9	2.479	1.479
23	2	3	6	1	0.507	955.0	369.6	585.4	2.584	1.584
23	2	3	6	2	0.507	830.0	331.7	498.3	2.502	1.502
24	2	3	1	1	0.507	675.0	237.7	437.3	2.840	1.840
24	2	3	1	2	0.507	770.0	304.9	465.1	2.526	1.526
25	2	2	6	1	0.507	905.0	331.8	573.2	2.728	1.728
25	2	2	6	2	0.507	870.0	297.5	572.5	2.924	1.924
26	2	2	1	1	0.507	825.0	313.6	511.4	2.631	1.631
26	2	2	1	2	0.507	830.0	295.7	534.3	2.807	1.807

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South

Table H.5. Additional data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
27	2	2	2	1	0.507	845.0	320.8	524.2	2.634	1.634
27	2	2	2	2	0.507	860.0	360.3	499.7	2.387	1.387
28	2	2	5	1	0.507	720.0	251.5	468.5	2.863	1.863
28	2	2	5	2	0.507	720.0	246.4	473.6	2.922	1.922
29	2	2	3	1	0.507	880.0	302.6	577.4	2.908	1.908
29	2	2	3	2	0.507	730.0	301.3	428.7	2.423	1.423
30	2	2	4	1	0.507	770.0	292.0	478.0	2.637	1.637
30	2	2	4	2	0.507	795.0	307.8	487.2	2.583	1.583
31	3	1	2	1	0.507	870.0	351.3	518.7	2.476	1.476
31	3	1	2	2	0.507	790.0	335.4	454.6	2.356	1.356
32	3	1	1	1	0.507	715.0	268.9	446.1	2.659	1.659
32	3	1	1	2	0.507	810.0	324.7	485.3	2.495	1.495
33	3	1	4	1	0.507	1000.0	405.1	594.9	2.469	1.469
33	3	1	4	2	0.507	960.0	370.0	590.0	2.595	1.595
34	3	1	5	1	0.507	955.0	384.6	570.4	2.483	1.483
34	3	1	5	2	0.507	865.0	357.2	507.8	2.422	1.422
35	3	1	3	1	0.507	1010.0	421.9	588.1	2.394	1.394
35	3	1	3	2	0.507	940.0	394.1	545.9	2.385	1.385
36	3	1	6	1	0.507	780.0	277.5	502.6	2.811	1.811
36	3	1	6	2	0.507	975.0	366.0	609.0	2.664	1.664
37	3	2	3	1	0.507	835.0	293.6	541.4	2.844	1.844
37	3	2	3	2	0.507	910.0	364.2	545.8	2.498	1.498
38	3	2	5	1	0.507	910.0	334.8	575.2	2.718	1.718
38	3	2	5	2	0.507	895.0	363.6	531.4	2.462	1.462
39	3	2	1	1	0.507	755.0	300.2	454.9	2.515	1.515
39	3	2	1	2	0.507	670.0	267.1	403.0	2.509	1.509

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South

Table H.5. Additional data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
40	3	2	4	1	0.507	865.0	351.8	513.3	2.459	1.459
40	3	2	4	2	0.507	710.0	302.6	407.4	2.346	1.346
41	3	2	6	1	0.507	825.0	292.2	532.8	2.823	1.823
41	3	2	6	2	0.507	775.0	302.3	472.7	2.564	1.564
42	3	2	2	1	0.507	680.0	249.6	430.5	2.725	1.725
42	3	2	2	2	0.507	645.0	234.7	410.4	2.749	1.749
43	3	3	4	1	0.507	750.0	274.9	475.1	2.728	1.728
43	3	3	4	2	0.507	815.0	342.2	472.8	2.382	1.382
44	3	3	5	1	0.507	800.0	290.9	509.1	2.750	1.750
44	3	3	5	2	0.507	860.0	344.0	516.0	2.500	1.500
45	3	3	3	1	0.507	755.0	258.8	496.2	2.917	1.917
45	3	3	3	2	0.507	800.0	326.4	473.6	2.451	1.451
46	3	3	1	1	0.507	680.0	230.4	449.6	2.951	1.951
46	3	3	1	2	0.507	695.0	249.5	445.5	2.786	1.786
47	3	3	2	1	0.507	970.0	358.9	611.1	2.703	1.703
47	3	3	2	2	0.507	825.0	323.1	501.9	2.554	1.554
48	3	3	6	1	0.507	805.0	275.1	530.0	2.927	1.927
48	3	3	6	2	0.507	800.0	305.0	495.1	2.623	1.623
49	2	1	4	1	0.507	1090.0	442.3	647.7	2.464	1.464
49	2	1	4	2	0.507	745.0	325.1	419.9	2.292	1.292
50	2	1	1	1	0.507	760.0	283.6	476.4	2.680	1.680
50	2	1	1	2	0.507	915.0	348.8	566.2	2.623	1.623
51	2	1	2	1	0.507	970.0	380.1	589.9	2.552	1.552
51	2	1	2	2	0.507	870.0	352.6	517.4	2.468	1.468
52	2	1	3	1	0.507	1000.0	413.0	587.0	2.421	1.421
52	2	1	3	2	0.507	915.0	385.2	529.8	2.375	1.375

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South

Table H.5. Additional data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Sample Area	Fresh Weight Bundle Harvest	Fresh Weight Bundle Grain	Fresh Weight Bundle Straw	Dry Matter: Grain Ratio	Straw:Grain Ratio
					m^2	g	g	g		
53	2	1	6	1	0.507	910.0	360.6	549.4	2.524	1.524
53	2	1	6	2	0.507	875.0	339.4	535.6	2.578	1.578
54	2	1	5	1	0.507	880.0	359.6	520.4	2.447	1.447
54	2	1	5	2	0.507	895.0	355.0	540.0	2.521	1.521

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.6. Protein data collected from 1963 to 1973 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Protein
					%
1963	1	1	1	5	8.30
1963	2	1	1	4	6.60
1963	3	1	1	6	9.30
1963	4	1	1	2	6.30
1963	5	1	1	3	6.50
1963	6	1	1	1	6.10
1963	7	1	3	1	6.00
1963	8	1	3	2	6.10
1963	9	1	3	5	7.10
1963	10	1	3	6	9.10
1963	11	1	3	3	6.50
1963	12	1	3	4	6.60
1963	13	1	2	2	6.30
1963	14	1	2	1	6.10
1963	15	1	2	5	6.80
1963	16	1	2	6	8.80
1963	17	1	2	3	6.60
1963	18	1	2	4	6.70
1963	19	2	3	3	6.60
1963	20	2	3	4	6.90
1963	21	2	3	2	7.00
1963	22	2	3	5	8.60
1963	23	2	3	6	10.20
1963	24	2	3	1	6.00
1963	25	2	2	6	11.90
1963	26	2	2	1	6.10
1963	27	2	2	2	6.50
1963	28	2	2	5	9.40
1963	29	2	2	3	8.00
1963	30	2	2	4	8.60
1963	31	3	1	2	6.60
1963	32	3	1	1	6.30
1963	33	3	1	4	8.20
1963	34	3	1	5	10.80
1963	35	3	1	3	7.90
1963	36	3	1	6	6.90
1963	37	3	2	3	6.90
1963	38	3	2	5	10.00
1963	39	3	2	1	6.30
1963	40	3	2	4	7.50
1963	41	3	2	6	11.10
1963	42	3	2	2	6.40
1963	43	3	3	4	7.70

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.6. Protein data collected from 1963 to 1973 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Protein
					%
1963	44	3	3	5	9.60
1963	45	3	3	3	6.30
1963	46	3	3	1	5.70
1963	47	3	3	2	6.00
1963	48	3	3	6	11.50
1963	49	2	1	4	7.00
1963	50	2	1	1	5.90
1963	51	2	1	2	5.80
1963	52	2	1	3	6.80
1963	53	2	1	6	11.00
1963	54	2	1	5	8.20
1965	1	1	1	5	11.50
1965	2	1	1	4	9.00
1965	3	1	1	6	12.20
1965	4	1	1	2	9.60
1965	5	1	1	3	9.80
1965	6	1	1	1	8.20
1965	7	1	3	1	9.50
1965	8	1	3	2	9.10
1965	9	1	3	5	11.40
1965	10	1	3	6	12.10
1965	11	1	3	3	11.20
1965	12	1	3	4	11.10
1965	13	1	2	2	8.40
1965	14	1	2	1	9.70
1965	15	1	2	5	11.50
1965	16	1	2	6	12.40
1965	17	1	2	3	12.10
1965	18	1	2	4	11.00
1965	19	2	3	3	12.50
1965	20	2	3	4	12.30
1965	21	2	3	2	9.50
1965	22	2	3	5	13.40
1965	23	2	3	6	12.90
1965	24	2	3	1	9.80
1965	25	2	2	6	12.50
1965	26	2	2	1	7.50
1965	27	2	2	2	7.30
1965	28	2	2	5	11.80
1965	29	2	2	3	10.50
1965	30	2	2	4	9.30
1965	31	3	1	2	8.80
1965	32	3	1	1	9.80

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.6. Protein data collected from 1963 to 1973 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Protein
					%
1965	33	3	1	4	9.70
1965	34	3	1	5	11.90
1965	35	3	1	3	9.70
1965	36	3	1	6	13.70
1965	37	3	2	3	10.50
1965	38	3	2	5	11.00
1965	39	3	2	1	8.80
1965	40	3	2	4	9.20
1965	41	3	2	6	12.40
1965	42	3	2	2	9.60
1965	43	3	3	4	8.60
1965	44	3	3	5	11.30
1965	45	3	3	3	9.50
1965	46	3	3	1	6.90
1965	47	3	3	2	7.50
1965	48	3	3	6	13.30
1965	49	2	1	4	8.70
1965	50	2	1	1	6.80
1965	51	2	1	2	7.20
1965	52	2	1	3	9.70
1965	53	2	1	6	13.70
1965	54	2	1	5	11.60
1967	1	1	1	5	12.00
1967	2	1	1	4	9.10
1967	3	1	1	6	13.10
1967	4	1	1	2	6.80
1967	5	1	1	3	7.90
1967	6	1	1	1	6.60
1967	7	1	3	1	6.30
1967	8	1	3	2	6.30
1967	9	1	3	5	9.50
1967	10	1	3	6	12.50
1967	11	1	3	3	8.70
1967	12	1	3	4	9.00
1967	13	1	2	2	7.10
1967	14	1	2	1	6.30
1967	15	1	2	5	9.40
1967	16	1	2	6	13.50
1967	17	1	2	3	8.60
1967	18	1	2	4	8.80
1967	19	2	3	3	9.00
1967	20	2	3	4	9.80
1967	21	2	3	2	9.30

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.6. Protein data collected from 1963 to 1973 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Protein
					%
1967	22	2	3	5	11.90
1967	23	2	3	6	14.60
1967	24	2	3	1	6.90
1967	25	2	2	6	14.70
1967	26	2	2	1	6.70
1967	27	2	2	2	6.30
1967	28	2	2	5	11.90
1967	29	2	2	3	8.00
1967	30	2	2	4	9.80
1967	31	3	1	2	7.60
1967	32	3	1	1	6.90
1967	33	3	1	4	9.40
1967	34	3	1	5	13.30
1967	35	3	1	3	9.20
1967	36	3	1	6	15.50
1967	37	3	2	3	8.20
1967	38	3	2	5	10.80
1967	39	3	2	1	6.60
1967	40	3	2	4	9.80
1967	41	3	2	6	15.10
1967	42	3	2	2	7.10
1967	43	3	3	4	8.40
1967	44	3	3	5	11.10
1967	45	3	3	3	7.90
1967	46	3	3	1	6.10
1967	47	3	3	2	6.30
1967	48	3	3	6	13.80
1967	49	2	1	4	9.80
1967	50	2	1	1	6.80
1967	51	2	1	2	6.50
1967	23	2	3	6	14.60
1967	24	2	3	1	6.90
1967	52	2	1	3	8.90
1967	53	2	1	6	14.50
1967	54	2	1	5	12.10
1969	1	1	1	5	12.10
1969	2	1	1	4	11.40
1969	3	1	1	6	14.40
1969	4	1	1	2	8.90
1969	5	1	1	3	9.50
1969	6	1	1	1	8.20
1969	7	1	3	1	7.50
1969	8	1	3	2	8.40

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.6. Protein data collected from 1963 to 1973 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Protein
					%
1969	9	1	3	5	9.40
1969	10	1	3	6	12.70
1969	11	1	3	3	9.70
1969	12	1	3	4	14.10
1969	13	1	2	2	11.10
1969	14	1	2	1	7.60
1969	15	1	2	5	12.30
1969	16	1	2	6	12.90
1969	17	1	2	3	11.50
1969	18	1	2	4	11.60
1969	19	2	3	3	10.80
1969	20	2	3	4	11.60
1969	21	2	3	2	10.30
1969	22	2	3	5	12.70
1969	23	2	3	6	13.70
1969	24	2	3	1	9.20
1969	25	2	2	6	12.90
1969	26	2	2	1	8.60
1969	27	2	2	2	8.90
1969	28	2	2	5	12.90
1969	29	2	2	3	10.70
1969	30	2	2	4	11.90
1969	31	3	1	2	10.10
1969	32	3	1	1	8.90
1969	33	3	1	4	12.90
1969	34	3	1	5	16.20
1969	35	3	1	3	12.80
1969	36	3	1	6	17.30
1969	37	3	2	3	11.30
1969	38	3	2	5	14.10
1969	39	3	2	1	9.40
1969	40	3	2	4	12.00
1969	41	3	2	6	15.80
1969	42	3	2	2	9.20
1969	43	3	3	4	10.60
1969	44	3	3	5	12.50
1969	45	3	3	3	10.10
1969	46	3	3	1	8.20
1969	47	3	3	2	6.80
1969	48	3	3	6	13.60
1969	49	2	1	4	13.20
1969	50	2	1	1	9.10
1969	51	2	1	2	8.10

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.6. Protein data collected from 1963 to 1973 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Protein
					%
1969	52	2	1	3	12.30
1969	53	2	1	6	17.20
1969	54	2	1	5	14.20
1971	1	1	1	5	10.30
1971	2	1	1	4	8.10
1971	3	1	1	6	11.30
1971	4	1	1	2	7.20
1971	5	1	1	3	6.90
1971	6	1	1	1	6.80
1971	7	1	3	1	6.60
1971	8	1	3	2	6.60
1971	9	1	3	5	8.80
1971	10	1	3	6	12.00
1971	11	1	3	3	7.80
1971	12	1	3	4	8.00
1971	13	1	2	2	6.60
1971	14	1	2	1	6.60
1971	15	1	2	5	9.10
1971	16	1	2	6	11.30
1971	17	1	2	3	8.10
1971	18	1	2	4	8.00
1971	19	2	3	3	8.40
1971	20	2	3	4	8.00
1971	21	2	3	2	7.30
1971	22	2	3	5	7.90
1971	23	2	3	6	12.50
1971	24	2	3	1	6.90
1971	25	2	2	6	13.90
1971	26	2	2	1	8.90
1971	27	2	2	2	6.60
1971	28	2	2	5	11.10
1971	29	2	2	3	7.80
1971	30	2	2	4	8.00
1971	31	3	1	2	7.10
1971	32	3	1	1	7.00
1971	33	3	1	4	9.10
1971	34	3	1	5	11.90
1971	35	3	1	3	8.50
1971	36	3	1	6	14.00
1971	37	3	2	3	7.00
1971	38	3	2	5	9.30
1971	39	3	2	1	7.60
1971	40	3	2	4	7.60

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.6. Protein data collected from 1963 to 1973 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Protein
					%
1971	41	3	2	6	11.70
1971	42	3	2	2	6.60
1971	43	3	3	4	7.00
1971	44	3	3	5	7.80
1971	45	3	3	3	6.80
1971	46	3	3	1	6.80
1971	47	3	3	2	8.40
1971	48	3	3	6	11.20
1971	49	2	1	4	8.40
1971	50	2	1	1	7.00
1971	51	2	1	2	7.30
1971	52	2	1	3	10.50
1971	53	2	1	6	11.40
1971	54	2	1	5	9.10
1973	1	1	1	5	11.70
1973	2	1	1	4	10.90
1973	3	1	1	6	11.90
1973	4	1	1	2	9.20
1973	5	1	1	3	8.90
1973	6	1	1	1	8.50
1973	7	1	3	1	8.00
1973	8	1	3	2	8.20
1973	9	1	3	5	11.40
1973	10	1	3	6	12.70
1973	11	1	3	3	10.80
1973	12	1	3	4	11.10
1973	13	1	2	2	9.20
1973	14	1	2	1	8.00
1973	15	1	2	5	12.10
1973	16	1	2	6	12.90
1973	17	1	2	3	11.50
1973	18	1	2	4	11.70
1973	19	2	3	3	11.20
1973	20	2	3	4	10.70
1973	21	2	3	2	9.60
1973	22	2	3	5	11.60
1973	23	2	3	6	12.80
1973	24	2	3	1	9.50
1973	25	2	2	6	13.30
1973	26	2	2	1	9.30
1973	27	2	2	2	8.70
1973	28	2	2	5	11.60
1973	29	2	2	3	11.40

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.6. Protein data collected from 1963 to 1973 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Grain Protein
					%
1973	30	2	2	4	11.90
1973	31	3	1	2	10.80
1973	32	3	1	1	10.20
1973	33	3	1	4	12.80
1973	34	3	1	5	14.50
1973	35	3	1	3	12.00
1973	36	3	1	6	15.20
1973	37	3	2	3	10.40
1973	38	3	2	5	11.90
1973	39	3	2	1	12.30
1973	40	3	2	4	12.40
1973	41	3	2	6	14.10
1973	42	3	2	2	10.50
1973	43	3	3	4	11.10
1973	44	3	3	5	10.70
1973	45	3	3	3	11.50
1973	46	3	3	1	8.40
1973	47	3	3	2	9.20
1973	48	3	3	6	13.70
1973	49	2	1	4	12.80
1973	50	2	1	1	9.40
1973	51	2	1	2	9.70
1973	52	2	1	3	12.80
1973	53	2	1	6	14.60
1973	54	2	1	5	12.50

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1977	1	1	1	5	1	*	*	2.470	0.390
1977	1	1	1	5	2	*	*	2.210	0.330
1977	1	1	1	5	3	*	*	*	*
1977	2	1	1	4	1	*	*	2.070	0.330
1977	2	1	1	4	2	*	*	2.090	0.300
1977	2	1	1	4	3	*	*	*	*
1977	3	1	1	6	1	*	*	2.360	0.390
1977	3	1	1	6	2	*	*	2.540	0.380
1977	3	1	1	6	3	*	*	*	*
1977	4	1	1	2	1	*	*	1.610	0.170
1977	4	1	1	2	2	*	*	1.470	0.190
1977	4	1	1	2	3	*	*	*	*
1977	5	1	1	3	1	*	*	1.640	0.280
1977	5	1	1	3	2	*	*	1.850	0.310
1977	5	1	1	3	3	*	*	*	*
1977	6	1	1	1	1	*	*	1.500	0.180
1977	6	1	1	1	2	*	*	1.450	0.150
1977	6	1	1	1	3	*	*	*	*
1977	7	1	3	1	1	*	*	1.490	0.200
1977	7	1	3	1	2	*	*	1.430	0.200
1977	7	1	3	1	3	*	*	*	*
1977	8	1	3	2	1	*	*	1.620	0.200
1977	8	1	3	2	2	*	*	1.520	0.180
1977	8	1	3	2	3	*	*	*	*
1977	9	1	3	5	1	*	*	2.070	0.290
1977	9	1	3	5	2	*	*	2.180	0.420
1977	9	1	3	5	3	*	*	*	*
1977	10	1	3	6	1	*	*	2.260	0.410
1977	10	1	3	6	2	*	*	2.130	0.400
1977	10	1	3	6	3	*	*	*	*
1977	11	1	3	3	1	*	*	2.030	0.340
1977	11	1	3	3	2	*	*	2.220	0.420
1977	11	1	3	3	3	*	*	*	*
1977	12	1	3	4	1	*	*	2.140	0.210
1977	12	1	3	4	2	*	*	2.070	0.290
1977	12	1	3	4	3	*	*	*	*
1977	13	1	2	2	1	*	*	1.600	0.190
1977	13	1	2	2	2	*	*	1.620	0.190
1977	13	1	2	2	3	*	*	*	*
1977	14	1	2	1	1	*	*	1.500	0.200
1977	14	1	2	1	2	*	*	1.520	0.180
1977	14	1	2	1	3	*	*	*	*
1977	15	1	2	5	1	*	*	2.100	0.320
1977	15	1	2	5	2	*	*	2.070	0.270
1977	15	1	2	5	3	*	*	*	*
1977	16	1	2	6	1	*	*	2.220	0.300
1977	16	1	2	6	2	*	*	2.340	0.400
1977	16	1	2	6	3	*	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1977	17	1	2	3	1	*	*	2.030	0.240
1977	17	1	2	3	2	*	*	2.060	0.240
1977	17	1	2	3	3	*	*	*	*
1977	18	1	2	4	1	*	*	2.020	0.250
1977	18	1	2	4	2	*	*	2.050	0.230
1977	18	1	2	4	3	*	*	*	*
1977	19	2	3	3	1	*	*	*	*
1977	19	2	3	3	2	*	*	*	*
1977	19	2	3	3	3	*	*	*	*
1977	20	2	3	4	1	*	*	*	*
1977	20	2	3	4	2	*	*	*	*
1977	20	2	3	4	3	*	*	*	*
1977	21	2	3	2	1	*	*	*	*
1977	21	2	3	2	2	*	*	*	*
1977	21	2	3	2	3	*	*	*	*
1977	22	2	3	5	1	*	*	*	*
1977	22	2	3	5	2	*	*	*	*
1977	22	2	3	5	3	*	*	*	*
1977	23	2	3	6	1	*	*	*	*
1977	23	2	3	6	2	*	*	*	*
1977	23	2	3	6	3	*	*	*	*
1977	24	2	3	1	1	*	*	*	*
1977	24	2	3	1	2	*	*	*	*
1977	24	2	3	1	3	*	*	*	*
1977	25	2	2	6	1	*	*	2.500	0.390
1977	25	2	2	6	2	*	*	2.520	0.290
1977	25	2	2	6	3	*	*	*	*
1977	26	2	2	1	1	*	*	1.660	0.200
1977	26	2	2	1	2	*	*	1.680	0.180
1977	26	2	2	1	3	*	*	*	*
1977	27	2	2	2	1	*	*	2.220	0.280
1977	27	2	2	2	2	*	*	2.190	0.260
1977	27	2	2	2	3	*	*	*	*
1977	28	2	2	5	1	*	*	2.310	0.260
1977	28	2	2	5	2	*	*	2.380	0.250
1977	28	2	2	5	3	*	*	*	*
1977	29	2	2	3	1	*	*	2.290	0.250
1977	29	2	2	3	2	*	*	2.200	0.250
1977	29	2	2	3	3	*	*	*	*
1977	30	2	2	4	1	*	*	1.930	0.240
1977	30	2	2	4	2	*	*	1.970	0.210
1977	30	2	2	4	3	*	*	*	*
1977	31	3	1	2	1	*	*	1.960	0.220
1977	31	3	1	2	2	*	*	1.930	0.220
1977	31	3	1	2	3	*	*	*	*
1977	32	3	1	1	1	*	*	2.140	0.280
1977	32	3	1	1	2	*	*	2.030	0.250
1977	32	3	1	1	3	*	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1977	33	3	1	4	1	*	*	2.640	0.390
1977	33	3	1	4	2	*	*	2.620	0.350
1977	33	3	1	4	3	*	*	*	*
1977	34	3	1	5	1	*	*	2.770	0.450
1977	34	3	1	5	2	*	*	2.600	0.340
1977	34	3	1	5	3	*	*	*	*
1977	35	3	1	3	1	*	*	2.590	0.440
1977	35	3	1	3	2	*	*	2.630	0.400
1977	35	3	1	3	3	*	*	*	*
1977	36	3	1	6	1	*	*	3.040	0.570
1977	36	3	1	6	2	*	*	3.170	0.510
1977	36	3	1	6	3	*	*	*	*
1977	37	3	2	3	1	*	*	*	*
1977	37	3	2	3	2	*	*	*	*
1977	37	3	2	3	3	*	*	*	*
1977	38	3	2	5	1	*	*	*	*
1977	38	3	2	5	2	*	*	*	*
1977	38	3	2	5	3	*	*	*	*
1977	39	3	2	1	1	*	*	*	*
1977	39	3	2	1	2	*	*	*	*
1977	39	3	2	1	3	*	*	*	*
1977	40	3	2	4	1	*	*	*	*
1977	40	3	2	4	2	*	*	*	*
1977	40	3	2	4	3	*	*	*	*
1977	41	3	2	6	1	*	*	*	*
1977	41	3	2	6	2	*	*	*	*
1977	41	3	2	6	3	*	*	*	*
1977	42	3	2	2	1	*	*	*	*
1977	42	3	2	2	2	*	*	*	*
1977	42	3	2	2	3	*	*	*	*
1977	43	3	3	4	1	*	*	2.350	0.340
1977	43	3	3	4	2	*	*	2.290	0.350
1977	43	3	3	4	3	*	*	*	*
1977	44	3	3	5	1	*	*	2.190	0.330
1977	44	3	3	5	2	*	*	2.220	0.270
1977	44	3	3	5	3	*	*	*	*
1977	45	3	3	3	1	*	*	2.050	0.340
1977	45	3	3	3	2	*	*	2.050	0.310
1977	45	3	3	3	3	*	*	*	*
1977	46	3	3	1	1	*	*	1.670	0.210
1977	46	3	3	1	2	*	*	1.730	0.190
1977	46	3	3	1	3	*	*	*	*
1977	47	3	3	2	1	*	*	1.670	0.190
1977	47	3	3	2	2	*	*	1.790	0.200
1977	47	3	3	2	3	*	*	*	*
1977	48	3	3	6	1	*	*	2.610	0.510
1977	48	3	3	6	2	*	*	2.600	0.480
1977	48	3	3	6	3	*	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1977	49	2	1	4	1	*	*	*	*
1977	49	2	1	4	2	*	*	*	*
1977	49	2	1	4	3	*	*	*	*
1977	50	2	1	1	1	*	*	*	*
1977	50	2	1	1	2	*	*	*	*
1977	50	2	1	1	3	*	*	*	*
1977	51	2	1	2	1	*	*	*	*
1977	51	2	1	2	2	*	*	*	*
1977	51	2	1	2	3	*	*	*	*
1977	52	2	1	3	1	*	*	*	*
1977	52	2	1	3	2	*	*	*	*
1977	52	2	1	3	3	*	*	*	*
1977	53	2	1	6	1	*	*	*	*
1977	53	2	1	6	2	*	*	*	*
1977	53	2	1	6	3	*	*	*	*
1977	54	2	1	5	1	*	*	*	*
1977	54	2	1	5	2	*	*	*	*
1977	54	2	1	5	3	*	*	*	*
1979	1	1	1	5	1	*	*	2.120	0.433
1979	1	1	1	5	2	*	*	2.041	0.339
1979	1	1	1	5	3	*	*	*	*
1979	2	1	1	4	1	*	*	1.989	0.363
1979	2	1	1	4	2	*	*	2.105	0.424
1979	2	1	1	4	3	*	*	*	*
1979	3	1	1	6	1	*	*	2.218	0.503
1979	3	1	1	6	2	*	*	2.094	0.606
1979	3	1	1	6	3	*	*	*	*
1979	4	1	1	2	1	*	*	1.508	0.197
1979	4	1	1	2	2	*	*	1.464	0.201
1979	4	1	1	2	3	*	*	*	*
1979	5	1	1	3	1	*	*	1.899	0.390
1979	5	1	1	3	2	*	*	1.985	0.401
1979	5	1	1	3	3	*	*	*	*
1979	6	1	1	1	1	*	*	1.458	0.218
1979	6	1	1	1	2	*	*	1.407	0.224
1979	6	1	1	1	3	*	*	*	*
1979	7	1	3	1	1	*	*	1.410	0.195
1979	7	1	3	1	2	*	*	1.483	0.202
1979	7	1	3	1	3	*	*	*	*
1979	8	1	3	2	1	*	*	1.514	0.236
1979	8	1	3	2	2	*	*	1.539	0.245
1979	8	1	3	2	3	*	*	*	*
1979	9	1	3	5	1	*	*	1.948	0.451
1979	9	1	3	5	2	*	*	2.096	0.566
1979	9	1	3	5	3	*	*	*	*
1979	10	1	3	6	1	*	*	2.076	0.464
1979	10	1	3	6	2	*	*	2.223	0.766
1979	10	1	3	6	3	*	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1979	11	1	3	3	1	*	*	1.944	0.356
1979	11	1	3	3	2	*	*	2.048	0.531
1979	11	1	3	3	3	*	*	*	*
1979	12	1	3	4	1	*	*	1.906	0.298
1979	12	1	3	4	2	*	*	2.040	0.434
1979	12	1	3	4	3	*	*	*	*
1979	13	1	2	2	1	*	*	1.803	0.174
1979	13	1	2	2	2	*	*	1.475	0.209
1979	13	1	2	2	3	*	*	*	*
1979	14	1	2	1	1	*	*	1.508	0.213
1979	14	1	2	1	2	*	*	1.438	0.199
1979	14	1	2	1	3	*	*	*	*
1979	15	1	2	5	1	*	*	1.845	0.303
1979	15	1	2	5	2	*	*	1.838	0.317
1979	15	1	2	5	3	*	*	*	*
1979	16	1	2	6	1	*	*	1.958	0.466
1979	16	1	2	6	2	*	*	2.150	0.499
1979	16	1	2	6	3	*	*	*	*
1979	17	1	2	3	1	*	*	1.814	0.359
1979	17	1	2	3	2	*	*	2.069	0.451
1979	17	1	2	3	3	*	*	*	*
1979	18	1	2	4	1	*	*	1.796	0.279
1979	18	1	2	4	2	*	*	1.900	0.358
1979	18	1	2	4	3	*	*	*	*
1979	19	2	3	3	1	*	*	*	*
1979	19	2	3	3	2	*	*	*	*
1979	19	2	3	3	3	*	*	*	*
1979	20	2	3	4	1	*	*	*	*
1979	20	2	3	4	2	*	*	*	*
1979	20	2	3	4	3	*	*	*	*
1979	21	2	3	2	1	*	*	*	*
1979	21	2	3	2	2	*	*	*	*
1979	21	2	3	2	3	*	*	*	*
1979	22	2	3	5	1	*	*	*	*
1979	22	2	3	5	2	*	*	*	*
1979	22	2	3	5	3	*	*	*	*
1979	23	2	3	6	1	*	*	*	*
1979	23	2	3	6	2	*	*	*	*
1979	23	2	3	6	3	*	*	*	*
1979	24	2	3	1	1	*	*	*	*
1979	24	2	3	1	2	*	*	*	*
1979	24	2	3	1	3	*	*	*	*
1979	25	2	2	6	1	*	*	2.100	0.461
1979	25	2	2	6	2	*	*	2.078	0.410
1979	25	2	2	6	3	*	*	*	*
1979	26	2	2	1	1	*	*	1.324	0.149
1979	26	2	2	1	2	*	*	1.354	0.197
1979	26	2	2	1	3	*	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1979	27	2	2	2	1	*	*	1.536	0.233
1979	27	2	2	2	2	*	*	1.518	0.236
1979	27	2	2	2	3	*	*	*	*
1979	28	2	2	5	1	*	*	1.968	0.323
1979	28	2	2	5	2	*	*	2.005	0.349
1979	28	2	2	5	3	*	*	*	*
1979	29	2	2	3	1	*	*	1.938	0.341
1979	29	2	2	3	2	*	*	1.915	0.350
1979	29	2	2	3	3	*	*	*	*
1979	30	2	2	4	1	*	*	1.880	0.292
1979	30	2	2	4	2	*	*	1.973	0.338
1979	30	2	2	4	3	*	*	*	*
1979	31	3	1	2	1	*	*	1.706	0.235
1979	31	3	1	2	2	*	*	1.607	0.243
1979	31	3	1	2	3	*	*	*	*
1979	32	3	1	1	1	*	*	1.746	0.235
1979	32	3	1	1	2	*	*	1.748	0.220
1979	32	3	1	1	3	*	*	*	*
1979	33	3	1	4	1	*	*	2.446	0.300
1979	33	3	1	4	2	*	*	2.429	0.375
1979	33	3	1	4	3	*	*	*	*
1979	34	3	1	5	1	*	*	2.859	0.561
1979	34	3	1	5	2	*	*	2.554	0.461
1979	34	3	1	5	3	*	*	*	*
1979	35	3	1	3	1	*	*	2.472	0.432
1979	35	3	1	3	2	*	*	2.255	0.416
1979	35	3	1	3	3	*	*	*	*
1979	36	3	1	6	1	*	*	2.966	0.747
1979	36	3	1	6	2	*	*	2.525	0.545
1979	36	3	1	6	3	*	*	*	*
1979	37	3	2	3	1	*	*	*	*
1979	37	3	2	3	2	*	*	*	*
1979	37	3	2	3	3	*	*	*	*
1979	38	3	2	5	1	*	*	*	*
1979	38	3	2	5	2	*	*	*	*
1979	38	3	2	5	3	*	*	*	*
1979	39	3	2	1	1	*	*	*	*
1979	39	3	2	1	2	*	*	*	*
1979	39	3	2	1	3	*	*	*	*
1979	40	3	2	4	1	*	*	*	*
1979	40	3	2	4	2	*	*	*	*
1979	40	3	2	4	3	*	*	*	*
1979	41	3	2	6	1	*	*	*	*
1979	41	3	2	6	2	*	*	*	*
1979	41	3	2	6	3	*	*	*	*
1979	42	3	2	2	1	*	*	*	*
1979	42	3	2	2	2	*	*	*	*
1979	42	3	2	2	3	*	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1979	43	3	3	4	1	*	*	2.033	0.317
1979	43	3	3	4	2	*	*	1.917	0.283
1979	43	3	3	4	3	*	*	*	*
1979	44	3	3	5	1	*	*	2.200	0.447
1979	44	3	3	5	2	*	*	2.105	0.415
1979	44	3	3	5	3	*	*	*	*
1979	45	3	3	3	1	*	*	1.976	0.416
1979	45	3	3	3	2	*	*	2.021	0.391
1979	45	3	3	3	3	*	*	*	*
1979	46	3	3	1	1	*	*	1.320	0.183
1979	46	3	3	1	2	*	*	1.294	0.202
1979	46	3	3	1	3	*	*	*	*
1979	47	3	3	2	1	*	*	1.377	0.191
1979	47	3	3	2	2	*	*	1.384	0.207
1979	47	3	3	2	3	*	*	*	*
1979	48	3	3	6	1	*	*	2.281	0.692
1979	48	3	3	6	2	*	*	2.329	0.651
1979	48	3	3	6	3	*	*	*	*
1979	49	2	1	4	1	*	*	*	*
1979	49	2	1	4	2	*	*	*	*
1979	49	2	1	4	3	*	*	*	*
1979	50	2	1	1	1	*	*	*	*
1979	50	2	1	1	2	*	*	*	*
1979	50	2	1	1	3	*	*	*	*
1979	51	2	1	2	1	*	*	*	*
1979	51	2	1	2	2	*	*	*	*
1979	51	2	1	2	3	*	*	*	*
1979	52	2	1	3	1	*	*	*	*
1979	52	2	1	3	2	*	*	*	*
1979	52	2	1	3	3	*	*	*	*
1979	53	2	1	6	1	*	*	*	*
1979	53	2	1	6	2	*	*	*	*
1979	53	2	1	6	3	*	*	*	*
1979	54	2	1	5	1	*	*	*	*
1979	54	2	1	5	2	*	*	*	*
1979	54	2	1	5	3	*	*	*	*
1981	1	1	1	5	1	*	*	*	*
1981	1	1	1	5	2	*	*	*	*
1981	1	1	1	5	3	9.21	*	*	*
1981	2	1	1	4	1	*	*	*	*
1981	2	1	1	4	2	*	*	*	*
1981	2	1	1	4	3	8.30	*	*	*
1981	3	1	1	6	1	*	*	*	*
1981	3	1	1	6	2	*	*	*	*
1981	3	1	1	6	3	9.40	*	*	*
1981	4	1	1	2	1	*	*	*	*
1981	4	1	1	2	2	*	*	*	*
1981	4	1	1	2	3	7.10	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1981	5	1	1	3	1	*	*	*	*
1981	5	1	1	3	2	*	*	*	*
1981	5	1	1	3	3	8.22	*	*	*
1981	6	1	1	1	1	*	*	*	*
1981	6	1	1	1	2	*	*	*	*
1981	6	1	1	1	3	6.72	*	*	*
1981	7	1	3	1	1	*	*	*	*
1981	7	1	3	1	2	*	*	*	*
1981	7	1	3	1	3	6.22	*	*	*
1981	8	1	3	2	1	*	*	*	*
1981	8	1	3	2	2	*	*	*	*
1981	8	1	3	2	3	6.88	*	*	*
1981	9	1	3	5	1	*	*	*	*
1981	9	1	3	5	2	*	*	*	*
1981	9	1	3	5	3	9.12	*	*	*
1981	10	1	3	6	1	*	*	*	*
1981	10	1	3	6	2	*	*	*	*
1981	10	1	3	6	3	9.64	*	*	*
1981	11	1	3	3	1	*	*	*	*
1981	11	1	3	3	2	*	*	*	*
1981	11	1	3	3	3	8.81	*	*	*
1981	12	1	3	4	1	*	*	*	*
1981	12	1	3	4	2	*	*	*	*
1981	12	1	3	4	3	8.96	*	*	*
1981	13	1	2	2	1	*	*	*	*
1981	13	1	2	2	2	*	*	*	*
1981	13	1	2	2	3	6.77	*	*	*
1981	14	1	2	1	1	*	*	*	*
1981	14	1	2	1	2	*	*	*	*
1981	14	1	2	1	3	6.22	*	*	*
1981	15	1	2	5	1	*	*	*	*
1981	15	1	2	5	2	*	*	*	*
1981	15	1	2	5	3	9.21	*	*	*
1981	16	1	2	6	1	*	*	*	*
1981	16	1	2	6	2	*	*	*	*
1981	16	1	2	6	3	10.10	*	*	*
1981	17	1	2	3	1	*	*	*	*
1981	17	1	2	3	2	*	*	*	*
1981	17	1	2	3	3	8.96	*	*	*
1981	18	1	2	4	1	*	*	*	*
1981	18	1	2	4	2	*	*	*	*
1981	18	1	2	4	3	9.12	*	*	*
1981	19	2	3	3	1	*	*	*	*
1981	19	2	3	3	2	*	*	*	*
1981	19	2	3	3	3	8.58	*	*	*
1981	20	2	3	4	1	*	*	*	*
1981	20	2	3	4	2	*	*	*	*
1981	20	2	3	4	3	8.30	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1981	21	2	3	2	1	*	*	*	*
1981	21	2	3	2	2	*	*	*	*
1981	21	2	3	2	3	7.51	*	*	*
1981	22	2	3	5	1	*	*	*	*
1981	22	2	3	5	2	*	*	*	*
1981	22	2	3	5	3	9.44	*	*	*
1981	23	2	3	6	1	*	*	*	*
1981	23	2	3	6	2	*	*	*	*
1981	23	2	3	6	3	9.52	*	*	*
1981	24	2	3	1	1	*	*	*	*
1981	24	2	3	1	2	*	*	*	*
1981	24	2	3	1	3	6.72	*	*	*
1981	25	2	2	6	1	*	*	*	*
1981	25	2	2	6	2	*	*	*	*
1981	25	2	2	6	3	8.73	*	*	*
1981	26	2	2	1	1	*	*	*	*
1981	26	2	2	1	2	*	*	*	*
1981	26	2	2	1	3	6.39	*	*	*
1981	27	2	2	2	1	*	*	*	*
1981	27	2	2	2	2	*	*	*	*
1981	27	2	2	2	3	6.44	*	*	*
1981	28	2	2	5	1	*	*	*	*
1981	28	2	2	5	2	*	*	*	*
1981	28	2	2	5	3	8.73	*	*	*
1981	29	2	2	3	1	*	*	*	*
1981	29	2	2	3	2	*	*	*	*
1981	29	2	2	3	3	7.51	*	*	*
1981	30	2	2	4	1	*	*	*	*
1981	30	2	2	4	2	*	*	*	*
1981	30	2	2	4	3	7.47	*	*	*
1981	31	3	1	2	1	*	*	*	*
1981	31	3	1	2	2	*	*	*	*
1981	31	3	1	2	3	6.99	*	*	*
1981	32	3	1	1	1	*	*	*	*
1981	32	3	1	1	2	*	*	*	*
1981	32	3	1	1	3	6.77	*	*	*
1981	33	3	1	4	1	*	*	*	*
1981	33	3	1	4	2	*	*	*	*
1981	33	3	1	4	3	8.30	*	*	*
1981	34	3	1	5	1	*	*	*	*
1981	34	3	1	5	2	*	*	*	*
1981	34	3	1	5	3	10.10	*	*	*
1981	35	3	1	3	1	*	*	*	*
1981	35	3	1	3	2	*	*	*	*
1981	35	3	1	3	3	8.30	*	*	*
1981	36	3	1	6	1	*	*	*	*
1981	36	3	1	6	2	*	*	*	*
1981	36	3	1	6	3	11.03	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1981	37	3	2	3	1	*	*	*	*
1981	37	3	2	3	2	*	*	*	*
1981	37	3	2	3	3	8.11	*	*	*
1981	38	3	2	5	1	*	*	*	*
1981	38	3	2	5	2	*	*	*	*
1981	38	3	2	5	3	9.48	*	*	*
1981	39	3	2	1	1	*	*	*	*
1981	39	3	2	1	2	*	*	*	*
1981	39	3	2	1	3	7.73	*	*	*
1981	40	3	2	4	1	*	*	*	*
1981	40	3	2	4	2	*	*	*	*
1981	40	3	2	4	3	9.69	*	*	*
1981	41	3	2	6	1	*	*	*	*
1981	41	3	2	6	2	*	*	*	*
1981	41	3	2	6	3	10.99	*	*	*
1981	42	3	2	2	1	*	*	*	*
1981	42	3	2	2	2	*	*	*	*
1981	42	3	2	2	3	7.51	*	*	*
1981	43	3	3	4	1	*	*	*	*
1981	43	3	3	4	2	*	*	*	*
1981	43	3	3	4	3	7.92	*	*	*
1981	44	3	3	5	1	*	*	*	*
1981	44	3	3	5	2	*	*	*	*
1981	44	3	3	5	3	9.48	*	*	*
1981	45	3	3	3	1	*	*	*	*
1981	45	3	3	3	2	*	*	*	*
1981	45	3	3	3	3	8.03	*	*	*
1981	46	3	3	1	1	*	*	*	*
1981	46	3	3	1	2	*	*	*	*
1981	46	3	3	1	3	6.44	*	*	*
1981	47	3	3	2	1	*	*	*	*
1981	47	3	3	2	2	*	*	*	*
1981	47	3	3	2	3	6.22	*	*	*
1981	48	3	3	6	1	*	*	*	*
1981	48	3	3	6	2	*	*	*	*
1981	48	3	3	6	3	9.69	*	*	*
1981	49	2	1	4	1	*	*	*	*
1981	49	2	1	4	2	*	*	*	*
1981	49	2	1	4	3	9.29	*	*	*
1981	50	2	1	1	1	*	*	*	*
1981	50	2	1	1	2	*	*	*	*
1981	50	2	1	1	3	6.99	*	*	*
1981	51	2	1	2	1	*	*	*	*
1981	51	2	1	2	2	*	*	*	*
1981	51	2	1	2	3	6.55	*	*	*
1981	52	2	1	3	1	*	*	*	*
1981	52	2	1	3	2	*	*	*	*
1981	52	2	1	3	3	8.36	*	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1981	53	2	1	6	1	*	*	*	*
1981	53	2	1	6	2	*	*	*	*
1981	53	2	1	6	3	10.60	*	*	*
1981	54	2	1	5	1	*	*	*	*
1981	54	2	1	5	2	*	*	*	*
1981	54	2	1	5	3	10.30	*	*	*
1983	1	1	1	5	1	*	*	*	*
1983	1	1	1	5	2	*	*	*	*
1983	1	1	1	5	3	*	*	2.047	0.495
1983	2	1	1	4	1	*	*	*	*
1983	2	1	1	4	2	*	*	*	*
1983	2	1	1	4	3	*	*	1.471	0.277
1983	3	1	1	6	1	*	*	*	*
1983	3	1	1	6	2	*	*	*	*
1983	3	1	1	6	3	*	*	1.979	0.509
1983	4	1	1	2	1	*	*	*	*
1983	4	1	1	2	2	*	*	*	*
1983	4	1	1	2	3	*	*	1.229	0.247
1983	5	1	1	3	1	*	*	*	*
1983	5	1	1	3	2	*	*	*	*
1983	5	1	1	3	3	*	*	1.644	0.324
1983	6	1	1	1	1	*	*	*	*
1983	6	1	1	1	2	*	*	*	*
1983	6	1	1	1	3	*	*	1.173	0.222
1983	7	1	3	1	1	*	*	*	*
1983	7	1	3	1	2	*	*	*	*
1983	7	1	3	1	3	*	*	1.311	0.224
1983	8	1	3	2	1	*	*	*	*
1983	8	1	3	2	2	*	*	*	*
1983	8	1	3	2	3	*	*	1.321	0.249
1983	9	1	3	5	1	*	*	*	*
1983	9	1	3	5	2	*	*	*	*
1983	9	1	3	5	3	*	*	1.715	0.331
1983	10	1	3	6	1	*	*	*	*
1983	10	1	3	6	2	*	*	*	*
1983	10	1	3	6	3	*	*	1.894	0.393
1983	11	1	3	3	1	*	*	*	*
1983	11	1	3	3	2	*	*	*	*
1983	11	1	3	3	3	*	*	1.660	0.316
1983	12	1	3	4	1	*	*	*	*
1983	12	1	3	4	2	*	*	*	*
1983	12	1	3	4	3	*	*	1.538	0.295
1983	13	1	2	2	1	*	*	*	*
1983	13	1	2	2	2	*	*	*	*
1983	13	1	2	2	3	*	*	1.304	0.226
1983	14	1	2	1	1	*	*	*	*
1983	14	1	2	1	2	*	*	*	*
1983	14	1	2	1	3	*	*	1.249	0.227

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1983	15	1	2	5	1	*	*	*	*
1983	15	1	2	5	2	*	*	*	*
1983	15	1	2	5	3	*	*	1.729	0.375
1983	16	1	2	6	1	*	*	*	*
1983	16	1	2	6	2	*	*	*	*
1983	16	1	2	6	3	*	*	1.873	0.395
1983	17	1	2	3	1	*	*	*	*
1983	17	1	2	3	2	*	*	*	*
1983	17	1	2	3	3	*	*	1.480	0.277
1983	18	1	2	4	1	*	*	*	*
1983	18	1	2	4	2	*	*	*	*
1983	18	1	2	4	3	*	*	1.717	0.311
1983	19	2	3	3	1	*	*	*	*
1983	19	2	3	3	2	*	*	*	*
1983	19	2	3	3	3	*	*	*	*
1983	20	2	3	4	1	*	*	*	*
1983	20	2	3	4	2	*	*	*	*
1983	20	2	3	4	3	*	*	*	*
1983	21	2	3	2	1	*	*	*	*
1983	21	2	3	2	2	*	*	*	*
1983	21	2	3	2	3	*	*	*	*
1983	22	2	3	5	1	*	*	*	*
1983	22	2	3	5	2	*	*	*	*
1983	22	2	3	5	3	*	*	*	*
1983	23	2	3	6	1	*	*	*	*
1983	23	2	3	6	2	*	*	*	*
1983	23	2	3	6	3	*	*	*	*
1983	24	2	3	1	1	*	*	*	*
1983	24	2	3	1	2	*	*	*	*
1983	24	2	3	1	3	*	*	*	*
1983	25	2	2	6	1	*	*	*	*
1983	25	2	2	6	2	*	*	*	*
1983	25	2	2	6	3	*	*	1.861	0.514
1983	26	2	2	1	1	*	*	*	*
1983	26	2	2	1	2	*	*	*	*
1983	26	2	2	1	3	*	*	1.275	0.238
1983	27	2	2	2	1	*	*	*	*
1983	27	2	2	2	2	*	*	*	*
1983	27	2	2	2	3	*	*	1.234	0.247
1983	28	2	2	5	1	*	*	*	*
1983	28	2	2	5	2	*	*	*	*
1983	28	2	2	5	3	*	*	1.627	0.313
1983	29	2	2	3	1	*	*	*	*
1983	29	2	2	3	2	*	*	*	*
1983	29	2	2	3	3	*	*	1.485	0.317
1983	30	2	2	4	1	*	*	*	*
1983	30	2	2	4	2	*	*	*	*
1983	30	2	2	4	3	*	*	1.418	0.270

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1983	31	3	1	2	1	*	*	*	*
1983	31	3	1	2	2	*	*	*	*
1983	31	3	1	2	3	*	*	1.435	0.272
1983	32	3	1	1	1	*	*	*	*
1983	32	3	1	1	2	*	*	*	*
1983	32	3	1	1	3	*	*	1.352	0.233
1983	33	3	1	4	1	*	*	*	*
1983	33	3	1	4	2	*	*	*	*
1983	33	3	1	4	3	*	*	1.445	0.276
1983	34	3	1	5	1	*	*	*	*
1983	34	3	1	5	2	*	*	*	*
1983	34	3	1	5	3	*	*	1.805	0.440
1983	35	3	1	3	1	*	*	*	*
1983	35	3	1	3	2	*	*	*	*
1983	35	3	1	3	3	*	*	1.461	0.282
1983	36	3	1	6	1	*	*	*	*
1983	36	3	1	6	2	*	*	*	*
1983	36	3	1	6	3	*	*	1.972	0.568
1983	37	3	2	3	1	*	*	*	*
1983	37	3	2	3	2	*	*	*	*
1983	37	3	2	3	3	*	*	*	*
1983	38	3	2	5	1	*	*	*	*
1983	38	3	2	5	2	*	*	*	*
1983	38	3	2	5	3	*	*	*	*
1983	39	3	2	1	1	*	*	*	*
1983	39	3	2	1	2	*	*	*	*
1983	39	3	2	1	3	*	*	*	*
1983	40	3	2	4	1	*	*	*	*
1983	40	3	2	4	2	*	*	*	*
1983	40	3	2	4	3	*	*	*	*
1983	41	3	2	6	1	*	*	*	*
1983	41	3	2	6	2	*	*	*	*
1983	41	3	2	6	3	*	*	*	*
1983	42	3	2	2	1	*	*	*	*
1983	42	3	2	2	2	*	*	*	*
1983	42	3	2	2	3	*	*	*	*
1983	43	3	3	4	1	*	*	*	*
1983	43	3	3	4	2	*	*	*	*
1983	43	3	3	4	3	*	*	1.757	0.383
1983	44	3	3	5	1	*	*	*	*
1983	44	3	3	5	2	*	*	*	*
1983	44	3	3	5	3	*	*	1.504	0.292
1983	45	3	3	3	1	*	*	*	*
1983	45	3	3	3	2	*	*	*	*
1983	45	3	3	3	3	*	*	1.366	0.210
1983	46	3	3	1	1	*	*	*	*
1983	46	3	3	1	2	*	*	*	*
1983	46	3	3	1	3	*	*	1.197	0.225

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1983	47	3	3	2	1	*	*	*	*
1983	47	3	3	2	2	*	*	*	*
1983	47	3	3	2	3	*	*	1.883	0.399
1983	48	3	3	6	1	*	*	*	*
1983	48	3	3	6	2	*	*	*	*
1983	48	3	3	6	3	*	*	1.489	0.302
1983	49	2	1	4	1	*	*	*	*
1983	49	2	1	4	2	*	*	*	*
1983	49	2	1	4	3	*	*	*	*
1983	50	2	1	1	1	*	*	*	*
1983	50	2	1	1	2	*	*	*	*
1983	50	2	1	1	3	*	*	*	*
1983	51	2	1	2	1	*	*	*	*
1983	51	2	1	2	2	*	*	*	*
1983	51	2	1	2	3	*	*	*	*
1983	52	2	1	3	1	*	*	*	*
1983	52	2	1	3	2	*	*	*	*
1983	52	2	1	3	3	*	*	*	*
1983	53	2	1	6	1	*	*	*	*
1983	53	2	1	6	2	*	*	*	*
1983	53	2	1	6	3	*	*	*	*
1983	54	2	1	5	1	*	*	*	*
1983	54	2	1	5	2	*	*	*	*
1983	54	2	1	5	3	*	*	*	*
1985	1	1	1	5	1	*	*	*	*
1985	1	1	1	5	2	*	*	*	*
1985	1	1	1	5	3	*	*	2.344	0.401
1985	2	1	1	4	1	*	*	*	*
1985	2	1	1	4	2	*	*	*	*
1985	2	1	1	4	3	*	*	2.115	0.380
1985	3	1	1	6	1	*	*	*	*
1985	3	1	1	6	2	*	*	*	*
1985	3	1	1	6	3	*	*	2.347	0.501
1985	4	1	1	2	1	*	*	*	*
1985	4	1	1	2	2	*	*	*	*
1985	4	1	1	2	3	*	*	1.725	0.359
1985	5	1	1	3	1	*	*	*	*
1985	5	1	1	3	2	*	*	*	*
1985	5	1	1	3	3	*	*	1.959	0.392
1985	6	1	1	1	1	*	*	*	*
1985	6	1	1	1	2	*	*	*	*
1985	6	1	1	1	3	*	*	1.817	0.282
1985	7	1	3	1	1	*	*	*	*
1985	7	1	3	1	2	*	*	*	*
1985	7	1	3	1	3	*	*	1.818	0.286
1985	8	1	3	2	1	*	*	*	*
1985	8	1	3	2	2	*	*	*	*
1985	8	1	3	2	3	*	*	1.780	0.280

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1985	9	1	3	5	1	*	*	*	*
1985	9	1	3	5	2	*	*	*	*
1985	9	1	3	5	3	*	*	2.158	0.470
1985	10	1	3	6	1	*	*	*	*
1985	10	1	3	6	2	*	*	*	*
1985	10	1	3	6	3	*	*	2.237	0.499
1985	11	1	3	3	1	*	*	*	*
1985	11	1	3	3	2	*	*	*	*
1985	11	1	3	3	3	*	*	2.144	0.487
1985	12	1	3	4	1	*	*	*	*
1985	12	1	3	4	2	*	*	*	*
1985	12	1	3	4	3	*	*	2.048	0.348
1985	13	1	2	2	1	*	*	*	*
1985	13	1	2	2	2	*	*	*	*
1985	13	1	2	2	3	*	*	1.847	0.284
1985	14	1	2	1	1	*	*	*	*
1985	14	1	2	1	2	*	*	*	*
1985	14	1	2	1	3	*	*	1.789	0.319
1985	15	1	2	5	1	*	*	*	*
1985	15	1	2	5	2	*	*	*	*
1985	15	1	2	5	3	*	*	2.105	0.442
1985	16	1	2	6	1	*	*	*	*
1985	16	1	2	6	2	*	*	*	*
1985	16	1	2	6	3	*	*	2.291	0.446
1985	17	1	2	3	1	*	*	*	*
1985	17	1	2	3	2	*	*	*	*
1985	17	1	2	3	3	*	*	2.096	0.375
1985	18	1	2	4	1	*	*	*	*
1985	18	1	2	4	2	*	*	*	*
1985	18	1	2	4	3	*	*	2.178	0.352
1985	19	2	3	3	1	*	*	*	*
1985	19	2	3	3	2	*	*	*	*
1985	19	2	3	3	3	*	*	1.979	0.360
1985	20	2	3	4	1	*	*	*	*
1985	20	2	3	4	2	*	*	*	*
1985	20	2	3	4	3	*	*	2.031	0.343
1985	21	2	3	2	1	*	*	*	*
1985	21	2	3	2	2	*	*	*	*
1985	21	2	3	2	3	*	*	1.921	0.308
1985	22	2	3	5	1	*	*	*	*
1985	22	2	3	5	2	*	*	*	*
1985	22	2	3	5	3	*	*	2.121	0.527
1985	23	2	3	6	1	*	*	*	*
1985	23	2	3	6	2	*	*	*	*
1985	23	2	3	6	3	*	*	2.253	0.560
1985	24	2	3	1	1	*	*	*	*
1985	24	2	3	1	2	*	*	*	*
1985	24	2	3	1	3	*	*	1.757	0.280

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1985	25	2	2	6	1	*	*	*	*
1985	25	2	2	6	2	*	*	*	*
1985	25	2	2	6	3	*	*	2.171	0.456
1985	26	2	2	1	1	*	*	*	*
1985	26	2	2	1	2	*	*	*	*
1985	26	2	2	1	3	*	*	1.619	0.300
1985	27	2	2	2	1	*	*	*	*
1985	27	2	2	2	2	*	*	*	*
1985	27	2	2	2	3	*	*	1.778	0.340
1985	28	2	2	5	1	*	*	*	*
1985	28	2	2	5	2	*	*	*	*
1985	28	2	2	5	3	*	*	2.215	0.546
1985	29	2	2	3	1	*	*	*	*
1985	29	2	2	3	2	*	*	*	*
1985	29	2	2	3	3	*	*	2.136	0.380
1985	30	2	2	4	1	*	*	*	*
1985	30	2	2	4	2	*	*	*	*
1985	30	2	2	4	3	*	*	2.138	0.409
1985	31	3	1	2	1	*	*	*	*
1985	31	3	1	2	2	*	*	*	*
1985	31	3	1	2	3	*	*	1.894	0.350
1985	32	3	1	1	1	*	*	*	*
1985	32	3	1	1	2	*	*	*	*
1985	32	3	1	1	3	*	*	1.833	0.373
1985	33	3	1	4	1	*	*	*	*
1985	33	3	1	4	2	*	*	*	*
1985	33	3	1	4	3	*	*	2.140	0.349
1985	34	3	1	5	1	*	*	*	*
1985	34	3	1	5	2	*	*	*	*
1985	34	3	1	5	3	*	*	2.179	0.557
1985	35	3	1	3	1	*	*	*	*
1985	35	3	1	3	2	*	*	*	*
1985	35	3	1	3	3	*	*	2.096	0.400
1985	36	3	1	6	1	*	*	*	*
1985	36	3	1	6	2	*	*	*	*
1985	36	3	1	6	3	*	*	2.268	0.317
1985	37	3	2	3	1	*	*	*	*
1985	37	3	2	3	2	*	*	*	*
1985	37	3	2	3	3	*	*	2.083	0.456
1985	38	3	2	5	1	*	*	*	*
1985	38	3	2	5	2	*	*	*	*
1985	38	3	2	5	3	*	*	2.086	0.324
1985	39	3	2	1	1	*	*	*	*
1985	39	3	2	1	2	*	*	*	*
1985	39	3	2	1	3	*	*	2.002	0.307
1985	40	3	2	4	1	*	*	*	*
1985	40	3	2	4	2	*	*	*	*
1985	40	3	2	4	3	*	*	2.255	0.451

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1985	41	3	2	6	1	*	*	*	*
1985	41	3	2	6	2	*	*	*	*
1985	41	3	2	6	3	*	*	2.492	0.503
1985	42	3	2	2	1	*	*	*	*
1985	42	3	2	2	2	*	*	*	*
1985	42	3	2	2	3	*	*	1.896	0.272
1985	43	3	3	4	1	*	*	*	*
1985	43	3	3	4	2	*	*	*	*
1985	43	3	3	4	3	*	*	2.050	0.395
1985	44	3	3	5	1	*	*	*	*
1985	44	3	3	5	2	*	*	*	*
1985	44	3	3	5	3	*	*	2.117	0.492
1985	45	3	3	3	1	*	*	*	*
1985	45	3	3	3	2	*	*	*	*
1985	45	3	3	3	3	*	*	1.980	0.274
1985	46	3	3	1	1	*	*	*	*
1985	46	3	3	1	2	*	*	*	*
1985	46	3	3	1	3	*	*	1.531	0.258
1985	47	3	3	2	1	*	*	*	*
1985	47	3	3	2	2	*	*	*	*
1985	47	3	3	2	3	*	*	1.619	0.235
1985	48	3	3	6	1	*	*	*	*
1985	48	3	3	6	2	*	*	*	*
1985	48	3	3	6	3	*	*	2.358	0.439
1985	49	2	1	4	1	*	*	*	*
1985	49	2	1	4	2	*	*	*	*
1985	49	2	1	4	3	*	*	2.414	0.395
1985	50	2	1	1	1	*	*	*	*
1985	50	2	1	1	2	*	*	*	*
1985	50	2	1	1	3	*	*	1.730	0.259
1985	51	2	1	2	1	*	*	*	*
1985	51	2	1	2	2	*	*	*	*
1985	51	2	1	2	3	*	*	1.780	0.293
1985	52	2	1	3	1	*	*	*	*
1985	52	2	1	3	2	*	*	*	*
1985	52	2	1	3	3	*	*	1.958	0.317
1985	53	2	1	6	1	*	*	*	*
1985	53	2	1	6	2	*	*	*	*
1985	53	2	1	6	3	*	*	2.420	0.743
1985	54	2	1	5	1	*	*	*	*
1985	54	2	1	5	2	*	*	*	*
1985	54	2	1	5	3	*	*	2.196	0.332
1987	1	1	1	5	1	*	*	2.162	0.713
1987	1	1	1	5	2	*	*	2.172	0.467
1987	1	1	1	5	3	*	2.136	*	*
1987	2	1	1	4	1	*	*	1.766	0.491
1987	2	1	1	4	2	*	*	1.816	0.356
1987	2	1	1	4	3	*	1.950	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1987	3	1	1	6	1	*	*	2.000	0.693
1987	3	1	1	6	2	*	*	2.273	0.568
1987	3	1	1	6	3	*	2.201	*	*
1987	4	1	1	2	1	*	*	1.372	0.243
1987	4	1	1	2	2	*	*	1.362	0.249
1987	4	1	1	2	3	*	1.451	*	*
1987	5	1	1	3	1	*	*	1.754	0.385
1987	5	1	1	3	2	*	*	1.760	0.384
1987	5	1	1	3	3	*	1.769	*	*
1987	6	1	1	1	1	*	*	1.396	0.245
1987	6	1	1	1	2	*	*	1.380	0.257
1987	6	1	1	1	3	*	1.583	*	*
1987	7	1	3	1	1	*	*	1.494	0.252
1987	7	1	3	1	2	*	*	1.349	0.228
1987	7	1	3	1	3	*	1.426	*	*
1987	8	1	3	2	1	*	*	1.439	0.267
1987	8	1	3	2	2	*	*	1.438	0.321
1987	8	1	3	2	3	*	1.561	*	*
1987	9	1	3	5	1	*	*	1.879	0.520
1987	9	1	3	5	2	*	*	1.917	0.654
1987	9	1	3	5	3	*	1.998	*	*
1987	10	1	3	6	1	*	*	1.926	0.457
1987	10	1	3	6	2	*	*	2.113	0.577
1987	10	1	3	6	3	*	2.125	*	*
1987	11	1	3	3	1	*	*	1.903	0.419
1987	11	1	3	3	2	*	*	1.813	0.435
1987	11	1	3	3	3	*	1.865	*	*
1987	12	1	3	4	1	*	*	1.814	0.349
1987	12	1	3	4	2	*	*	1.864	0.398
1987	12	1	3	4	3	*	1.861	*	*
1987	13	1	2	2	1	*	*	1.479	0.245
1987	13	1	2	2	2	*	*	1.467	0.239
1987	13	1	2	2	3	*	1.619	*	*
1987	14	1	2	1	1	*	*	1.366	0.261
1987	14	1	2	1	2	*	*	1.526	0.250
1987	14	1	2	1	3	*	1.551	*	*
1987	15	1	2	5	1	*	*	1.878	0.593
1987	15	1	2	5	2	*	*	2.058	0.605
1987	15	1	2	5	3	*	2.038	*	*
1987	16	1	2	6	1	*	*	2.095	0.541
1987	16	1	2	6	2	*	*	2.048	0.609
1987	16	1	2	6	3	*	2.198	*	*
1987	17	1	2	3	1	*	*	1.976	0.417
1987	17	1	2	3	2	*	*	1.688	0.304
1987	17	1	2	3	3	*	1.993	*	*
1987	18	1	2	4	1	*	*	1.761	0.507
1987	18	1	2	4	2	*	*	2.140	0.404
1987	18	1	2	4	3	*	2.147	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1987	19	2	3	3	1	*	*	1.997	0.526
1987	19	2	3	3	2	*	*	2.038	0.436
1987	19	2	3	3	3	*	2.140	*	*
1987	20	2	3	4	1	*	*	1.752	0.268
1987	20	2	3	4	2	*	*	2.230	0.529
1987	20	2	3	4	3	*	1.941	*	*
1987	21	2	3	2	1	*	*	1.878	0.290
1987	21	2	3	2	2	*	*	1.769	0.266
1987	21	2	3	2	3	*	1.773	*	*
1987	22	2	3	5	1	*	*	2.204	0.494
1987	22	2	3	5	2	*	*	2.345	0.504
1987	22	2	3	5	3	*	2.250	*	*
1987	23	2	3	6	1	*	*	2.325	0.552
1987	23	2	3	6	2	*	*	2.290	0.567
1987	23	2	3	6	3	*	2.258	*	*
1987	24	2	3	1	1	*	*	1.323	0.207
1987	24	2	3	1	2	*	*	1.629	0.270
1987	24	2	3	1	3	*	1.718	*	*
1987	25	2	2	6	1	*	*	2.201	0.606
1987	25	2	2	6	2	*	*	2.158	0.638
1987	25	2	2	6	3	*	2.206	*	*
1987	26	2	2	1	1	*	*	1.423	0.253
1987	26	2	2	1	2	*	*	1.280	0.229
1987	26	2	2	1	3	*	1.501	*	*
1987	27	2	2	2	1	*	*	1.416	0.235
1987	27	2	2	2	2	*	*	1.609	0.319
1987	27	2	2	2	3	*	1.507	*	*
1987	28	2	2	5	1	*	*	2.071	0.477
1987	28	2	2	5	2	*	*	2.066	0.522
1987	28	2	2	5	3	*	2.176	*	*
1987	29	2	2	3	1	*	*	1.630	0.267
1987	29	2	2	3	2	*	*	1.846	0.376
1987	29	2	2	3	3	*	1.789	*	*
1987	30	2	2	4	1	*	*	1.786	0.320
1987	30	2	2	4	2	*	*	1.516	0.287
1987	30	2	2	4	3	*	1.879	*	*
1987	31	3	1	2	1	*	*	1.430	0.248
1987	31	3	1	2	2	*	*	1.503	0.282
1987	31	3	1	2	3	*	1.656	*	*
1987	32	3	1	1	1	*	*	1.385	0.242
1987	32	3	1	1	2	*	*	1.491	0.256
1987	32	3	1	1	3	*	1.527	*	*
1987	33	3	1	4	1	*	*	2.037	0.434
1987	33	3	1	4	2	*	*	2.008	0.388
1987	33	3	1	4	3	*	1.953	*	*
1987	34	3	1	5	1	*	*	2.503	0.605
1987	34	3	1	5	2	*	*	2.637	0.597
1987	34	3	1	5	3	*	2.427	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1987	35	3	1	3	1	*	*	1.914	0.355
1987	35	3	1	3	2	*	*	1.754	0.378
1987	35	3	1	3	3	*	1.898	*	*
1987	36	3	1	6	1	*	*	2.839	0.854
1987	36	3	1	6	2	*	*	2.591	0.821
1987	36	3	1	6	3	*	2.746	*	*
1987	37	3	2	3	1	*	*	1.703	0.321
1987	37	3	2	3	2	*	*	1.768	0.405
1987	37	3	2	3	3	*	1.775	*	*
1987	38	3	2	5	1	*	*	2.400	0.485
1987	38	3	2	5	2	*	*	2.129	0.538
1987	38	3	2	5	3	*	2.113	*	*
1987	39	3	2	1	1	*	*	2.058	0.231
1987	39	3	2	1	2	*	*	2.153	0.392
1987	39	3	2	1	3	*	1.838	*	*
1987	40	3	2	4	1	*	*	1.688	0.393
1987	40	3	2	4	2	*	*	2.064	0.320
1987	40	3	2	4	3	*	2.035	*	*
1987	41	3	2	6	1	*	*	2.267	0.483
1987	41	3	2	6	2	*	*	2.654	0.591
1987	41	3	2	6	3	*	2.369	*	*
1987	42	3	2	2	1	*	*	1.596	0.243
1987	42	3	2	2	2	*	*	1.365	0.203
1987	42	3	2	2	3	*	1.682	*	*
1987	43	3	3	4	1	*	*	1.873	0.315
1987	43	3	3	4	2	*	*	1.880	0.326
1987	43	3	3	4	3	*	1.904	*	*
1987	44	3	3	5	1	*	*	2.238	0.349
1987	44	3	3	5	2	*	*	2.264	0.475
1987	44	3	3	5	3	*	2.216	*	*
1987	45	3	3	3	1	*	*	1.981	0.403
1987	45	3	3	3	2	*	*	1.830	0.302
1987	45	3	3	3	3	*	1.847	*	*
1987	46	3	3	1	1	*	*	1.488	0.220
1987	46	3	3	1	2	*	*	1.448	0.217
1987	46	3	3	1	3	*	1.428	*	*
1987	47	3	3	2	1	*	*	1.404	0.227
1987	47	3	3	2	2	*	*	1.531	0.249
1987	47	3	3	2	3	*	1.585	*	*
1987	48	3	3	6	1	*	*	2.568	0.697
1987	48	3	3	6	2	*	*	2.147	0.516
1987	48	3	3	6	3	*	2.439	*	*
1987	49	2	1	4	1	*	*	2.157	0.379
1987	49	2	1	4	2	*	*	1.990	0.429
1987	49	2	1	4	3	*	2.082	*	*
1987	50	2	1	1	1	*	*	1.496	0.211
1987	50	2	1	1	2	*	*	1.397	0.238
1987	50	2	1	1	3	*	1.535	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.7. Protein and grain N data collected from 1977 to 1987 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Year	Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Grain Protein	Combined Grain N	Bundle Grain N	Bundle Straw N
						%	%	%	%
1987	51	2	1	2	1	*	1.535	1.438	0.256
1987	51	2	1	2	2	*	*	1.487	0.205
1987	51	2	1	2	3	*	*	*	*
1987	52	2	1	3	1	*	*	1.796	0.294
1987	52	2	1	3	2	*	*	1.923	0.301
1987	52	2	1	3	3	*	1.951	*	*
1987	53	2	1	6	1	*	*	2.407	0.634
1987	53	2	1	6	2	*	*	2.860	0.779
1987	53	2	1	6	3	*	2.689	*	*
1987	54	2	1	5	1	*	*	2.290	0.422
1987	54	2	1	5	2	*	*	2.148	0.485
1987	54	2	1	5	3	*	2.290	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South; 3 = Whole Plot

Table H.8. Grain N data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Grain N	Bundle Straw N
					%	%
1	1	1	5	1	2.39	1.06
1	1	1	5	2	2.33	0.82
1	1	1	5	3	2.23	1.00
1	1	1	5	4	2.36	0.77
2	1	1	4	1	1.79	0.56
2	1	1	4	2	1.78	0.50
2	1	1	4	3	1.77	0.59
2	1	1	4	4	2.21	0.49
3	1	1	6	1	2.18	0.70
3	1	1	6	2	2.16	0.79
3	1	1	6	3	2.17	0.71
3	1	1	6	4	2.29	0.56
4	1	1	2	1	1.45	0.49
4	1	1	2	2	1.55	0.45
4	1	1	2	3	1.46	0.44
4	1	1	2	4	1.70	0.46
5	1	1	3	1	1.88	0.53
5	1	1	3	2	2.19	0.56
5	1	1	3	3	1.84	0.53
5	1	1	3	4	1.85	0.58
6	1	1	1	1	1.34	0.34
6	1	1	1	2	1.34	0.37
6	1	1	1	3	1.33	0.38
6	1	1	1	4	1.54	0.42
7	1	3	1	1	1.31	0.38
7	1	3	1	2	1.24	0.34
7	1	3	1	3	1.28	0.41
7	1	3	1	4	*	0.42
8	1	3	2	1	1.55	0.42
8	1	3	2	2	1.48	0.42
8	1	3	2	3	1.41	0.40
8	1	3	2	4	1.72	0.57
9	1	3	5	1	2.05	0.67
9	1	3	5	2	2.09	0.70
9	1	3	5	3	2.17	0.65
9	1	3	5	4	2.22	0.87
10	1	3	6	1	2.23	0.73
10	1	3	6	2	2.13	0.68
10	1	3	6	3	2.20	0.86
10	1	3	6	4	2.33	0.81

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = Center; 3 = South; 4 = Collins

Table H.8. Grain N data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Grain N	Bundle Straw N
					%	%
11	1	3	3	1	1.76	0.43
11	1	3	3	2	1.88	0.46
11	1	3	3	3	1.85	0.54
11	1	3	3	4	1.94	0.61
12	1	3	4	1	1.68	0.42
12	1	3	4	2	1.90	0.52
12	1	3	4	3	1.78	0.44
12	1	3	4	4	2.04	0.50
13	1	2	2	1	1.46	0.41
13	1	2	2	2	1.42	0.45
13	1	2	2	3	1.45	0.41
13	1	2	2	4	1.80	0.41
14	1	2	1	1	1.27	0.46
14	1	2	1	2	1.30	0.61
14	1	2	1	3	1.27	0.30
14	1	2	1	4	1.44	0.37
15	1	2	5	1	2.02	0.68
15	1	2	5	2	2.06	0.72
15	1	2	5	3	2.12	0.77
15	1	2	5	4	2.20	0.57
16	1	2	6	1	2.09	0.93
16	1	2	6	2	2.13	0.86
16	1	2	6	3	2.13	0.87
16	1	2	6	4	2.24	0.67
17	1	2	3	1	1.95	0.61
17	1	2	3	2	1.85	0.49
17	1	2	3	3	1.81	0.45
17	1	2	3	4	1.86	0.42
18	1	2	4	1	*	0.45
18	1	2	4	2	1.74	0.45
18	1	2	4	3	1.77	0.49
18	1	2	4	4	2.08	0.49
19	2	3	3	1	1.68	0.51
19	2	3	3	2	1.67	0.48
19	2	3	3	3	1.90	0.52
19	2	3	3	4	1.80	0.40
20	2	3	4	1	1.54	0.47
20	2	3	4	2	1.39	0.42
20	2	3	4	3	1.65	0.41
20	2	3	4	4	*	0.50

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = Center; 3 = South; 4 = Collins

Table H.8. Grain N data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Grain N	Bundle Straw N
					%	%
21	2	3	2	1	1.39	0.43
21	2	3	2	2	1.44	0.41
21	2	3	2	3	1.51	0.42
21	2	3	2	4	1.77	0.49
22	2	3	5	1	1.81	0.46
22	2	3	5	2	2.03	0.61
22	2	3	5	3	1.82	0.47
22	2	3	5	4	2.09	0.54
23	2	3	6	1	2.22	0.72
23	2	3	6	2	2.04	0.83
23	2	3	6	3	2.02	0.78
23	2	3	6	4	2.08	0.56
24	2	3	1	1	1.27	0.38
24	2	3	1	2	1.33	0.36
24	2	3	1	3	1.34	0.39
24	2	3	1	4	1.41	0.42
25	2	2	6	1	2.24	0.65
25	2	2	6	2	2.24	0.87
25	2	2	6	3	*	0.76
25	2	2	6	4	2.23	0.69
26	2	2	1	1	1.30	0.34
26	2	2	1	2	1.34	0.37
26	2	2	1	3	1.30	0.42
26	2	2	1	4	1.45	0.29
27	2	2	2	1	1.45	0.43
27	2	2	2	2	1.42	0.36
27	2	2	2	3	1.47	0.37
27	2	2	2	4	1.67	0.59
28	2	2	5	1	1.91	0.86
28	2	2	5	2	2.04	0.50
28	2	2	5	3	1.87	0.57
28	2	2	5	4	2.20	0.42
29	2	2	3	1	1.63	0.44
29	2	2	3	2	1.53	0.51
29	2	2	3	3	1.61	0.54
29	2	2	3	4	1.85	0.47
30	2	2	4	1	1.67	0.47
30	2	2	4	2	1.56	0.43
30	2	2	4	3	1.65	0.46
30	2	2	4	4	1.88	0.49

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = Center; 3 = South; 4 = Collins

Table H.8. Grain N data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Grain N	Bundle Straw N
					%	%
31	3	1	2	1	1.54	0.37
31	3	1	2	2	1.51	0.37
31	3	1	2	3	1.48	0.48
31	3	1	2	4	1.51	0.46
32	3	1	1	1	1.30	0.33
32	3	1	1	2	1.29	0.40
32	3	1	1	3	1.25	0.35
32	3	1	1	4	1.58	0.40
33	3	1	4	1	1.69	0.37
33	3	1	4	2	1.52	0.40
33	3	1	4	3	1.62	0.38
33	3	1	4	4	1.92	0.46
34	3	1	5	1	2.27	0.62
34	3	1	5	2	2.22	0.62
34	3	1	5	3	2.17	0.78
34	3	1	5	4	2.53	0.83
35	3	1	3	1	1.63	0.46
35	3	1	3	2	1.57	0.57
35	3	1	3	3	1.81	0.58
35	3	1	3	4	1.92	0.49
36	3	1	6	1	2.64	0.96
36	3	1	6	2	2.57	0.73
36	3	1	6	3	2.46	0.93
36	3	1	6	4	2.58	0.85
37	3	2	3	1	1.51	0.43
37	3	2	3	2	1.67	0.51
37	3	2	3	3	1.78	0.59
37	3	2	3	4	1.99	0.59
38	3	2	5	1	2.34	0.70
38	3	2	5	2	2.16	0.52
38	3	2	5	3	2.06	0.63
38	3	2	5	4	2.27	0.59
39	3	2	1	1	1.44	0.49
39	3	2	1	2	1.46	0.51
39	3	2	1	3	1.57	0.48
39	3	2	1	4	1.60	0.45
40	3	2	4	1	1.80	0.46
40	3	2	4	2	1.93	0.53
40	3	2	4	3	2.13	0.57
40	3	2	4	4	2.34	0.58

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = Center; 3 = South; 4 = Collins

Table H.8. Grain N data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Grain N	Bundle Straw N
					%	%
41	3	2	6	1	2.28	0.72
41	3	2	6	2	2.32	0.58
41	3	2	6	3	2.35	0.56
41	3	2	6	4	2.62	0.66
42	3	2	2	1	1.49	0.37
42	3	2	2	2	1.51	0.38
42	3	2	2	3	1.67	0.38
42	3	2	2	4	1.62	0.38
43	3	3	4	1	1.72	0.47
43	3	3	4	2	1.69	0.53
43	3	3	4	3	1.69	0.38
43	3	3	4	4	1.90	0.47
44	3	3	5	1	1.90	0.49
44	3	3	5	2	2.10	0.47
44	3	3	5	3	2.07	0.58
44	3	3	5	4	2.27	0.71
45	3	3	3	1	1.57	0.56
45	3	3	3	2	1.62	0.42
45	3	3	3	3	1.63	0.40
45	3	3	3	4	1.79	0.45
46	3	3	1	1	1.29	0.34
46	3	3	1	2	1.25	0.38
46	3	3	1	3	1.24	0.28
46	3	3	1	4	1.35	0.29
47	3	3	2	1	1.36	0.42
47	3	3	2	2	1.39	0.36
47	3	3	2	3	1.39	0.30
47	3	3	2	4	1.58	0.40
48	3	3	6	1	2.19	0.78
48	3	3	6	2	2.21	0.90
48	3	3	6	3	2.07	0.64
48	3	3	6	4	2.27	0.79
49	2	1	4	1	1.89	0.46
49	2	1	4	2	1.68	0.52
49	2	1	4	3	1.97	0.54
49	2	1	4	4	2.30	0.62
50	2	1	1	1	1.30	0.35
50	2	1	1	2	1.28	0.34
50	2	1	1	3	1.31	0.30
50	2	1	1	4	1.46	0.36

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = Center; 3 = South; 4 = Collins

Table H.8. Grain N data collected for 1989 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Bundle Grain N	Bundle Straw N
					%	%
51	2	1	2	1	1.37	0.30
51	2	1	2	2	1.39	0.44
51	2	1	2	3	1.38	0.36
51	2	1	2	4	1.51	0.31
52	2	1	3	1	1.67	0.44
52	2	1	3	2	1.60	0.46
52	2	1	3	3	1.56	0.47
52	2	1	3	4	*	0.54
53	2	1	6	1	2.34	0.77
53	2	1	6	2	2.35	0.78
53	2	1	6	3	2.47	0.92
53	2	1	6	4	2.80	0.91
54	2	1	5	1	2.14	0.62
54	2	1	5	2	2.12	0.67
54	2	1	5	3	2.19	0.74
54	2	1	5	4	2.38	0.54

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = Center; 3 = South; 4 = Collins

Table H.9. Grain N data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Grain N	Bundle Straw N
					%	%	%
1	1	1	5	1	*	2.13	0.52
1	1	1	5	2	*	2.12	0.54
1	1	1	5	3	2.06	*	*
2	1	1	4	1	*	1.73	0.28
2	1	1	4	2	*	1.76	0.40
2	1	1	4	3	2.06	*	*
3	1	1	6	1	*	2.17	0.56
3	1	1	6	2	*	2.14	0.58
3	1	1	6	3	2.30	*	*
4	1	1	2	1	*	1.42	0.26
4	1	1	2	2	*	1.41	0.29
4	1	1	2	3	1.56	*	*
5	1	1	3	1	*	1.70	0.31
5	1	1	3	2	*	1.59	0.39
5	1	1	3	3	1.85	*	*
6	1	1	1	1	*	1.40	0.32
6	1	1	1	2	*	1.32	0.27
6	1	1	1	3	1.51	*	*
7	1	3	1	1	*	1.38	0.41
7	1	3	1	2	*	1.37	0.34
7	1	3	1	3	1.54	*	*
8	1	3	2	1	*	1.50	0.50
8	1	3	2	2	*	1.45	0.34
8	1	3	2	3	1.73	*	*
9	1	3	5	1	*	2.16	0.72
9	1	3	5	2	*	2.10	0.86
9	1	3	5	3	2.29	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = Center; 3 = South

Table H.9. Grain N data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Grain N	Bundle Straw N
					%	%	%
10	1	3	6	1	*	2.25	0.89
10	1	3	6	2	*	2.23	0.58
10	1	3	6	3	2.37	*	*
11	1	3	3	1	*	1.89	0.39
11	1	3	3	2	*	1.84	0.42
11	1	3	3	3	2.03	*	*
12	1	3	4	1	*	1.90	0.45
12	1	3	4	2	*	1.81	0.49
12	1	3	4	3	2.08	*	*
13	1	2	2	1	*	1.54	0.29
13	1	2	2	2	*	1.50	0.46
13	1	2	2	3	1.58	*	*
14	1	2	1	1	*	1.40	0.29
14	1	2	1	2	*	1.33	0.25
14	1	2	1	3	1.53	*	*
15	1	2	5	1	*	2.11	0.44
15	1	2	5	2	*	2.13	0.48
15	1	2	5	3	2.27	*	*
16	1	2	6	1	*	2.22	0.57
16	1	2	6	2	*	2.21	0.49
16	1	2	6	3	2.36	*	*
17	1	2	3	1	*	1.84	0.36
17	1	2	3	2	*	1.93	0.57
17	1	2	3	3	2.18	*	*
18	1	2	4	1	*	2.11	0.63
18	1	2	4	2	*	1.88	0.55
18	1	2	4	3	2.27	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = Center; 3 = South

Table H.9. Grain N data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Grain N	Bundle Straw N
					%	%	%
19	2	3	3	1	*	1.89	0.51
19	2	3	3	2	*	1.90	0.46
19	2	3	3	3	2.15	*	*
20	2	3	4	1	*	2.16	0.54
20	2	3	4	2	*	2.14	0.64
20	2	3	4	3	2.24	*	*
21	2	3	2	1	*	1.81	0.59
21	2	3	2	2	*	1.70	0.49
21	2	3	2	3	1.87	*	*
22	2	3	5	1	*	2.13	0.71
22	2	3	5	2	*	2.14	0.88
22	2	3	5	3	2.24	*	*
23	2	3	6	1	*	2.09	0.60
23	2	3	6	2	*	2.14	0.53
23	2	3	6	3	2.28	*	*
24	2	3	1	1	*	1.50	0.42
24	2	3	1	2	*	1.50	0.38
24	2	3	1	3	1.52	*	*
25	2	2	6	1	*	2.15	0.64
25	2	2	6	2	*	2.10	0.68
25	2	2	6	3	2.29	*	*
26	2	2	1	1	*	1.42	0.47
26	2	2	1	2	*	1.35	0.52
26	2	2	1	3	1.48	*	*
27	2	2	2	1	*	1.57	0.47
27	2	2	2	2	*	1.53	0.46
27	2	2	2	3	1.47	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = Center; 3 = South

Table H.9. Grain N data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Grain N	Bundle Straw N
					%	%	%
28	2	2	5	1	*	2.03	0.68
28	2	2	5	2	*	2.09	0.69
28	2	2	5	3	2.08	*	*
29	2	2	3	1	*	1.66	0.53
29	2	2	3	2	*	1.71	0.56
29	2	2	3	3	1.77	*	*
30	2	2	4	1	*	1.75	0.50
30	2	2	4	2	*	1.75	0.56
30	2	2	4	3	1.67	*	*
31	3	1	2	1	*	1.49	0.51
31	3	1	2	2	*	1.45	0.49
31	3	1	2	3	1.67	*	*
32	3	1	1	1	*	1.37	0.36
32	3	1	1	2	*	1.37	0.45
32	3	1	1	3	1.46	*	*
33	3	1	4	1	*	1.76	0.45
33	3	1	4	2	*	1.72	0.41
33	3	1	4	3	1.86	*	*
34	3	1	5	1	*	2.01	0.49
34	3	1	5	2	*	2.02	0.56
34	3	1	5	3	2.23	*	*
35	3	1	3	1	*	1.65	0.47
35	3	1	3	2	*	1.81	0.58
35	3	1	3	3	2.22	*	*
36	3	1	6	1	*	2.20	0.67
36	3	1	6	2	*	2.25	0.68
36	3	1	6	3	1.94	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = Center; 3 = South

Table H.9. Grain N data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Grain N	Bundle Straw N
					%	%	%
37	3	2	3	1	*	1.72	0.40
37	3	2	3	2	*	1.70	0.44
37	3	2	3	3	1.80	*	*
38	3	2	5	1	*	2.19	0.53
38	3	2	5	2	*	2.07	0.65
38	3	2	5	3	2.22	*	*
39	3	2	1	1	*	1.42	0.36
39	3	2	1	2	*	1.30	0.28
39	3	2	1	3	1.62	*	*
40	3	2	4	1	*	1.97	0.48
40	3	2	4	2	*	1.79	0.39
40	3	2	4	3	1.98	*	*
41	3	2	6	1	*	2.26	0.61
41	3	2	6	2	*	2.19	0.61
41	3	2	6	3	2.40	*	*
42	3	2	2	1	*	1.64	0.43
42	3	2	2	2	*		0.33
42	3	2	2	3	1.63	*	*
43	3	3	4	1	*	1.69	0.44
43	3	3	4	2	*	1.68	0.44
43	3	3	4	3	1.67	*	*
44	3	3	5	1	*	2.03	0.43
44	3	3	5	2	*	2.16	0.49
44	3	3	5	3	2.09	*	*
45	3	3	3	1	*	1.78	0.35
45	3	3	3	2	*	1.85	0.36
45	3	3	3	3	1.81	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = Center; 3 = South

Table H.9. Grain N data collected for 1991 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Grain N	Bundle Straw N
					%	%	%
46	3	3	1	1	*	1.41	0.20
46	3	3	1	2	*	1.39	*
46	3	3	1	3	1.44	*	*
47	3	3	2	1	*	1.55	*
47	3	3	2	2	*	1.59	*
47	3	3	2	3	1.55	*	*
48	3	3	6	1	*	2.21	*
48	3	3	6	2	*	2.23	*
48	3	3	6	3	2.24	*	*
49	2	1	4	1	*	2.07	*
49	2	1	4	2	*	2.07	0.50
49	2	1	4	3	2.21	*	*
50	2	1	1	1	*	1.42	0.24
50	2	1	1	2	*	1.39	0.26
50	2	1	1	3	1.55	*	*
51	2	1	2	1	*	1.45	0.23
51	2	1	2	2	*	1.49	0.25
51	2	1	2	3	1.65	*	*
52	2	1	3	1	*	1.83	0.37
52	2	1	3	2	*	1.80	0.42
52	2	1	3	3	2.06	*	*
53	2	1	6	1	*	2.24	0.46
53	2	1	6	2	*	2.32	0.56
53	2	1	6	3	2.39	*	*
54	2	1	5	1	*	2.17	0.53
54	2	1	5	2	*	2.22	0.47
54	2	1	5	3	2.50	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = Center; 3 = South

Table H.10. Grain N data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Straw N	Bundle Straw C
					%	%	%
1	1	1	5	1	2.26	0.85	43.49
1	1	1	5	2	2.33	0.87	43.41
2	1	1	4	1	2.24	0.47	44.31
2	1	1	4	2	2.24	0.39	44.1
3	1	1	6	1	2.22	0.67	43.37
3	1	1	6	2	2.27	0.79	42.6
4	1	1	2	1	2.07	0.35	43.12
4	1	1	2	2	2.09	0.30	43.91
5	1	1	3	1	2.13	0.37	43.39
5	1	1	3	2	2.00	0.50	43.06
6	1	1	1	1	2.04	0.26	43.53
6	1	1	1	2	1.63	0.28	43.96
7	1	3	1	1	1.82	0.24	44.36
7	1	3	1	2	1.59	0.23	44.6
8	1	3	2	1	2.24	0.39	44.25
8	1	3	2	2	1.93	0.29	43.69
9	1	3	5	1	2.26	0.64	43.93
9	1	3	5	2	2.43	0.84	44.22
10	1	3	6	1	2.52	0.47	44.77
10	1	3	6	2	2.43	0.86	43.13
11	1	3	3	1	2.31	0.41	43.68
11	1	3	3	2	2.29	0.72	42.85
12	1	3	4	1	2.33	0.50	44.83
12	1	3	4	2	2.25	0.49	44.67
13	1	2	2	1	1.87	*	*
13	1	2	2	2	1.83	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.10. Grain N data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Straw N	Bundle Straw C
					%	%	%
14	1	2	1	1	2.00	*	*
14	1	2	1	2	1.63	*	*
15	1	2	5	1	2.37	*	*
15	1	2	5	2	2.28	*	*
16	1	2	6	1	2.51	*	*
16	1	2	6	2	2.36	*	*
17	1	2	3	1	2.43	*	*
17	1	2	3	2	2.49	*	*
18	1	2	4	1	2.42	*	*
18	1	2	4	2	2.62	*	*
19	2	3	3	1	2.39	0.49	43.68
19	2	3	3	2	2.43	0.50	43.54
20	2	3	4	1	2.26	0.40	44.08
20	2	3	4	2	2.38	0.50	43.15
21	2	3	2	1	1.94	0.25	44.64
21	2	3	2	2	2.29	0.30	43.89
22	2	3	5	1	2.06	0.58	43.68
22	2	3	5	2	2.28	0.67	43.68
23	2	3	6	1	2.04	0.80	43.94
23	2	3	6	2	2.37	0.65	43.37
24	2	3	1	1	1.59	0.20	44.27
24	2	3	1	2	1.76	0.27	43.8
25	2	2	6	1	2.12	*	*
25	2	2	6	2	2.30	*	*
26	2	2	1	1	1.75	*	*
26	2	2	1	2	1.58	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep
‡ See Appendix C for N history of fertility subplots
δ Location: 1 = North; 2 = South

Table H.10. Grain N data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Straw N	Bundle Straw C
					%	%	%
27	2	2	2	1	1.74	*	*
27	2	2	2	2	1.90	*	*
28	2	2	5	1	2.12	*	*
28	2	2	5	2	2.25	*	*
29	2	2	3	1	1.97	*	*
29	2	2	3	2	2.11	*	*
30	2	2	4	1	1.96	*	*
30	2	2	4	2	2.18	*	*
31	3	1	2	1	1.91	0.23	43.98
31	3	1	2	2	1.88	0.34	44.3
32	3	1	1	1	1.79	0.19	44.27
32	3	1	1	2	1.61	0.21	44.34
33	3	1	4	1	1.84	0.35	43.62
33	3	1	4	2	1.99	0.41	43.77
34	3	1	5	1	2.23	0.43	44.29
34	3	1	5	2	2.20	0.45	44.77
35	3	1	3	1	1.99	0.38	44.19
35	3	1	3	2	2.11	0.40	43.74
36	3	1	6	1	2.32	0.55	44.04
36	3	1	6	2	2.20	0.75	43.32
37	3	2	3	1	2.02	*	*
37	3	2	3	2	2.16	*	*
38	3	2	5	1	2.27	*	*
38	3	2	5	2	2.33	*	*
39	3	2	1	1	1.69	*	*
39	3	2	1	2	1.58	*	*

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.10. Grain N data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Straw N	Bundle Straw C
					%	%	%
40	3	2	4	1	2.29	*	*
40	3	2	4	2	2.40	*	*
41	3	2	6	1	2.35	*	*
41	3	2	6	2	2.31	*	*
42	3	2	2	1	1.72	*	*
42	3	2	2	2	1.83	*	*
43	3	3	4	1	1.92	0.39	43.92
43	3	3	4	2	1.87	0.28	44.66
44	3	3	5	1	1.75	0.74	43.04
44	3	3	5	2	2.18	0.48	44.59
45	3	3	3	1	1.87	0.47	43.95
45	3	3	3	2	1.98	0.35	44.54
46	3	3	1	1	1.46	0.21	44.98
46	3	3	1	2	1.53	0.23	44.14
47	3	3	2	1	1.48	0.28	44.05
47	3	3	2	2	1.74	0.19	44
48	3	3	6	1	2.17	*	*
48	3	3	6	2	2.11	*	*
49	2	1	4	1	2.10	0.47	44.2
49	2	1	4	2	2.14	0.38	44.12
50	2	1	1	1	1.48	0.16	44.77
50	2	1	1	2	1.46	0.19	43.75
51	2	1	2	1	1.69	0.24	44.72
51	2	1	2	2	1.62	0.26	43.69
52	2	1	3	1	1.92	0.28	43.81
52	2	1	3	2	2.10	0.36	43.37

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Table H.10. Grain N data collected for 1993 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Plot Number	Replication	Tillage Treatment	Fertility Subplot	Location	Combined Grain N	Bundle Straw N	Bundle Straw C
					%	%	%
53	2	1	6	1	2.27	0.66	44.12
53	2	1	6	2	2.51	0.64	43.69
54	2	1	5	1	2.18	0.70	43.09
54	2	1	5	2	2.26	0.47	44.62

† Tillage Treatments: 1 = Moldboard Plow; 2 = Offset Disk; 3 = Subsurface Sweep

‡ See Appendix C for N history of fertility subplots

δ Location: 1 = North; 2 = South

Appendix I. pH and bulk density data collected for the Tillage/Fertility Experiment

Table I.1. pH data collected in 1995for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Tillage Treatment	Fertilizer Rate	Depth	Replication 1 North	Replication 1 South	Replication 2 North	Replication 2 South	Replication 3 North	Replication 3 South
			Plot #6	Plot #6	Plot #50	Plot #50	Plot #32	Plot #32
	kg ha^{-1}	in	pH					
Plow	0	0-4	5.63	5.98	5.80	5.66	6.29	6.34
		4-8	5.62	5.49	5.42	5.46	5.72	5.66
		8-12	5.70	5.76	5.94	6.17	5.99	5.94
		12-24	6.39	6.33	6.52	6.73	6.45	6.30
		24-36	6.68	7.26	6.91	7.60	7.06	6.63
		36-48	7.37	7.56	7.81	7.99	7.51	7.44
		48-60	7.68	7.74	*	*	*	*
		60-72	7.79	7.85	*	*	*	*
		72-84	7.78	7.86	*	*	*	*
		84-96	7.80	7.84	*	*	*	*
		96-108	7.85	7.85	*	*	*	*
			Plot #4	Plot #4	Plot #51	Plot #51	Plot #31	Plot #31
			pH					
	45	0-4	5.54	5.32	5.62	5.74	6.19	6.15
		4-8	5.20	5.11	5.23	5.32	5.84	5.53
		8-12	5.84	5.78	5.97	6.20	5.95	6.56
		12-24	6.41	6.31	6.65	6.74	6.37	7.07
		24-36	6.74	6.60	7.07	7.41	7.06	7.34
		36-48	7.55	7.30	7.84	7.91	7.36	7.50
		48-60	7.74	7.73	*	*	*	*
		60-72	7.68	7.85	*	*	*	*
		72-84	7.83	7.86	*	*	*	*
		84-96	7.79	7.89	*	*	*	*
		96-108	7.85	7.90	*	*	*	*
		108-120	*	7.86	*	*	*	*
			Plot #5	Plot #5	Plot #52	Plot #52	Plot #35	Plot #35
			pH					
	90-3	0-4	5.55	5.56	5.47	5.19	5.37	6.17
		4-8	5.26	5.09	5.12	5.07	5.29	5.11
		8-12	5.85	5.90	5.94	6.01	5.90	5.97
		12-24	6.33	6.39	6.73	6.64	6.36	6.49
		24-36	6.57	6.66	7.16	7.21	7.56	7.29
		36-48	6.89	7.41	7.83	7.80	7.80	7.82
		48-60	7.71	7.73	*	*	*	*
		60-72	7.89	7.79	*	*	*	*
		72-84	7.97	7.78	*	*	*	*
		84-96	7.94	7.74	*	*	*	*
		96-108	7.86	7.75	*	*	*	*
		108-120	*	7.74	*	*	*	*

† pH measure in calcium chloride

Table I.1. pH data collected in 1995 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Tillage Treatment	Fertilizer Rate	Depth	Replication 1 North	Replication 1 South	Replication 2 North	Replication 2 South	Replication 3 North	Replication 3 South
			Plot #2	Plot #2	Plot #49	Plot #49	Plot #33	Plot #33
	kg ha^{-1}	in	pH					
	90-4	0-4	5.20	5.08	5.38	5.48	5.42	5.66
		4-8	4.94	4.91	5.05	4.96	5.09	4.99
		8-12	5.49	5.88	6.61	5.62	5.78	5.63
		12-24	6.42	6.52	7.23	6.79	6.31	6.22
		24-36	6.70	6.80	7.51	7.56	6.84	7.05
		36-48	7.59	7.66	7.91	7.88	7.38	7.39
		48-60	7.74	7.85	*	*	*	*
		60-72	7.75	7.94	*	*	*	*
		72-84	7.65	7.94	*	*	*	*
		84-96	7.59	7.95	*	*	*	*
		96-108	7.53	7.79	*	*	*	*
		108-120	7.67	7.79	*	*	*	*
			Plot #1	Plot #1	Plot #54	Plot #54	Plot #34	Plot #34
			pH					
	135	0-4	4.84	4.84	5.18	5.31	5.58	5.37
		4-8	4.82	4.71	4.91	4.84	4.88	4.89
		8-12	5.99	5.61	5.73	5.88	5.77	5.76
		12-24	6.59	6.40	6.66	6.65	6.53	6.54
		24-36	7.02	6.64	7.70	7.66	7.13	6.99
		36-48	7.23	7.32	7.94	7.83	7.71	7.74
		48-60	7.51	7.75	*	*	*	*
		60-72	7.47	7.85	*	*	*	*
		72-84	7.37	7.79	*	*	*	*
		84-96	7.52	7.82	*	*	*	*
		96-108	7.53	7.84	*	*	*	*
		108-120	7.56	7.81	*	*	*	*
		120-132	7.70	7.82	*	*	*	*
			Plot #3	Plot #3	Plot #53	Plot #53	Plot #36	Plot #36
			pH					
	180	0-4	5.00	4.88	4.97	4.98	5.42	5.02
		4-8	4.75	4.56	4.61	4.60	4.85	4.62
		8-12	5.60	5.76	5.46	5.34	5.84	5.96
		12-24	6.33	6.52	6.65	6.55	6.51	6.71
		24-36	6.86	6.80	7.33	7.14	7.14	7.14
		36-48	7.59	7.57	7.83	7.86	7.70	7.89
		48-60	7.85	7.86	*	*	*	*
		60-72	7.54	7.67	*	*	*	*
		72-84	7.78	7.77	*	*	*	*
		84-96	7.44	7.73	*	*	*	*
		96-108	7.78	7.87	*	*	*	*
		108-120	7.71	7.71	*	*	*	*

† pH measure in calcium chloride

Table I.1. pH data collected in 1995 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Tillage Treatment	Fertilizer Rate	Depth	Replication 1 North	Replication 1 South	Replication 2 North	Replication 2 South	Replication 3 North	Replication 3 South
			Plot #7	Plot #7	Plot #24	Plot #24	Plot #46	Plot #46
	kg ha^{-1}	in	pH					
Sweep	0	0-4	5.97	5.64	5.82	5.24	5.89	6.16
		4-8	5.69	5.53	5.56	5.40	5.95	5.98
		8-12	6.11	6.04	6.17	6.26	6.54	6.36
		12-24	6.40	6.32	6.43	6.48	6.80	6.67
		24-36	6.72	6.66	7.65	6.88	7.52	7.43
		36-48	7.09	7.54	7.81	7.41	7.88	7.36
		48-60	7.09	7.75	*	7.83	*	*
		60-72	7.62	7.78	*	*	*	*
		72-84	7.78	7.84	*	*	*	*
		84-96	7.76	7.83	*	*	*	*
		96-108	*	7.86	*	*	*	*
			Plot #8	Plot #8	Plot #21	Plot #21	Plot #47	Plot #47
			pH					
	45	0-4	5.72	5.57	4.94	4.72	5.51	5.81
		4-8	5.22	5.30	5.15	4.96	5.55	5.52
		8-12	6.08	5.89	6.29	6.04	6.46	6.16
		12-24	6.49	6.22	6.22	6.49	7.31	6.59
		24-36	6.90	6.53	6.92	7.01	7.66	7.36
		36-48	7.48	7.54	7.11	7.40	7.92	7.84
		48-60	7.61	7.73	7.30	7.65	*	*
		60-72	7.77	7.79	*	*	*	*
		72-84	7.90	7.79	*	*	*	*
		84-96	7.82	7.74	*	*	*	*
		96-108	*	7.74	*	*	*	*
			Plot #11	Plot #11	Plot #19	Plot #19	Plot #45	Plot #45
			pH					
	90-3	0-4	5.04	5.34	5.11	5.18	6.11	6.02
		4-8	5.01	5.00	4.84	4.82	5.44	6.13
		8-12	5.92	5.91	6.11	6.02	6.21	6.62
		12-24	6.20	6.37	6.39	6.66	6.79	6.96
		24-36	6.51	6.58	6.92	6.89	7.64	7.68
		36-48	7.52	6.93	7.51	7.62	7.98	7.74
		48-60	7.85	7.24	7.47	7.73	*	*
		60-72	7.93	7.69	7.59	7.81	*	*
		72-84	7.93	7.69	*	*	*	*
		84-96	7.99	7.79	*	*	*	*
		96-108	*	7.79	*	*	*	*

† pH measure in calcium chloride

Table I.1. pH data collected in 1995 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Tillage Treatment	Fertilizer Rate	Depth	Replication 1 North	Replication 1 South	Replication 2 North	Replication 2 South	Replication 3 North	Replication 3 South
			Plot #12	Plot #12	Plot #20	Plot #20	Plot #43	Plot #43
	kg ha^{-1}	in	pH					
	90-4	0-4	5.61	5.36	5.08	5.05	5.41	5.61
		4-8	5.00	5.17	4.89	4.86	6.24	5.38
		8-12	6.07	6.09	5.78	5.89	6.28	6.70
		12-24	6.48	6.44	6.44	6.34	6.59	6.80
		24-36	6.70	6.72	7.05	6.95	7.40	7.59
		36-48	7.35	7.53	7.47	7.32	7.78	7.88
		48-60	7.59	7.81	7.39	7.54	*	*
		60-72	7.72	7.89	*	7.63	*	*
		72-84	7.74	7.85	*	*	*	*
			Plot #9	Plot #9	Plot #22	Plot #22	Plot #44	Plot #44
			pH					
	135	0-4	4.85	4.83	4.62	4.53	5.29	4.96
		4-8	4.72	4.56	4.58	4.62	5.05	5.37
		8-12	5.78	5.57	5.90	5.67	6.19	6.11
		12-24	6.24	6.25	6.31	6.78	6.69	6.92
		24-36	6.52	6.47	6.59	7.43	7.36	7.43
		36-48	7.37	6.91	7.31	7.91	7.71	7.87
		48-60	7.51	7.46	7.49	8.21	*	*
		60-72	7.55	7.58	*	*	*	*
		72-84	7.64	7.61	*	*	*	*
		84-96	7.61	7.56	*	*	*	*
		96-108	*	7.55	*	*	*	*
		108-120	*	7.54	*	*	*	*
			Plot #10	Plot #10	Plot #23	Plot #23	Plot #48	Plot #48
			pH					
	180	0-4	4.56	4.96	4.90	4.88	5.47	5.45
		4-8	4.66	4.59	4.71	4.79	4.98	5.11
		8-12	5.81	5.82	6.03	6.22	6.25	6.36
		12-24	6.41	6.50	6.75	6.93	6.84	6.82
		24-36	7.39	6.82	7.13	7.28	7.58	7.62
		36-48	8.34	7.32	7.72	7.37	7.91	7.95
		48-60	8.45	7.59	7.89	7.68	*	*
		60-72	8.35	7.70	*	*	*	*
		72-84	8.10	7.77	*	*	*	*
		84-96	7.95	7.67	*	*	*	*
		96-108	*	7.74	*	*	*	*

† pH measure in calcium chloride

Table I.1. pH data collected in 1995 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Tillage Treatment	Fertilizer Rate	Depth	Replication 1 North	1 South	2 North	2 South	3 North	3 South
			Plot #14	Plot #14	Plot #26	Plot #26	Plot #39	Plot #39
	kg ha^{-1}	in	pH					
Disk	0	0-4	5.72	5.59	5.26	5.31	5.94	6.00
		4-8	5.90	5.92	5.64	5.49	6.22	6.13
		8-12	6.23	6.16	6.04	5.96	6.62	6.32
		12-24	6.48	6.43	6.49	6.30	7.27	6.62
		24-36	6.81	6.73	7.36	6.49	7.59	7.41
		36-48	7.57	7.62	7.74	7.23	7.50	7.78
		48-60	7.78	7.87	*	*	*	*
		60-72	7.90	7.95	*	*	*	*
		72-84	8.01	7.95	*	*	*	*
		84-96	*	7.90	*	*	*	*
			Plot #13	Plot #13	Plot #27	Plot #27	Plot #42	Plot #42
			pH					
	45	0-4	5.48	5.61	5.36	5.29	5.91	5.88
		4-8	5.36	5.41	5.49	5.36	6.05	6.23
		8-12	6.05	6.05	5.87	5.75	6.76	6.97
		12-24	6.42	6.44	6.27	6.07	7.43	6.68
		24-36	6.71	6.60	6.56	6.24	7.70	7.77
		36-48	7.59	7.51	7.08	6.97	7.90	7.76
		48-60	7.73	7.78	*	7.26	*	*
		60-72	7.89	7.81	*	*	*	*
		72-84	*	7.89	*	*	*	*
			Plot #17	Plot #17	Plot #29	Plot #29	Plot #37	Plot #37
			pH					
	90-3	0-4	5.06	5.12	5.90	5.95	5.07	5.32
		4-8	5.38	5.50	5.84	5.88	5.53	5.73
		8-12	6.00	6.05	5.99	5.99	6.23	6.73
		12-24	6.30	6.21	6.21	6.10	6.55	6.61
		24-36	7.21	6.68	6.47	6.34	7.18	7.16
		36-48	7.55	7.56	6.54	6.44	7.78	7.85
		48-60	7.70	7.58	*	*	*	*
		60-72	7.70	*	*	*	*	*
		72-84	7.73	*	*	*	*	*

† pH measure in calcium chloride

Table I.1. pH data collected in 1995 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (Continued).

Tillage Treatment	Fertilizer Rate	Depth	Replication 1 North	Replication 1 South	Replication 2 North	Replication 2 South	Replication 3 North	Replication 3 South
			Plot #18	Plot #18	Plot #30	Plot #30	Plot #40	Plot #40
	kg ha^{-1}	in	pH					
	90-4	0-4	5.30	4.86	5.79	6.04	5.59	5.84
		4-8	5.31	5.10	5.57	5.78	5.73	5.67
		8-12	5.96	5.91	5.81	6.07	6.36	6.53
		12-24	6.29	6.23	6.68	6.84	6.86	7.35
		24-36	7.00	7.17	6.98	7.19	7.24	7.58
		36-48	7.23	7.40	7.74	7.48	7.74	7.82
		48-60	7.44	7.81	*	*	*	*
		60-72	7.55	7.88	*	*	*	*
			Plot #15	Plot #15	Plot #28	Plot #28	Plot #38	Plot #38
			pH					
	135	0-4	4.72	4.80	5.16	5.27	4.79	5.06
		4-8	5.02	5.23	5.37	5.29	5.24	5.80
		8-12	6.02	6.29	5.69	5.66	6.12	6.26
		12-24	6.48	6.71	6.10	5.76	6.53	6.77
		24-36	6.87	7.60	6.24	6.32	7.00	7.47
		36-48	7.81	7.82	6.48	6.61	7.74	7.89
		48-60	8.02	8.02	*	*	*	*
		60-72	8.12	8.01	*	*	*	*
		72-84	8.06	*	*	*	*	*
			Plot #16	Plot #16	Plot #25	Plot #25	Plot #41	Plot #41
			pH					
	180	0-4	4.97	4.43	4.86	4.78	5.71	5.37
		4-8	5.03	4.72	5.14	4.69	5.99	5.87
		8-12	6.05	5.72	6.28	5.90	6.96	7.18
		12-24	6.59	6.25	6.59	6.59	7.27	7.51
		24-36	7.08	6.60	6.85	7.02	7.55	7.66
		36-48	7.66	7.07	7.52	7.56	7.78	7.86
		48-60	7.90	7.57	*	*	*	*
		60-72	7.94	7.60	*	*	*	*
		72-84	7.95	*	*	*	*	*

† pH measure in calcium chloride

Table I.2. Surface bulk density data collected for 1996 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Rep	Till	Fert	Plot #	Depth	Can #	Wet Weight	Dry Weight	Depth	pi*r^2	# cores	H_2O	Bulk Density Original	Bulk Density Retakes	Mean
				in		g	g	cm						
1	1	5	1	0-4	659	112.66	93.54	8.89	2.7002	3	0.2044	1.28	1.25	1.27
1	1	5	1	4-8	660	118.48	97.27	8.89	2.7002	3	0.2181	1.34	1.32	1.33
1	1	5	1	8-12	661	101.35	83.16	8.89	2.7002	3	0.2187	1.15	1.14	1.15
1	1	4	2	0-4	662	111.96	91.69	8.89	2.7002	3	0.2211	1.27	*	1.27
1	1	4	2	4-8	663	110.18	89.80	8.89	2.7002	3	0.2269	1.25	*	1.25
1	1	4	2	8-12	664	105.65	86.42	8.89	2.7002	3	0.2225	1.20	*	1.20
1	1	6	3	0-4	665	102.07	82.60	8.89	2.7002	3	0.2357	1.15	*	1.15
1	1	6	3	4-8	666	105.50	85.36	8.89	2.7002	3	0.2359	1.19	*	1.19
1	1	6	3	8-12	667	102.22	83.62	8.89	2.7002	3	0.2224	1.16	*	1.16
1	1	2	4	0-4	668	112.27	89.75	8.89	2.7002	3	0.2509	1.25	*	1.25
1	1	2	4	4-8	669	121.07	97.00	8.89	2.7002	3	0.2481	1.35	*	1.35
1	1	2	4	8-12	670	105.34	86.00	8.89	2.7002	3	0.2249	1.19	*	1.19
1	1	3	5	0-4	671	110.79	89.73	8.89	2.7002	3	0.2347	1.25	*	1.25
1	1	3	5	4-8	672	113.63	91.44	8.89	2.7002	3	0.2427	1.27	*	1.27
1	1	3	5	8-12	673	105.87	86.33	8.89	2.7002	3	0.2263	1.20	*	1.20
1	1	1	6	0-4	674	112.47	92.96	8.89	2.7002	3	0.2099	1.29	*	1.29
1	1	1	6	4-8	675	111.34	91.00	8.89	2.7002	3	0.2235	1.26	*	1.26
1	1	1	6	8-12	676	109.08	89.20	8.89	2.7002	3	0.2229	1.24	*	1.24
1	3	1	7	0-4	677	108.96	90.98	8.89	2.7002	3	0.1976	1.26	*	1.26
1	3	1	7	4-8	678	110.14	90.14	8.89	2.7002	3	0.2219	1.25	*	1.25
1	3	1	7	8-12	679	96.71	78.85	8.89	2.7002	3	0.2265	1.09	*	1.09
1	3	2	8	0-4	721	111.30	87.09	8.89	2.7002	3	0.2780	1.21	*	1.21
1	3	2	8	4-8	722	113.92	90.04	8.89	2.7002	3	0.2652	1.25	*	1.25
1	3	2	8	8-12	723	100.71	81.07	8.89	2.7002	3	0.2423	1.13	*	1.13

† Sampled 4-15 through 4-18, 1996
‡ Tube size = 1.8542cm * 8.89cm
δ Tube volume = 24.0052 cm^3
Volume of 3 cores = 72.0155cm^3

Table I.2. Surface bulk density data collected for 1996 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Rep	Till	Fert	Plot #	Depth	Can #	Wet Weight	Dry Weight	Depth	pi*r^2	# cores	H_2O	Bulk Density Original	Bulk Density Retakes	Mean
				in		g	g	cm						
1	3	5	9	0-4	724	104.40	81.44	8.89	2.7002	3	0.2819	1.18	1.22	1.20
1	3	5	9	4-8	725	109.81	86.79	8.89	2.7002	3	0.2652	1.20	1.19	1.20
1	3	5	9	8-12	726	96.22	77.30	8.89	2.7002	3	0.2448	1.08	1.09	1.09
1	3	6	10	0-4	721	102.48	81.32	8.89	2.7002	3	0.2602	1.13		1.13
1	3	6	10	4-8	722	108.48	86.39	8.89	2.7002	3	0.2557	1.20	*	1.20
1	3	6	10	8-12	723	98.38	79.09	8.89	2.7002	3	0.2439	1.10	*	1.10
1	3	3	11	0-4	724	103.30	80.42	8.89	2.7002	3	0.2845	1.12	*	1.12
1	3	3	11	4-8	725	107.83	85.09	8.89	2.7002	3	0.2672	1.18	*	1.18
1	3	3	11	8-12	726	103.30	83.21	8.89	2.7002	3	0.2414	1.16	*	1.16
1	3	4	12	0-4	727	112.70	88.60	8.89	2.7002	3	0.2720	1.21	1.18	1.20
1	3	4	12	4-8	728	113.98	90.34	8.89	2.7002	3	0.2617	1.26	1.26	1.26
1	3	4	12	8-12	729	101.33	81.75	8.89	2.7002	3	0.2395	1.14	1.13	1.14
1	2	2	13	0-4	730	107.89	84.65	8.89	2.7002	3	0.2745	1.21	1.23	1.22
1	2	2	13	4-8	731	116.36	92.33	8.89	2.7002	3	0.2603	1.27	1.26	1.27
1	2	2	13	8-12	732	96.28	78.32	8.89	2.7002	3	0.2293	1.12	1.14	1.13
1	2	1	14	0-4	733	108.06	86.96	8.89	2.7002	3	0.2426	1.21	*	1.21
1	2	1	14	4-8	734	108.70	87.98	8.89	2.7002	3	0.2355	1.22	*	1.22
1	2	1	14	8-12	735	104.51	84.41	8.89	2.7002	3	0.2381	1.17	*	1.17
1	2	5	15	0-4	736	103.21	81.00	8.89	2.7002	3	0.2742	1.12	*	1.12
1	2	5	15	4-8	737	111.25	88.40	8.89	2.7002	3	0.2585	1.23	*	1.23
1	2	5	15	8-12	738	102.44	82.15	8.89	2.7002	3	0.2470	1.14	*	1.14
1	2	6	16	0-4	721	99.75	76.92	8.89	2.7002	3	0.2968	1.07	*	1.07
1	2	6	16	4-8	722	109.51	84.84	8.89	2.7002	3	0.2908	1.18	*	1.18
1	2	6	16	8-12	723	105.83	83.57	8.89	2.7002	3	0.2664	1.16	*	1.16

† Sampled 4-15 through 4-18, 1996

‡ Tube size = 1.8542cm * 8.89cm

δ Tube volume = 24.0052 cm^3

Volume of 3 cores = 72.0155cm^3

Table I.2. Surface bulk density data collected for 1996 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Rep	Till	Fert	Plot #	Depth	Can #	Wet Weight	Dry Weight	Depth	pi*r^2	# cores	H_2O	Bulk Density Original	Bulk Density Retakes	Mean
				in		g	g	cm						
1	2	3	17	0-4	724	102.50	79.32	8.89	2.7002	3	0.2922	1.10	*	1.10
1	2	3	17	4-8	725	110.22	85.61	8.89	2.7002	3	0.2875	1.19	*	1.19
1	2	3	17	8-12	726	105.12	83.30	8.89	2.7002	3	0.2619	1.16	*	1.16
1	2	4	18	0-4	727	110.23	84.84	8.89	2.7002	3	0.2993	1.18	*	1.18
1	2	4	18	4-8	728	112.73	87.48	8.89	2.7002	3	0.2886	1.21	*	1.21
1	2	4	18	8-12	729	100.53	79.09	8.89	2.7002	3	0.2711	1.10	*	1.10
2	3	3	19	0-4	730	116.22	88.61	8.89	2.7002	3	0.3116	1.15	1.07	1.11
2	3	3	19	4-8	731	118.34	91.34	8.89	2.7002	3	0.2956	1.21	1.15	1.18
2	3	3	19	8-12	732	100.28	78.00	8.89	2.7002	3	0.2856	1.06	1.04	1.05
2	3	4	20	0-4	733	106.74	82.79	8.89	2.7002	3	0.2893	1.15	*	1.15
2	3	4	20	4-8	734	108.90	84.88	8.89	2.7002	3	0.2830	1.18	*	1.18
2	3	4	20	8-12	735	105.49	81.13	8.89	2.7002	3	0.3003	1.13	*	1.13
2	3	2	21	0-4	736	102.81	78.76	8.89	2.7002	3	0.3054	1.10	1.11	1.11
2	3	2	21	4-8	737	112.46	86.50	8.89	2.7002	3	0.3001	1.19	1.17	1.18
2	3	2	21	8-12	738	104.92	80.59	8.89	2.7002	3	0.3019	1.08	1.04	1.06
2	3	5	22	0-4	739	101.68	79.27	8.89	2.7002	3	0.2827	1.10	*	1.10
2	3	5	22	4-8	740	113.38	88.20	8.89	2.7002	3	0.2855	1.22	*	1.22
2	3	5	22	8-12	741	106.32	81.76	8.89	2.7002	3	0.3004	1.14	*	1.14
2	3	6	23	0-4	742	106.49	81.17	8.89	2.7002	3	0.3119	1.13	*	1.13
2	3	6	23	4-8	743	116.37	89.41	8.89	2.7002	3	0.3015	1.24	*	1.24
2	3	6	23	8-12	744	109.13	83.38	8.89	2.7002	3	0.3088	1.16	*	1.16
2	3	1	24	0-4	745	107.14	86.35	8.89	2.7002	3	0.2408	1.20	*	1.20
2	3	1	24	4-8	746	115.77	91.61	8.89	2.7002	3	0.2637	1.27	*	1.27
2	3	1	24	8-12	747	109.71	84.94	8.89	2.7002	3	0.2916	1.18	*	1.18

† Sampled 4-15 through 4-18, 1996
‡ Tube size = 1.8542cm * 8.89cm
δ Tube volume = 24.0052 cm^3
Volume of 3 cores = 72.0155cm^3

Table I.2. Surface bulk density data collected for 1996 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Rep	Till	Fert	Plot #	Depth	Can #	Wet Weight	Dry Weight	Depth	pi*r^2	# cores	H_2O	Bulk Density Original	Bulk Density Retakes	Mean
				in		g	g	cm						
2	2	6	25	0-4	721	106.94	82.70	8.89	2.7002	3	0.2931	1.15	*	1.15
2	2	6	25	4-8	722	121.56	94.88	8.89	2.7002	3	0.2812	1.32	*	1.32
2	2	6	25	8-12	723	111.92	86.32	8.89	2.7002	3	0.2966	1.20	*	1.20
2	2	1	26	0-4	724	110.04	86.04	8.89	2.7002	3	0.2789	1.19	*	1.19
2	2	1	26	4-8	725	122.48	96.98	8.89	2.7002	3	0.2629	1.35	*	1.35
2	2	1	26	8-12	726	110.86	87.01	8.89	2.7002	3	0.2741	1.21	*	1.21
2	2	2	27	0-4	727	107.84	84.64	8.89	2.7002	3	0.2741	1.18	*	1.18
2	2	2	27	4-8	728	120.92	95.40	8.89	2.7002	3	0.2675	1.32	*	1.32
2	2	2	27	8-12	729	107.99	84.98	8.89	2.7002	3	0.2708	1.18	*	1.18
2	2	5	28	0-4	730	103.31	80.96	8.89	2.7002	3	0.2761	1.18	1.24	1.21
2	2	5	28	4-8	731	120.50	94.93	8.89	2.7002	3	0.2694	1.34	1.35	1.35
2	2	5	28	8-12	732	104.96	82.82	8.89	2.7002	3	0.2673	1.18	1.20	1.19
2	2	3	29	0-4	733	112.18	87.86	8.89	2.7002	3	0.2768	1.22	*	1.22
2	2	3	29	4-8	734	120.19	95.09	8.89	2.7002	3	0.2640	1.32	*	1.32
2	2	3	29	8-12	735	107.90	85.77	8.89	2.7002	3	0.2580	1.19	*	1.19
2	2	4	30	0-4	736	112.54	89.58	8.89	2.7002	3	0.2563	1.24	*	1.24
2	2	4	30	4-8	737	121.31	96.11	8.89	2.7002	3	0.2622	1.33	*	1.33
2	2	4	30	8-12	738	110.14	87.99	8.89	2.7002	3	0.2517	1.22	*	1.22
2	1	4	49	0-4	760	113.20	89.57	8.89	2.7002	3	0.2638	1.24	*	1.24
2	1	4	49	4-8	761	118.90	93.29	8.89	2.7002	3	0.2745	1.30	*	1.30
2	1	4	49	8-12	762	116.72	92.04	8.89	2.7002	3	0.2681	1.28	*	1.28
2	1	1	50	0-4	763	114.07	93.19	8.89	2.7002	3	0.2241	1.29	*	1.29
2	1	1	50	4-8	764	113.59	91.16	8.89	2.7002	3	0.2461	1.27	*	1.27
2	1	1	50	8-12	765	108.74	86.27	8.89	2.7002	3	0.2605	1.20	*	1.20
2	1	2	51	0-4	766	73.00	58.26	8.89	2.7002	2	0.2530	1.21	*	1.21
2	1	2	51	4-8	767	78.29	62.01	8.89	2.7002	2	0.2625	1.29	*	1.29
2	1	2	51	8-12	768	76.88	60.29	8.89	2.7002	2	0.2752	1.26	*	1.26

† Sampled 4-15 through 4-18, 1996

‡ Tube size = 1.8542cm * 8.89cm

δ Tube volume = 24.0052 cm^3

Volume of 3 cores = 72.0155cm^3

Table I.2. Surface bulk density data collected for 1996 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Rep	Till	Fert	Plot #	Depth	Can #	Wet Weight	Dry Weight	Depth	pi*r^2	# cores	H_2O	Bulk Density Original	Bulk Density Retakes	Mean
				in		g	g	cm						
2	1	3	52	0-4	769	72.79	57.81	8.89	2.7002	2	0.2591	1.20	*	1.20
2	1	3	52	4-8	770	76.79	60.89	8.89	2.7002	2	0.2611	1.27	*	1.27
2	1	3	52	8-12	771	74.66	58.92	8.89	2.7002	2	0.2671	1.23	*	1.23
2	1	6	53	0-4	772	72.86	58.00	8.89	2.7002	2	0.2562	1.21	*	1.21
2	1	6	53	4-8	773	73.70	58.47	8.89	2.7002	2	0.2605	1.22	*	1.22
2	1	6	53	8-12	774	76.06	60.66	8.89	2.7002	2	0.2539	1.26	*	1.26
2	1	5	54	0-4	775	74.53	59.75	8.89	2.7002	2	0.2474	1.24	*	1.24
2	1	5	54	4-8	776	74.87	59.39	8.89	2.7002	2	0.2606	1.24	*	1.24
2	1	5	54	8-12	777	78.79	62.92	8.89	2.7002	2	0.2522	1.31	*	1.31
3	1	2	31	0-4	739	114.74	91.48	8.89	2.7002	3	0.2543	1.27	*	1.27
3	1	2	31	4-8	740	115.02	91.55	8.89	2.7002	3	0.2564	1.27	*	1.27
3	1	2	31	8-12	741	113.28	90.84	8.89	2.7002	3	0.2470	1.26	*	1.26
3	1	1	32	0-4	742	115.26	92.61	8.89	2.7002	3	0.2446	1.29	*	1.29
3	1	1	32	4-8	743	121.22	97.23	8.89	2.7002	3	0.2467	1.35	*	1.35
3	1	1	32	8-12	744	112.24	90.21	8.89	2.7002	3	0.2442	1.25	*	1.25
3	1	4	33	0-4	745	116.85	92.97	8.89	2.7002	3	0.2569	1.27	1.25	1.26
3	1	4	33	4-8	746	121.72	97.02	8.89	2.7002	3	0.2546	1.32	1.28	1.30
3	1	4	33	8-12	747	113.40	90.70	8.89	2.7002	3	0.2503	1.27	1.28	1.28
3	1	5	34	0-4	748	113.99	91.06	8.89	2.7002	3	0.2518	1.26	*	1.26
3	1	5	34	4-8	749	115.55	91.95	8.89	2.7002	3	0.2567	1.28	*	1.28
3	1	5	34	8-12	750	113.14	90.36	8.89	2.7002	3	0.2521	1.25	*	1.25
3	1	3	35	0-4	751	115.64	92.10	8.89	2.7002	3	0.2556	1.28	*	1.28
3	1	3	35	4-8	752	117.85	93.75	8.89	2.7002	3	0.2571	1.30	*	1.30
3	1	3	35	8-12	753	113.67	90.42	8.89	2.7002	3	0.2571	1.26	*	1.26

† Sampled 4-15 through 4-18, 1996
‡ Tube size = 1.8542cm * 8.89cm
δ Tube volume = 24.0052 cm^3
Volume of 3 cores = 72.0155cm^3

Table I.2. Surface bulk density data collected for 1996 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Rep	Till	Fert	Plot #	Depth	Can #	Wet Weight	Dry Weight	Depth	pi*r^2	# cores	H_2O	Bulk Density Original	Bulk Density Retakes	Mean
				in		g	g	cm						
3	1	6	36	0-4	721	109.31	86.32	8.89	2.7002	3	0.2663	1.20	*	1.20
3	1	6	36	4-8	722	111.53	88.10	8.89	2.7002	3	0.2659	1.22	*	1.22
3	1	6	36	8-12	723	112.11	89.02	8.89	2.7002	3	0.2594	1.24	*	1.24
3	2	3	37	0-4	724	111.05	88.42	8.89	2.7002	3	0.2559	1.23	*	1.23
3	2	3	37	4-8	725	119.14	94.98	8.89	2.7002	3	0.2544	1.32	*	1.32
3	2	3	37	8-12	726	104.49	83.73	8.89	2.7002	3	0.2479	1.16	*	1.16
3	2	5	38	0-4	727	112.93	90.79	8.89	2.7002	3	0.2439	1.26	*	1.26
3	2	5	38	4-8	728	115.53	92.49	8.89	2.7002	3	0.2491	1.28	*	1.28
3	2	5	38	8-12	729	105.45	84.54	8.89	2.7002	3	0.2473	1.17	*	1.17
3	2	1	39	0-4	730	114.46	93.99	8.89	2.7002	3	0.2178	1.31	*	1.31
3	2	1	39	4-8	731	118.90	95.59	8.89	2.7002	3	0.2439	1.33	*	1.33
3	2	1	39	8-12	732	105.98	84.55	8.89	2.7002	3	0.2535	1.17	*	1.17
3	2	4	40	0-4	733	111.77	89.89	8.89	2.7002	3	0.2434	1.25	*	1.25
3	2	4	40	4-8	734	120.19	96.31	8.89	2.7002	3	0.2479	1.34	*	1.34
3	2	4	40	8-12	735	104.21	82.93	8.89	2.7002	3	0.2566	1.15	*	1.15
3	2	6	41	0-4	736	100.46	82.18	8.89	2.7002	3	0.2224	1.15	1.15	1.15
3	2	6	41	4-8	737	112.11	89.68	8.89	2.7002	3	0.2501	1.26	1.27	1.27
3	2	6	41	8-12	738	98.38	78.47	8.89	2.7002	3	0.2537	1.14	1.18	1.16
3	2	2	42	0-4	739	106.63	85.62	8.89	2.7002	3	0.2454	1.19	*	1.19
3	2	2	42	4-8	740	115.13	91.65	8.89	2.7002	3	0.2562	1.27	*	1.27
3	2	2	42	8-12	741	103.46	82.50	8.89	2.7002	3	0.2541	1.15	*	1.15
3	3	4	43	0-4	742	108.20	88.27	8.89	2.7002	3	0.2258	1.23	*	1.23
3	3	4	43	4-8	743	118.57	95.08	8.89	2.7002	3	0.2471	1.32	*	1.32
3	3	4	43	8-12	744	104.14	82.31	8.89	2.7002	3	0.2652	1.14	*	1.14
3	3	5	44	0-4	745	107.67	85.12	8.89	2.7002	3	0.2649	1.18	*	1.18
3	3	5	44	4-8	746	117.02	93.21	8.89	2.7002	3	0.2554	1.29	*	1.29
3	3	5	44	8-12	747	106.77	84.30	8.89	2.7002	3	0.2665	1.17	*	1.17

† Sampled 4-15 through 4-18, 1996
‡ Tube size = 1.8542cm * 8.89cm
δ Tube volume = 24.0052 cm^3
Volume of 3 cores = 72.0155cm^3

Table I.2. Surface bulk density data collected for 1996 for the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997 (continued).

Rep	Till	Fert	Plot #	Depth	Can #	Wet Weight	Dry Weight	Depth	pi*r^2	# cores	H_2O	Bulk Density Original	Bulk Density Retakes	Mean
				in		g	g	cm						
3	3	3	45	0-4	748	105.77	86.39	8.89	2.7002	3	0.2243	1.20	*	1.20
3	3	3	45	4-8	749	114.43	91.50	8.89	2.7002	3	0.2506	1.27	*	1.27
3	3	3	45	8-12	750	104.20	82.28	8.89	2.7002	3	0.2664	1.14	*	1.14
3	3	1	46	0-4	751	109.80	90.53	8.89	2.7002	3	0.2129	1.26	*	1.26
3	3	1	46	4-8	752	122.64	97.21	8.89	2.7002	3	0.2616	1.35	*	1.35
3	3	1	46	8-12	753	107.45	84.03	8.89	2.7002	3	0.2787	1.17	*	1.17
3	3	2	47	0-4	754	109.24	87.85	8.89	2.7002	3	0.2435	1.22	*	1.22
3	3	2	47	4-8	755	117.23	93.72	8.89	2.7002	3	0.2509	1.30	*	1.30
3	3	2	47	8-12	756	110.90	87.26	8.89	2.7002	3	0.2709	1.21	*	1.21
3	3	6	48	0-4	757	105.38	84.30	8.89	2.7002	3	0.2501	1.17	*	1.17
3	3	6	48	4-8	758	117.92	94.29	8.89	2.7002	3	0.2506	1.31	*	1.31
3	3	6	48	8-12	759	106.91	83.34	8.89	2.7002	3	0.2828	1.16	*	1.16

† Sampled 4-15 through 4-18, 1996
‡ Tube size = 1.8542cm * 8.89cm
δ Tube volume = 24.0052 cm^3
Volume of 3 cores = 72.0155cm^3

Table I.3. Bulk density and soil moisture data for 1996 for replication 1 of the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plow		Fertility Subplot						
Bulk Density	Depth	1	2	3	4	5	6	Mean
	in	g cm^{-3}						
	0-4	1.29	1.25	1.25	1.27	1.27	1.15	1.25
	4-8	1.26	1.35	1.27	1.25	1.33	1.19	1.27
	8-12	1.24	1.19	1.20	1.20	1.15	1.16	1.19
Soil Moisture	Depth	1	2	3	4	5	6	Mean
	in	%						
	0-4	20.99	25.09	23.47	22.11	20.44	23.57	22.61
	4-8	22.35	24.81	24.27	22.69	21.81	23.59	23.25
	8-12	22.29	22.49	22.63	22.25	21.87	22.24	22.30
Disk		Fertility Subplot						
Bulk Density	Depth	1	2	3	4	5	6	Mean
	in	g cm^{-3}						
	0-4	1.21	1.22	1.10	1.18	1.12	1.07	1.15
	4-8	1.22	1.27	1.19	1.21	1.23	1.18	1.22
	8-12	1.17	1.13	1.16	1.10	1.14	1.16	1.14
Soil Moisture	Depth	1	2	3	4	5	6	Mean
	in	%						
	0-4	24.26	27.45	29.22	29.93	27.42	29.68	27.99
	4-8	23.55	26.03	28.75	28.86	25.85	29.08	27.02
	8-12	23.81	22.93	26.19	27.11	24.70	26.64	25.23
Sweep		Fertility Subplot						
Bulk Density	Depth	1	2	3	4	5	6	Mean
	in	g cm^{-3}						
	0-4	1.26	1.21	1.12	1.20	1.20	1.13	1.19
	4-8	1.25	1.25	1.18	1.26	1.20	1.20	1.22
	8-12	1.09	1.13	1.16	1.14	1.09	1.10	1.12
Soil Moisture	Depth	1	2	3	4	5	6	Mean
	in	%						
	0-4	19.76	27.80	28.45	22.11	27.20	26.02	25.22
	4-8	22.19	26.52	26.72	22.69	26.17	25.57	24.98
	8-12	22.65	2423	24.14	22.25	23.95	24.39	23.60

† See Appendix C for N history of fertility subplots

Table I.4. Bulk density and soil moisture data for 1996 for replication 2 of the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plow		Fertility Subplot						
Bulk Density	Depth	1	2	3	4	5	6	Mean
	in	$g\ cm^{-3}$						
	0-4	1.29	1.21	1.20	1.24	1.24	1.21	1.23
	4-8	1.27	1.29	1.27	1.30	1.24	1.22	1.26
	8-12	1.20	1.26	1.23	1.28	1.31	1.26	1.26
Soil Moisture	Depth	1	2	3	4	5	6	Mean
	in	%						
	0-4	22.41	25.30	25.91	26.38	24.74	25.62	25.06
	4-8	24.61	26.25	26.11	27.45	26.06	26.05	26.09
	8-12	26.05	27.52	26.71	26.81	25.22	25.39	26.28

Disk		Fertility Subplot						
Bulk Density	Depth	1	2	3	4	5	6	Mean
	in	$g\ cm^{-3}$						
	0-4	1.19	1.18	1.22	1.24	1.21	1.15	1.20
	4-8	1.35	1.32	1.32	1.33	1.35	1.32	1.33
	8-12	1.21	1.18	1.19	1.22	1.19	1.20	1.20
Soil Moisture	Depth	1	2	3	4	5	6	Mean
	in	%						
	0-4	27.89	27.41	27.68	25.63	27.61	29.31	27.59
	4-8	26.29	26.75	26.40	26.22	26.94	28.12	26.79
	8-12	27.41	27.08	25.80	25.17	26.73	29.66	26.98

Sweep		Fertility Subplot						
Bulk Density	Depth	1	2	3	4	5	6	Mean
	in	$g\ cm^{-3}$						
	0-4	1.20	1.11	1.11	1.15	1.10	1.13	1.13
	4-8	1.27	1.18	1.18	1.18	1.22	1.24	1.21
	8-12	1.18	1.06	1.05	1.13	1.14	1.16	1.12
Soil Moisture	Depth	1	2	3	4	5	6	Mean
	in	%						
	0-4	24.08	30.54	31.16	28.93	28.27	31.19	29.03
	4-8	26.37	30.01	29.56	28.30	28.55	30.15	28.82
	8-12	29.16	30.19	28.56	30.03	30.04	30.88	29.81

† See Appendix C for N history of fertility subplots

Table I.5. Bulk density and soil moisture data for 1996 for replication 3 of the Tillage/ Fertility Experiment at Pendleton, Oregon, 1945 to 1997.

Plow		Fertility Subplot						
Bulk Density	Depth	1	2	3	4	5	6	Mean
	in	$g\ cm^{-3}$						
	0-4	1.29	1.27	1.28	1.26	1.26	1.20	1.26
	4-8	1.35	1.27	1.30	1.30	1.28	1.22	1.29
	8-12	1.25	1.26	1.26	1.28	1.25	1.24	1.26
Soil Moisture	Depth	1	2	3	4	5	6	Mean
	in	%						
	0-4	24.46	25.43	25.56	25.69	25.18	26.63	25.49
	4-8	24.67	25.64	25.71	25.46	25.67	26.59	25.62
	8-12	24.42	24.70	25.71	25.03	25.21	25.94	25.17

Disk		Fertility Subplot						
Bulk Density	Depth	1	2	3	4	5	6	Mean
	in	$g\ cm^{-3}$						
	0-4	1.31	1.19	1.23	1.25	1.26	1.15	1.23
	4-8	1.33	1.27	1.32	1.34	1.28	1.27	1.30
	8-12	1.17	1.15	1.16	1.15	1.17	1.16	1.16
Soil Moisture	Depth	1	2	3	4	5	6	Mean
	in	%						
	0-4	21.78	24.54	25.59	24.34	24.39	22.24	23.81
	4-8	24.39	25.62	25.44	24.79	24.91	25.01	25.03
	8-12	25.35	25.41	24.79	25.66	24.73	25.37	25.22

Sweep		Fertility Subplot						
Bulk Density	Depth	1	2	3	4	5	6	Mean
	in	$g\ cm^{-3}$						
	0-4	1.26	1.22	1.20	1.23	1.18	1.17	1.21
	4-8	1.35	1.30	1.27	1.32	1.29	1.31	1.31
	8-12	1.17	1.21	1.14	1.14	1.17	1.16	1.17
Soil Moisture	Depth	1	2	3	4	5	6	Mean
	in	%						
	0-4	21.29	24.35	22.43	22.58	26.49	25.01	23.69
	4-8	26.16	25.09	25.06	24.71	25.54	25.06	25.27
	8-12	27.87	27.09	26.64	26.52	26.65	28.28	27.18

† See Appendix C for N history of fertility subplots