Farming Soils, Not Fields: Varying Fertilizer and Cultivars Within Fields to Increase Profitability and Enhance Environmental Quality
by PATRICK M CARR

A thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Crop and Soil Science
Montana State University

Abstract:
Fertilizer and other inputs are traditionally applied uniformly within a field. However, most fields contain two or more soils with different crop yield potentials. This study was conducted to 1) measure crop yield differences between contrasting soils within fields, and 2) compare the economics of Farming Soils, Not Fields, where contrasting soils in a field receive different versus uniform rates and formulations of fertilizer. Relative amounts of straw production and straw:grain ratios on contrasting soils were also compared, as was grain yield, test weight, and protein of spring wheat and spring barley cultivars.

Grain yield, test weight, and returns over variable costs varied greatly among soil units within fields in crop yield variability studies ($P < .05$). Other soil fertility studies indicated that returns were \$4 to \$23 per hectare greater for the soil treatment than for the field treatment in 5 of 6 fields, but overall, the returns were not significantly different. However, a recommended fertilizer treatment was not always the optimum treatment. In three fields, additional returns of \$54 to \$79 per hectare resulted when optimum soil treatments were applied rather than the field treatment. The data reveal the importance of appropriate crop yield goals, accurate soil tests, and reliable fertilizer recommendations when developing a strategy for generating greater returns by Farming Soils, Not Fields, than applying a uniform rate and formulation of fertilizer in a field.

Soils produced varying amounts of straw within many fields in crop residue studies, and straw:grain ratios also differed among soils. Soils influenced straw production of different spring wheat and spring barley cultivars, as well as grain yield, test weight, and protein.

A draft procedure for varying inputs within fields is presented. This procedure could be applied commercially, after some modification.

# FARMING SOILS, NOT FIELDS: VARYING FERTILIZER AND CULTIVARS WITHIN FIELDS TO INCREASE PROFITABILITY AND ENHANCE ENVIRONMENTAL QUALITY

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Patrick Martin Carr

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# APPROVAL

of a thesis submitted by

Patrick M. Carr

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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# ABSTRACT

Fertilizer and other inputs are traditionally applied uniformly within a field. However, most fields contain two or more soils with different crop yield potentials. This study was conducted to 1) measure crop yield differences between contrasting soils within fields, and 2) compare the economics of Farming Soils, Not Fields, where contrasting soils in a field receive different versus uniform rates and formulations of fertilizer. Relative amounts of straw production and straw:grain ratios on contrasting soils were also compared, as was grain yield, test weight, and protein of spring wheat and spring barley cultivars.

Grain yield, test weight, and returns over variable costs varied greatly among soil units within fields in crop yield variability studies ($P < .05$). Other soil fertility studies indicated that returns were \$4 to \$23 per hectare greater for the soil treatment than for the field treatment in 5 of 6 fields, but overall, the returns were not significantly different. However, a recommended fertilizer treatment was not always the optimum treatment. In three fields, additional returns of \$54 to \$79 per hectare resulted when optimum soil treatments were applied rather than the field treatment. The data reveal the importance of appropriate crop yield goals, accurate soil tests, and reliable fertilizer recommendations when developing a strategy for generating greater returns by Farming Soils, Not Fields, than applying a uniform rate and formulation of fertilizer in a field.

Soils produced varying amounts of straw within many fields in crop residue studies, and straw:grain ratios also differed among soils. Soils influenced straw production of different spring wheat and spring barley cultivars, as well as grain yield, test weight, and protein.

A draft procedure for varying inputs within fields is presented. This procedure could be applied commercially, after some modification.

# INTRODUCTION

Margins of profit have declined for many farming operations over the past decade. The decline is partially due to general reductions in commodity prices that have occurred since the early 1980's (Runge, 1986). Reductions in profits have also occurred because of increased costs of fertilizer, herbicide, and other inputs (Hargrove et al., 1988). Reduced prices and increased costs have forced many farmers out of business.

Growers in the U.S. have lost market share since the mid 1970's, largely because foreign growers can produce crops at lower cost and, thus, sell these agricultural commodities at lower prices than U.S. growers. For example, wheat was produced in Argentina at half the cost incurred in growing wheat in the U.S. during 1986 (Table 1). Fewer inputs were used by producers in other major wheat-exporting countries as well.

Large production capabilities ensure that the U.S. will continue to dominate world grain markets, but competitors will make inroads into markets traditionally controlled by the U.S. (Anonymous, 1986). For example, the U.S. forfeited 17% of its market share in the world wheat market between 1981 and 1985. This trend could

Table 1. Production costs of selected wheat exporting countries in 1986.[1]

| | Argentina | South Africa | U.S. | Australia |
|---|---|---|---|---|
| | mg ha$^{-1}$ | | | |
| Yield | 1.81 | 1.48 | 2.22 | 1.54 |
| | mg ha$^{-1}$ | | | |
| TVC[2] | 17.12 | 31.55 | 27.53 | 17.12 |
| TFC | 16.37 | 23.07 | 36.91 | 31.26 |
| TC | 33.49 | 54.62 | 64.44 | 48.38 |

[1] Ortmann et al. (1987)

[2] TVC, total variable costs; TFC, total fixed costs; TC, total costs.

continue, unless the U.S. is willing to accept lower returns from wheat exports.

American agriculturalists are productive, but inputs must be used more efficiently for U.S. farmers to be competitive in world markets (Jolliff and Snapp, 1988). Current cropping systems need to be modified, and new systems adopted, if the U.S. farm industry is to retain or gain a significant share of the market. Current yield levels should be maintained but at lower input costs.

New cropping systems need to be more profitable and environmentally sensitive than current systems to enhance the sustainability of U.S. agriculture. A sustainable system provides basic food or fiber needs, is profitable for the grower, and enhances environmental quality (Anonymous, 1989). Components of any sustainable cropping system include crop rotation, cultivar selection, fertility, pest management, and tillage strategies (Francis et al., 1987).

Farming Soils, Not Fields is a strategy for managing soils differently within a given field according to each soil's potential. This strategy might reduce costs, increase profit margins, and improve the quality of soil and water resources. The economic and environmental consequences of Farming Soils, Not Fields, suggest that this cropping system will become an integral part of sustainable cropping systems in the future.

## The Concept: Farming Soils, Not Fields

Large differences in yield occur within many fields. This yield variation often corresponds to differences in the capabilities of contrasting soils to supply water and nutrients to plants. Farming Soils, Not Fields is a system in which inputs are tailored to individual soils within a field. For example, different fertilizer rates and formulations are applied to each soil in a field, and cultivars are seeded according to soil type. Varying inputs by soil type might allow optimum management of each soil in a field, in contrast to applying inputs uniformly across different soils.

Efficient use of inputs occurs when inputs are varied in a field rather than applied uniformly. For example, optimum levels of P and K fertilizers were applied throughout an irrigated potato field when rates and formulations were varied by soil type (Hammond et al., 1988). Excess fertilizer would have been applied to half the field if a uniform rate and formulation were used. Fertilizer applications at levels in excess of plant needs can lead to groundwater pollution (Bidwell, 1986); avoiding excess fertilizer applications by Farming Soils, Not Fields can reduce the likelihood of groundwater contamination from agricultural chemicals.

Commercial applicators which vary fertilizer rates and formulations by soil type are being used in farming operations (Reichenberger and Russnogle, 1989). Some units can also spread fertilizer impregnated with herbicides. Similar systems are being developed for selective placement of herbicides (Russnogle, 1989).

The goal of this project was to determine if additional economic returns could result by varying fertilizer and cultivars in some fields according to soil patterns versus applying these inputs uniformly within a field. To answer this question, objectives of this study were to: 1) measure crop yield differences between contrasting soils in fields managed uniformly, and 2) compare the economics of Farming Soils, Not Fields, where fertilizer, cultivars, and fertilizer with cultivars, are varied according to soil differences, rather than applying these inputs uniformly within a field. Contrasting soils also produce varying amounts of straw within fields, so a further objective was to compare straw production and straw:grain ratios on contrasting soils in the same field. A final objective of this investigation was to determine if yield, grain protein and test weight of spring wheat and spring barley are related to soil characteristics.

# LITERATURE REVIEW

## Soil Variability and Fertility

Fertilizers are usually applied uniformly; that is, a single formulation and rate of fertilizer is applied throughout a field. However, many fields consist of two or more soils with different crop yield potentials and soil test levels requiring different fertilizer programs for most economical yields. Spratt and McIver (1972) found soils occupying five landscape positions at 15 locations responded differently to N and P fertilizer applications. Wheat yields ranged from 1152 kg $ha^{-1}$ to 1932 kg $ha^{-1}$ prior to the addition of fertilizer. Differences were generally not eliminated by fertilizer applications.

The soil fertility status of a field is often variable since many fields include several soils, each with different nutrient supplying capabilities (Ferguson and Gorby, 1966; Power et al., 1961; Rennie and Clayton, 1960). Schweitzer (1980) reported that differences in fertility levels between soils in some fields were the major cause of crop yield variability. Other researchers have suggested that fertility and other edaphic factors explained yield differences between soils in fields (Larson, 1986; Malo and Worcester, 1975).

Soil physical factors explain crop yield variation in many fields. Evans and Catt (1987) attributed yield variability to hydrologic and temperature differences. Results of several studies indicate that differences in available water largely explained yield variation between soils (Evans, 1972; Hannah et al., 1982; Yeh et al., 1986). These physical factors are related to fertilizer management since they can influence the crop yield goals which, together with soil test results, determine fertilizer recommendations.

## Soil Variability and Crop Cultivars

A single cultivar is usually planted on two or more contrasting soils that occur in a field, thereby ignoring edaphic heterogeneity. Alternatively, planting a different cultivar on each soil may improve cultivar performance and thereby provide greater economic returns.

Cultivars respond differently to environmental factors. In work with peanut (Arachis hypogaeal L.), Shorter and Norman (1983) reported that cultivars from different genetic origins had different yield responses at 10 locations. Environment X cultivar interactions have also been reported for several seed quality parameters in winter wheat (Triticum aestivum L.) (Peterson et al., 1986; Baenziger et al., 1985). The data suggest that one cultivar may be more productive than another cultivar in some environments.

Soil variation explained environment X cultivar interactions for several varieties of wheat and barley (Hordeum spp. L.) grown in Kansas (Liang et al., 1966). Edaphic differences, along with precipitation and temperature variation, were important factors determining relative performance of different cultivars.

Soil variability can have a greater impact on crop yield and quality than other factors that influence crop production. For example, sugar beet yield was influenced more by soil type than by differences in cultivation, fertilizer, and cultivar (Deleenheer and Simon, 1950). Yield and quality of wheat were related to soil type in fields under uniform management (Lee and Spillane, 1970). However, relative productivity of soils was influenced by the cultivar grown, which complicated assessment of soil differences on wheat yield and quality. Ciha (1984) reported that both cultivar and soil type influenced yield components of winter wheat, but only cultivar significantly influenced test weight. The data indicate that both cultivar and soil type must be considered for production of optimum crop quality and yield in fields containing contrasting soils.

Planting different crops in parts of the same field may result in greater economic returns than planting one crop in fields containing several soils. Jones and others (1987) suggested that different crops should be planted on contrasting landscape positions in a field to maximize returns over variable costs. This might create problems with field management and harvesting. An alternative is to plant different cultivars on contrasting soils in a field.

Commercial application units are currently operated which vary fertilizer rates and formulations within a field. Fertilizer is applied in a field according to yield goals and soil nutrient status of the various soils. Planting several cultivars in a field might be possible using similar technology.

## Soil Variability and Crop Residue

Wind erosion is a serious problem on much of the cropland in the Northern Great Plains, where over one billion megagrams of topsoil were removed by wind during 1982 (USDA-SCS, 1987). Without implementing several conservation practices, soil loss was expected to continue at this level. Wind erosion results in the removal of the most fertile portion of the soil, thereby lowering soil productivity (Lyles, 1975). Blowing soil particles can also damage seedlings and lower the marketability of many crops. Uncontrolled wind erosion reduces productivity to a point where cropland can neither be managed nor restored economically, and much is abandoned.

Establishing and maintaining a vegetative cover, whether living or nonliving, helps protect cropland from wind erosion. Wheat straw, for example, absorbs much of the shear stress that is applied to bare, unprotected soil by wind (Troeh et al., 1980). Straw on the surface also forms barriers, preventing soil creep and saltation (Hayes and Fenster, 1983). Soil losses can be minimized when sufficient amounts of straw are produced on formerly bare soils, as indicated from field studies in Montana (Krall et al., 1958).

Field samples can be collected to measure amounts of straw produced in fields (Whitfield et al., 1962). However, field collection is both labor and time intensive, and impractical for inventory of large areas (Aase and Siddoway, 1981). Estimates of straw production can be made on the basis of grain yields, if a constant straw:grain ratio is assumed.

Several straw:grain ratios have been determined for spring wheat from field data. Bauer and Zubriski (1978) reported an average straw:grain ratio of 1.91 for several spring wheat cultivars, with a range of 0.72 to 4.71. Deviation from the average value decreased as yield levels increased. A straw:grain ratio of 1.7 was indicated by data collected over 8 years in Nebraska (Fenster and McCalla, 1970), whereas Black et al. (1974) suggested a ratio of 1.3. Although the data indicate a considerable range in the straw:grain ratio for spring wheat, for conservation planning purposes, the Soil Conservation Service (SCS) assumes a constant straw:grain ratio of 1.6 in Montana (Nadwornick, 1989, personal communication).

Management practices influence the straw:grain ratio of small grain crops. For example, average ratios of 1.6 and 3.8 were determined for irrigated and nonirrigated wheat cultivars, respectively, in North Dakota field studies (Frank et al, 1977). Tillage operations also affect the straw:grain ratio, with a narrower range among cultivars in stubble-mulch than clean-fallow fields (Tucker et al., 1971; Zing et al., 1955, 1957). Reitz (1976) suggested that fertility and planting date influenced the straw:grain ratio.

It is unclear what influence soil type has on the straw:grain ratio of spring barley and spring wheat, even though fertility and other factors vary between many soils (Beckett and Webster, 1971). Since most fields are comprised of two or more contrasting soils, edaphic influences on the straw:grain ratio would result in overestimating residue production on some soils and underestimating on others if a constant straw:grain ratio is assumed.

# MATERIALS AND METHODS

## Soil Variability and Fertility

### Yield Variability Study

Three locations in central Montana were selected to represent important dryland wheat-(*Triticum aestivum* L.) and barley-(*Hordeum vulgare* L.) producing regions of the state (Figure 1). During 1987, four fields containing at least two distinct soils were identified at these locations. Soil unit boundaries were first delineated using a soil survey report. Color-infrared aerial photographs or satellite images were subsequently used to modify boundaries. Producer knowledge of the field was incorporated to develop an operational soil unit management map. Soil Conservation (SCS) personnel and the researchers evaluated the maps in the field to ensure accurate delineation of the map units. The entire field was tilled and planted to barley or wheat by the farmer.

Grain samples were collected using a research combine from 10 $m^2$ areas along transects approximately 500-m long which crossed soil units in each field. An average of 20 samples were collected from each soil unit. Test weight and yield were determined for each sample. Returns over

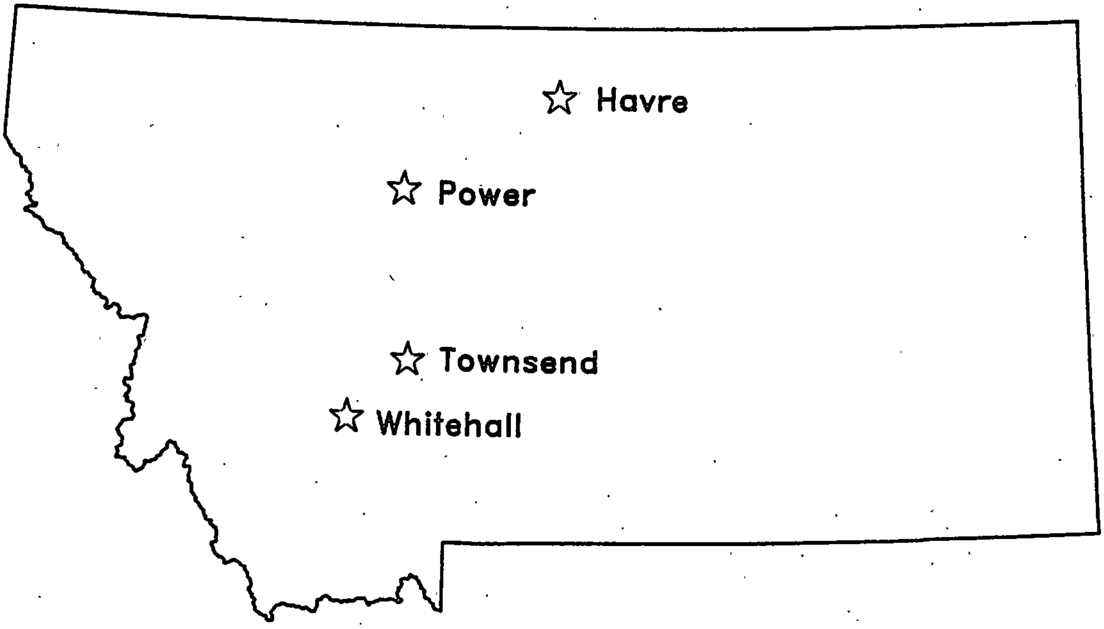

Figure 1. Location of study sites.

variable costs (returns) were calculated by subtracting actual production cost in each field from the price of the grain, which during 1987 was \$0.08 $kg^{-1}$ for feed barley and \$0.10 $kg^{-1}$ for spring wheat at 14% grain protein, respectively. Data were subjected to a one-way analysis of variance with soil map unit as the independent variable.

Soil Fertility Studies

Soil fertility studies were conducted in three fields during 1987 and 1988 (Table 2). Each field contained at least two different soils. Twenty soil samples were collected and mixed from each soil unit at 0 to 15 cm, 15 to 30 cm, 30 to 60 cm and 60 to 90 cm depths except at Whitehall (1987), where samples were collected at 0 to 15 cm and 15 to 60 cm depths. The 0 to 15 cm composite sample was analyzed for organic matter, using a modified Walkley-Black technique (Walkley and Black, 1934), $NO_3$-N by cadmium reduction (Henrikson and Selner-Olsen, 1970), $NH_4OAc$-extractable K (Knudsen et al., 1982), and $NaHCO_3$-extractable P (Olsen and Sommers, 1982). A 1:2 soil:water slurry was used to determine pH and electrical conductivity (USDA, 1954). Composite samples for other depths were analyzed for $NO_3$-N. Field average soil test values were determined by combining and mixing corresponding depth samples from all soil units. Soil test results show that the soil units in each field are different in one or more properties.

Fertilizer recommendations were made for each soil unit, based on soil test results, yield goals and Montana State University fertilizer guidelines (Bauder et al., 1986). Yield goals for soil units were initially based on SCS estimates for soil series and were then modified, based upon historical field records and grower experience. The fertilizer treatment for the field was based on soil test results for the whole field, fertilizer guidelines and a yield goal established from crop yield records for

Table 2. Soil fertility test results for soil units in six Montana fields.

| Year | Location | Soil unit[1] | $NO_3$-N[2] | P | K |
|---|---|---|---|---|---|
| | | | kg $ha^{-1}$ | --- ppm | --- |
| 1987 | Havre | Evanston | 25 | 15 | 390 |
| | | Phillips | 50 | 17 | 350 |
| | | Telstad | 40 | 13 | 260 |
| 1987 | Power | Cabbart | 60 | 13 | 470 |
| | | Delpoint | 105 | 14 | 420 |
| 1987 | Whitehall | Ethridge | 10 | 8 | 410 |
| | | Varney | 24 | 10 | 480 |
| | | Yawdim | 10 | 25 | 510 |
| | | Yetull | 20 | 10 | 460 |
| 1988 | Havre | Gerdrum | 130 | 30 | 620 |
| | | Joplin | 40 | 10 | 260 |
| | | Phillips | 40 | 15 | 360 |
| | | Telstad | 45 | 10 | 295 |
| 1988 | Townsend | Amesha | 80 | 8 | 300 |
| | | Brocko | 50 | 16 | 240 |
| 1988 | Whitehall | Ethridge | 30 | 30 | 330 |
| | | Varney | 15 | 20 | 380 |
| | | Walbert | 30 | 20 | 360 |

[1] Soil unit names are based upon predominant soil series.

[2] Soil test results for N were for 0 to 60 cm depths at Whitehall (1987) and 0 to 90 cm depths at other locations; soil test results for P and K were for 0 to 15 cm depths at all locations.

the field (Table 3). A different fertilizer treatment was recommended and applied for each soil unit and field except at Power and Havre (1987), where an approximation of the recommended treatment was applied along with 14 additional fertilizer treatments above and below each recommended nutrient rate.

Table 3. Yield goals and recommended fertilizer programs for soil management units in six Montana fields.

| Year | Location[1] | Soil unit and field | Crop[2] | Yield goal | Recommended rate N | P | K |
|---|---|---|---|---|---|---|---|
| | | | | ----- kg ha$^{-1}$ ------ | | | |
| 1987 | Havre | Evanston | sw | 3020 | 78 | 10 | 30 |
| | | Phillips | sw | 2350 | 36 | 0 | 0 |
| | | Telstad | sw | 2690 | 37 | 10 | 30 |
| | | Field | sw | 2690 | 37 | 10 | 30 |
| 1987 | Power | Cabbart | ww | 2350 | 47 | 10 | 0 |
| | | Delpoint | ww | 3360 | 63 | 10 | 0 |
| | | Field | ww | 3025 | 63 | 10 | 0 |
| 1987 | Whitehall | Ethridge | sw | 2960 | 140 | 19 | 0 |
| | | Varney | sw | 2350 | 66 | 7 | 0 |
| | | Yawdim | sw | 1075 | 45 | 9 | 0 |
| | | Yetull | sw | 1275 | 25 | 17 | 0 |
| | | Field | sw | 1950 | 51 | 12 | 0 |
| 1988 | Havre | Gerdrum | sw | 3360 | 56 | 11 | 0 |
| | | Joplin | sw | 2015 | 28 | 11 | 0 |
| | | Phillips | sw | 1680 | 11 | 11 | 0 |
| | | Telstad | sw | 2690 | 45 | 11 | 0 |
| | | Field | sw | 2350 | 15 | 11 | 0 |
| 1988 | Townsend | Amesha | sb | 2150 | 0 | 36 | 0 |
| | | Brocko | sb | 2420 | 8 | 11 | 34 |
| | | Field | sb | 2150 | 0 | 0 | 0 |
| 1988 | Whitehall | Ethridge | sw | 3025 | 134 | 0 | 0 |
| | | Varney | sw | 2690 | 121 | 0 | 0 |
| | | Walbert | sw | 2150 | 74 | 0 | 0 |
| | | Field | sw | 2690 | 111 | 0 | 0 |

[1] At Havre and Power, one of 15 established fertilizer rate combinations was used as the recommended rate based upon soil test results and yield goals.

[2] sw, spring wheat; ww, winter wheat; sb, spring barley.

Fertilizer was applied using a research drill at Havre (1987) and Power, a commercial no-till drill at

Whitehall and Townsend, and a commercial air seeder at Havre (1988). Nitrogen was applied as $NH_4NO_3$ (34-0-0) at all sites except Havre (1988), where N was applied as $NH_4H_2PO_4$ (11-55-0) prior to seeding and $CO(NH_2)_2$ (46-0-0) as a topdress at seeding. Potassium was applied as KCl (0-0-60) at all sites. Phosphorus was applied as $H_3PO_4$ (0-54-0) at Power and Havre (1987), as $NH_4H_2PO_4$ at Havre (1988), and as $Ca(H_2PO_4)_2$ (0-45-0) at other locations. Fertilizer treatments were applied in a randomized complete block design with four replications except at Whitehall (1987) where the treatments were applied in 12-m x 600-m strips, and at Havre (1988) where 12-m x 1600-m strips crossed soil units.

During 1987, 'Newana' spring wheat was seeded at Havre and 'Bronze Chief' at Whitehall. 'Norwin' winter wheat was seeded in the fall of 1986 at Power. During 1988, 'Piroline' spring barley was seeded at Townsend and 'Newana' spring wheat at Whitehall. Four spring wheat cultivars, 'Cutless', 'Lew', 'Glenman' and 'Rambo' were seeded across each fertilizer treatment at Havre. Local practices were used in seedbed preparation and weed control.

Plots at Havre (1987), Power, Townsend, and Whitehall (1988) were harvested using a research combine. Harvested plot size was 7.5 $m^2$ at Power and Havre, and 15 $m^2$ at

Townsend and Whitehall. Four 37 $m^2$ samples were harvested at Whitehall (1987) from each plot. Twelve 9 $m^2$ samples were harvested at Havre (1988) from each soil unit X fertilizer treatment (3 samples per cultivar, with 4 cultivars per soil unit). Reported data are averaged across cultivars.

Test weight and yield were determined for each sample. Percent grain protein was determined for all wheat samples using a near-infrared analyzer at the Cereal Quality Laboratory at Montana State University. Percent grain protein of barley was not determined since the crop was sold as feed and protein did not influence the price. Returns were calculated by subtracting fertilizer and application costs from gross return based on current grain prices, taking percent grain protein into account for wheat.

Average price paid for N, P, and K fertilizer was \$0.55 $kg^{-1}$, \$0.97 $kg^{-1}$, and \$0.35 $kg^{-1}$, respectively, during 1987 and \$0.55 $kg^{-1}$, \$1.37 $kg^{-1}$, and \$0.31 $kg^{-1}$ during 1988. Average price received for spring wheat was \$0.10 $kg^{-1}$ at 14 percent grain protein during 1987, with an additional \$0.002 $kg^{-1}$ received each quarter percent up and minus \$0.004 $kg^{-1}$ each quarter down from 14 percent to 13.5 percent, where \$0.09 $kg^{-1}$ was received. Average price received for winter wheat was \$0.10 $kg^{-1}$ at 11 percent grain protein during 1987, with an additional \$0.0004 $kg^{-1}$ received each quarter percent up and down from 11 percent. During 1988, \$0.16 $kg^{-1}$ was received for spring wheat at 14 percent grain protein, with an additional \$0.0004 $kg^{-1}$ received each half percent up and minus \$0.0007 $kg^{-1}$ each quarter percent down from 14 percent to 12.5 percent, where \$0.15 $kg^{-1}$ was paid. Average price received for spring barley was \$0.08 $kg^{-1}$.

Data were subjected to analysis of variance using soil units and fertilizer treatments as independent variables except at Havre (1988), where cultivars were also treated as an independent variable. In fields where treatments were applied in a randomized complete block design, each soil map unit was also evaluated as a location with fertilizer treatment as the independent variable. A procedure described by Cochran and Cox (1957) was used to determine error terms in cases where variances with soils as locations were heterogenous.

## Soil Variability and Crop Cultivar

### Crop X Soil Studies, 1987

The study site included three contrasting soils in a 130 hectare field near Havre. Soil map boundaries were first delineated using a soil survey report, and modified using color-infrared aerial photographs. Producer knowledge of the field was incorporated to develop an operational soil unit management map.

Twelve spring wheat cultivars ('Copper', 'Cutless', 'Fortuna, 'Glenman', 'Lew', 'MT 751', 'MT 7926', 'Newana', 'NK 751', 'Pondera', 'Success', and 'Wheaton') and twelve spring barley cultivars ('Bowman', 'Clark', 'Gallatin', 'Harrington', 'Hazen', 'Hector', 'Kimberly', 'Lewis', 'MT 81161', 'MT 81616', 'Piroline', and 'Steptoe') were each established in 5 $m^2$ field plots on each soil unit. Field plots were arranged in a randomized complete block design with four replications on each soil unit.

Fertilizer was applied using a commercial drill at a rate of 63 kg of N $ha^{-1}$ as $CO(NH_2)_2$ prior to final seedbed preparation, with an additional 15 kg of N $ha^{-1}$ and 17 kg of P $ha^{-1}$ as $(NH_4)_3PO_4$ applied at planting. Fertilizer rates were based on both soil test results and a yield goal established for the whole field from historical records. Local practices were used for pest control.

Grain from 4.5 $m^2$ areas was harvested from each plot using a research combine. Grain yield, test weight and protein were determined. Returns over variable costs (returns) were calculated by subtracting fertilizer and application costs from gross return based on current grain prices. Percent grain protein was taken into account for wheat, but was not for barley, since it was sold for livestock feed.

Data were subjected to analysis of variance using cultivars as the independent variable and grain yield, protein and test weight as dependent variables with each soil unit as a location. The whole field was also analyzed as a location, with soil units and cultivars as independent variables. The error term with the field as a location was determined from the pooled sums of squares with soil units as the independent variable.

### Cultivar X Fertilizer X Soil Unit, 1987

Field plots of four spring wheat cultivars ('Fortuna', 'Glenman', 'Lew', and 'Newana') were established on the Evanston loam, Phillips clay loam, and Telstad loam in the field near Havre previously described. Nitrogen was applied at planting to the plots (13 $m^2$ each) as $NH_4NO_3$ at 0%, 75%, 100%, or 125% of the recommended rate based on soil tests and yield goals for each soil unit. Recommended rates of N were 63, 36, and 50 kg $ha^{-1}$ for Evanston, Phillips-Kevin, and Telstad-Joplin soil units, respectively. Phosphorus (P) was applied to all plots at a rate of 10 kg $ha^{-1}$ as $H_3PO_4$ and K at a rate of 30 kg $ha^{-1}$ as KCl. The cultivar X fertilizer plots were arranged in a randomized complete block design with four replications on each soil unit.

Grain was harvested from 8.5 $m^2$ areas in each plot; grain yield, test weight, protein and returns were determined as previously described. Cultivar and fertilizer were both treated as independent variables when soil units were treated as locations during statistical analysis.

### Cultivar X Fertilizer X Soil Unit, 1988

Four spring wheat cultivars ('Cutless', 'Glenman', 'Lew', and 'Rambo') were planted in 2 m x 1600 m strips that crossed four soil units in a field. Nitrogen fertilizer was applied in 12 m x 1600 m strips as $CO(NH_2)_2$ in the fall at rates of 4, 7, 20, 37, 50, and 60 kg $ha^{-1}$. An additional 7 kg $ha^{-1}$ was applied at planting, along with 15 kg $ha^{-1}$ P as $(NH_4)_3PO_4$ and 19 kg $ha^{-1}$ K as KCl. Fertilizer was applied so that strips of all four cultivars occurred within each N fertilizer strip. A check strip (no fertilizer) was included as a treatment.

Three 8.5 $m^2$ samples were harvested using a research combine from each cultivar X fertilizer strip on each soil unit. Mean values for each cultivar X fertilizer treatment were used for statistical analysis. The soil unit X fertilizer treatment interaction was the error term for soil units and fertilizer treatments, and the soil unit X fertilizer X cultivar treatment was the error term for other variables and interactions.

## Soil Variability and Crop Residue

### Soil X Cultivar Studies, 1987

Plants were clipped at 13 cm above the soil surface from 8.5 $m^2$ areas in the Crop X Soil Studies plots using a research combine. Grain and straw were separated by the combine; grain was stored in a hopper and then collected in small plot sample bags. Straw was caught and collected on tarps as it was thrown from the rear of the combine. Grain and straw weights were determined, as was a straw:grain ratio, for each sample. Weight of the 13 cm of straw remaining in the plots was not measured, but based on its relation to total plant height, was estimated to weigh 15 percent of the weight of the straw which was collected.

Data were subjected to analysis of variance using cultivars as the independent variable and grain yield, straw yield, and the straw:grain ratio as dependent variables, with each soil unit as a location. The whole field was also analyzed as a location, with soil units and cultivars as independent variables. The error term with the field as a location was determined from the pooled sums of squares with soil units as the independent variable.

## Soil X Fertilizer Studies, 1988

Plants were clipped at the surface from one 1 $m^2$ area from each plot in Soil Fertility Studies at Townsend and Whitehall using methods reported by Whitfield et al. (1962). Samples were dried at 60° C until a constant weight was measured. A research combine was used to separate grain from straw. Grain was collected and weighed; straw weight was determined by subtracting the weight of the grain from the initial weight of the dried sample. Data were subjected to analysis of variance using soil units and fertilizer treatments as independent variables. Soil units were also evaluated as locations with fertilizer treatments as the independent variable.

## Soil X Fertilizer X Cultivar Studies, 1988

Three 1 $m^2$ samples were collected from each Soil X Fertilizer X Cultivar strip in the field at Havre. Grain and straw weights were determined, as already described. Analysis of variance was conducted on the mean values of each cultivar X fertilizer treatment using soil unit, fertilizer, and cultivar as independent variables. The soil unit X fertilizer interaction was the error term for soil units and fertilizer treatments, and the soil unit X cultivar X fertilizer interaction was the error term for other variables and interactions.

# RESULTS AND DISCUSSION

## Soil Variability and Fertility

### Yield Variability Study

High yielding soil units produced over twice as much grain as low yielding units (Table 4). Returns were negative on low-yielding soil units in each field. Conversely, positive returns of \$49 $ha^{-1}$ to \$240 $ha^{-1}$ were generated on the high-yielding soil units except at Power, where grasshopper damage was severe. The data suggest that overall returns would have been improved by taking low yielding soil units out of production during 1987. Soil units at every location produced significantly different ($P < .05$) grain yield and returns.

### Soil Fertility Studies

Soil units differed in grain yield and in returns over variable costs except at Whitehall (1987) (Table 5). An average yield difference of 1650 kg $ha^{-1}$ occurred between low-yielding and high-yielding soil units in the same field; returns varied an average of \$133 $ha^{-1}$. Fewer grain samples were collected from soil units at Whitehall (1987) than in other fields and may explain lack of significant differences in grain yields between the soils.

Table 4. Yield, test weight, and returns over variable costs of grain harvested on soil units in four Montana fields during 1987.

| Location | Crop[1] | Soil unit | Yield | Test Weight | Returns[2] |
|---|---|---|---|---|---|
| | | | kg ha$^{-1}$ | kg m$^{-3}$ | \$ ha$^{-1}$ |
| Havre (a) | b-r | Kevin | 1540 a[3] | 680 a | -16.80 a |
| | | Evanston | 3910 c | 670 b | 165.70 c |
| | | Phillips | 2080 b | 680 a | 24.50 b |
| Havre (b) | b-f | Telstad | 1720 a | 690 a | -3.10 a |
| | | Gerdrum | 4870 c | 700 b | 240.20 c |
| | | Phillips | 2430 b | 700 b | 51.50 b |
| Power | b-r | Abor | 1130 a | 660 a | -49.00 a |
| | | Cargill | 880 b | 650 b | -68.10 b |
| Whitehall | sw-r | Ethridge | 1810 a | 770 a | -2.30 b |
| | | Varney | 2320 b | 790 b | 49.30 c |
| | | Yetull | 1470 a | 760 a | -39.20 a |

[1] b-r, barley-recrop; b-f, barley-fallow; sw-r, spring wheat-recrop.

[2] Returns, returns over variable costs.

[3] Values followed by the same letter in columns representing a location do not differ significantly at the 5% level of probability, respectively, according to Student's t test, except at Power ($P < .10$).

Percent protein and test weight varied between soil units in all fields except at Townsend ($P < .05$). Drought evidently affected grain quality at this location.

Average returns were greater for soil unit treatments compared to field treatments in 5 of the 6 fields studied (Table 6). The soil unit treatment increased spring wheat yield an average of 71 kg ha$^{-1}$ compared to the field treatment; an average increase of

Table 5. Yield, test weight, protein and returns over variable costs of grain produced on soil units in six Montana fields.

| | | | Grain | | | |
|---|---|---|---|---|---|---|
| Year | Field | Soil unit | Yield | Test Weight | Protein | Returns[1] |
| | | | kg ha$^{-1}$ | kg m$^{-3}$ | g kg$^{-1}$ | \$ ha$^{-1}$ |
| 1987 | Havre | Evanston | 2470 a[2] | 790 a | 137 a | 186.00 a |
| | | Phillips | 2870 c | 770 b | 134 b | 229.10 b |
| | | Telstad | 2630 b | 770 b | 131 c | 196.20 a |
| 1987 | Power | Cabbart | 2330 a | 790 a | 132 a | 196.20 a |
| | | Delpoint | 3390 b | 820 b | 127 b | 292.40 b |
| 1987 | Whitehall | Ethridge | 1940 a | 770 ab | 134 a | 144.60 a |
| | | Varney | 2010 a | 800 b | 116 b | 137.40 a |
| | | Yawdim | 1740 a | 790 b | 123 b | 118.40 a |
| | | Yetull | 1830 a | 750 a | 135 a | 131.90 a |
| 1988 | Havre | Gerdrum | 2130 a | 810 a | 167 a | 296.60 a |
| | | Joplin | 1130 b | 800 c | 168 a | 138.20 b |
| | | Phillips | 930 b | 805 b | 173 b | 106.90 b |
| | | Telstad | 1000 b | 800 c | 172 b | 118.40 b |
| 1988 | Townsend[3] | Amesha | 1890 a | 670 a | [4] | 191.60 a |
| | | Brocko | 2110 a | 680 a | [4] | 214.90 a |
| 1988 | Whitehall | Ethridge | 140 a | [5] | 185 b | -26.50 a |
| | | Varney | 400 c | [5] | 181 b | 15.00 c |
| | | Walbert | 240 b | [5] | 171 a | -10.90 b |

[1] Returns, returns over variable costs.

[2] Values followed by the same letter in columns representing a location do not differ significantly at the 5% level of probability, according to Student's t test.

[3] Soil units differed in yield, test weight, protein, and returns at the 10% level of significance.

[4] Grain in this field was sold as feed, so protein was not determined since it did not influence price.

[5] Not available due to drought.

Table 6. Returns over variable costs resulting from recommended, average and optimum fertilizer treatments on soil units in four Montana fields.

| | | Fertilizer treatment | | | |
|---|---|---|---|---|---|
| Field (year) | Soil unit | Check | Field | Soil Unit | Optimum[1] |
| | | $ ha$^{-1}$ | | | |
| Havre (1987) | Evanston | 174.75 a[2] | 155.74 a | 160.79 a | 234.30 a |
| | Phillips | 224.39 a | 165.41 b | 165.41 b | 233.45 b |
| | Telstad | 240.13 ab | 210.26 a | 229.63 ab | 272.80 b |
| | Mean | 213.09 ab | 177.14 a | 185.77 a | 246.85 b |
| Power (1987) | Cabbart | 193.80 a | 202.84 ab | 211.69 b | 211.69 b |
| | Delpoint | 260.94 a | 324.19 b | 324.19 b | 324.19 b |
| | Mean | 227.37 a | 263.51 a | 267.94 a | 267.94 a |
| Whitehall (1987) | Ethridge | 95.97 | 166.10 | 247.84 | 247.84 |
| | Varney | 68.97 | 162.71 | 201.86 | 201.86 |
| | Yawdim | 81.81 | 128.64 | 114.93 | 178.88 |
| | Yetull | 100.67 | 163.43 | 81.91 | 185.18 |
| | Mean | 86.85 a | 155.22 ab | 161.63 ab | 203.44 b |
| Havre (1988) | Gerdrum | 311.10 | 245.20 | 334.82 | 428.97 |
| | Joplin | 157.40 | 132.67 | 133.93 | 166.20 |
| | Phillips | 191.72 | 113.27 | 102.20 | 191.72 |
| | Telstad | 148.38 | 117.64 | 129.31 | 148.38 |
| | Mean | 202.14 ab | 152.19 c | 175.06 bc | 233.82 a |
| Townsend (1988) | Amesha | 213.82 a | 213.82 a | 180.75 b | 213.82 a |
| | Brocko | 229.46 a | 229.46 a | 216.31 a | 229.46 a |
| | Mean | 221.64 a | 221.64 a | 198.53 b | 221.64 a |
| Whitehall (1988) | Ethridge | 18.31 a | -41.17 b | -53.08 b | 18.31 a |
| | Varney | 33.23 a | -7.54 b | 19.40 a | 33.23 a |
| | Walbert | 34.31 a | -30.89 b | 1.41 ab | 34.82 a |
| | Mean | 28.78 a | -26.53 b | 10.76 ab | 28.79 a |

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[1] Highest returns over variable costs generated by field, soil unit or other fertilizer treatments (optimum) or the check (no fertilizer) on a soil unit.

[2] Values followed by the same letter in rows do not differ significantly at the 1% (***), 5% (**), and 10% (*) levels.

83 kg $ha^{-1}$ resulted with winter wheat. However, no significant differences were measured between the field and soil unit treatments except at Townsend, where greater returns were generated by the field treatment than the soil unit treatment ($P < .10$). Drought reduced the expected yield in this field, which may explain why the field treatment generated significantly larger returns than the soil unit treatment, and why the check (no fertilizer) generated higher returns than soil unit recommended fertilizer treatments in all fields during 1988.

Larger returns were usually produced by a fertilizer treatment (optimum) other than the treatment recommended for the soil unit or field (Table 6). Additional returns of \$70 $ha^{-1}$ and \$55 $ha^{-1}$ were generated from the optimum treatment compared to the field treatment in the fields at Havre (1987) and Whitehall (1988), respectively ($P < .01$). An additional \$80 $ha^{-1}$ resulted from the optimum fertilizer treatment versus the field treatment at Havre during 1988 ($P < .10$).

Yields from optimum treatments significantly ($P < .01$) exceeded yields from soil unit treatments at Havre and Whitehall during 1988. Lack of moisture during 1988 probably accounts for these differences. Fertilizer recommendations were based on yield goals appropriate for years with near normal precipitation, but drought resulted in low crop yields and less than anticipated fertilizer responses.

The optimum fertilizer treatment generated an additional \$61 $ha^{-1}$ compared to the soil unit treatment at Havre during 1987. Here the difference may have resulted from discrepancies between the yield goal for each soil which was used in developing the soil unit treatment (Table 3), and the actual crop yield in 1987 (Table 5). Actual yield was less than the estimated yield potential for two soils. The data indicate that appropriate yield goals for each soil are necessary to consistently produce greater returns from applying fertilizer by soil unit rather than by field.

The data suggest that Farming Soils, Not Fields can generate greater returns than applying a field-average fertilizer treatment in fields comprised of contrasting soils. However, varying inputs on contrasting soil units requires selection of appropriate crop yield goals for each soil unit in a field. Accurate soil tests and fertilizer recommendations are also needed. If these requirements can be met then varying fertilizer rates and formulations might be an alternative to conventional fertilizer strategies and a method to improve fertilizer profitability.

## Soil Variability and Crop Cultivar

### Crop X Soil Studies, 1987

Soil units produced different grain yields and returns over variable costs ($P < .01$) (Table 7). Larger yields and returns were produced on Evanston than on Telstad-Joplin soil units, regardless of crop. Returns on the Evanston and Phillips-Kevin soil units were similar for wheat, but an additional \$27 $ha^{-1}$ was produced when barley was grown on the Evanston soil unit ($P < .01$). The data indicate that differences in returns between soils can be influenced by the type of crop cultivated. Test weight and protein of barley and wheat varied between soil units ($P < .01$). The protein content of wheat was similar on Evanston and Phillips-Kevin soils.

Wheat cultivars differed in returns, ranging from \$114 $ha^{-1}$ with NK 751 to \$259 $ha^{-1}$ with Cutless ($P < .01$) (Table 8). Highest returns were not produced by the highest yielding cultivar, Glenman, but by a high yielding cultivar with the highest grain protein levels (Cutless). Test weight varied among cultivars, although it did not affect returns. The data indicate the importance of considering grain protein levels when making economic comparisons between spring wheat cultivars.

Table 7. Yield, test weight, protein and returns over variable costs of grain produced on three soil units, 1987.

| Crop[1] | Soil unit | Grain Yield | Grain Test Weight | Grain Protein | Grain Returns[2] |
|---|---|---|---|---|---|
| | | kg ha$^{-1}$ | kg m$^{-3}$ | g kg$^{-1}$ | \$ ha$^{-1}$ |
| sw | Evanston | 2710 a[3] | 810 a | 142.6 a | 225.00 a |
| | Phillips-Kevin | 2620 a | 800 b | 141.6 a | 214.80 a |
| | Telstad-Joplin | 2256 b | 760 c | 126.8 b | 154.30 b |
| sb | Evanston | 3145 a | 660 a | 133.4 a | 185.10 a |
| | Phillips-Kevin | 2799 b | 655 b | 127.3 b | 158.40 b |
| | Telstad-Joplin | 2660 b | 622 c | 116.6 c | 147.60 a |

[1] sw, spring wheat; sb, spring barley

[2] Returns, returns over variable costs.

[3] Values followed by the same letter in columns following each crop do not differ significantly at the 1% level of probability according to Student's t test.

Soil units affected the ranking of wheat cultivars based upon returns over variable costs ($P < .05$) (Table 9). Highest returns were produced by Cutless on Evanston and Phillips-Kevin soil units. Wheaton produced highest returns on the Telstad-Joplin soil unit. Differences in returns from Cutless and Wheaton resulted from grain protein content being similar on the Telstad-Joplin soil unit, but higher for Cutless on Evanston and Phillips-Kevin soil units (data not presented).

Returns of barley cultivars ranged from \$66 ha$^{-1}$ with Hazen to \$205 ha$^{-1}$ with Steptoe ($P < .01$) (Table 10). Steptoe produced the highest yield, but poorest quality

Table 8. Yield, test weight, protein and returns over variable costs of grain produced by twelve spring wheat cultivars.

| | Grain | | | |
|---|---|---|---|---|
| Cultivar | Yield | Test weight | Protein | Returns[1] |
| | kg ha$^{-1}$ | g m$^{-3}$ | g kg$^{-1}$ | \$ ha$^{-1}$ |
| Glenman | 3040 a[2] | 774.2 a | 125.2 ab | 220.00 b |
| MT 7926 | 2767 ab | 811.5 f | 126.8 bc | 200.90 bc |
| Wheaton | 2740 ab | 786.5 bc | 132.0 d | 203.40 bc |
| Cutless | 2731 abc | 787.2 bc | 153.8 h | 258.60 a |
| Copper | 2702 abcd | 793.3 bcde | 139.7 e | 220.70 b |
| Treasure | 2639 bcde | 790.1 bcd | 120.3 a | 185.00 c |
| Lew | 2628 bcde | 797.6 de | 131.9 d | 199.50 bc |
| Pondera | 2391 cdef | 794.5 cde | 145.2 fg | 198.20 bc |
| Newana | 2386 ef | 800.6 e | 146.2 fg | 201.80 bc |
| Fortuna | 2301 ef | 786.1 b | 149.2 gh | 198.10 bc |
| Success | 2208 f | 791.7 bcd | 143.0 ef | 177.60 c |
| NK 751 | 1814 g | 771.8 a | 130.8 cd | 114.30 d |
| S X C[3] | **[4] | NS | NS | ** |

[1] Returns, returns over variable costs.

[2] Values followed by the same letter do not differ significantly at the 1% level of probability according to Student's t test.

[3] S X C, soil X cultivar interaction.

[4] **, $P < .05$; NS, not significant.

grain, among barley cultivars ($P < .01$). However, since grain protein does not influence feed barley prices, Steptoe provided largest returns among the cultivars.

## Cultivar X Fertilizer X Soil Unit, 1987-1988

Soil units varied in yield, protein, test weight, and returns over variable costs during 1987 and 1988 ($P < .01$) (Table 11). Returns differed by \$45 ha$^{-1}$ between soil

Table 9. Returns over variable costs from twelve spring wheat cultivars on three soil units, 1987.

| | Soil unit | | |
|---|---|---|---|
| Cultivar | Evanston | Telstad-Joplin | Phillips-Kevin |
| | $ $ ha^{-1}$ | | |
| Cutless | 307.30 a[1] | 189.50 abc | 278.80 a |
| Newana | 243.30 ab | 136.40 cd | 225.70 abcd |
| Treasure | 242.70 ab | 125.70 de | 186.70 cd |
| Copper | 232.30 b | 176.40 abcd | 253.40 ab |
| Fortuna | 225.50 b | 140.30 bcd | 228.30 abcd |
| Glenman | 227.40 b | 194.50 ab | 244.00 abc |
| Lew | 228.60 b | 160.20 abcd | 209.60 bcd |
| Pondera | 217.70 b | 162.90 abcd | 214.00 bcd |
| Wheaton | 229.50 b | 200.60 a | 180.00 d |
| MT 7926 | 211.60 bc | 163.70 abcd | 227.40 abcd |
| Success | 200.10 bc | 122.80 de | 210.00 bcd |
| NK 751 | 145.50 c | 78.20 e | 119.10 e |

[1] Values followed by the same letter do not differ significantly at the 1% level of probability according to Student's t test.

units during 1987, corresponding to a yield difference of 352 kg $ha^{-1}$ between low-yielding and high-yielding soil units. The high-yielding soil unit produced nearly twice as much grain as other soil units during 1988, and returns ranged from \$107 $ha^{-1}$ to \$297 $ha^{-1}$ among soil units.

Returns over variable costs did not vary among the four cultivars used in the 1987 trial, although grain yield, test weight, and protein differed ($P < .01$) (Table 12). Glenman produced the highest grain yield, but low protein content, so returns did not differ significantly from other cultivars ($P = .80$). Fortuna and Newana produced high protein grain, but were low-yielding

Table 10. Yield, test weight, protein and returns over variable costs of grain produced by twelve spring barley cultivars.

| | Grain | | | |
|---|---|---|---|---|
| Cultivar | Yield kg $ha^{-1}$ | Test weight g $m^{-3}$ | Protein g $kg^{-1}$ | Returns[1] \$ $ha^{-1}$ |
| Steptoe | 3669 a[2] | 587.1 a | 110.1 a | 204.60 a |
| MT81616 | 3456 ab | 650.3 cde | 127.8 de | 203.50 ab |
| Clark | 3348 abc | 656.7 ef | 122.2 bc | 197.30 ab |
| Lewis | 3233 bc | 671.0 g | 123.9 bcd | 172.90 cde |
| MT81161 | 3146 bc | 645.0 cd | 118.8 b | 178.00 abc |
| Gallatin | 3076 c | 661.9 fg | 125.6 cd | 168.40 de |
| Harrington | 2982 cd | 642.5 c | 121.0 bc | 161.20 bcde |
| Bowman | 2654 de | 653.3 def | 131.3 ef | 148.80 cde |
| Hector | 2277 e | 667.2 g | 131.1 ef | 126.40 de |
| Kimberly | 2557 e | 656.6 ef | 136.0 fg | 147.40 cde |
| Piroline | 2415 e | 662.1 fg | 139.6 g | 125.70 e |
| Hazen | 1509 f | 600.8 b | 121.7 bc | 66.31 f |
| S X C[3] | NS[4] | * | * | NS |

[1] Returns, returns over variable costs.

[2] Values followed by the same letter in a column do not differ significantly at the 5% level of probability according to Student's t test.

[3] S X C, soil X cultivar interaction.

[4] NS, not significant; *, $P < .10$.

cultivars. Returns for all cultivars were roughly \$200 ha$^{-1}$, and soil X cultivar interactions for yield and returns were not significant, nor were cultivar X fertilizer and soil X fertilizer interactions significant.

Grain yield, test weight and protein varied among cultivars during 1988 ($P < .01$). Returns also differed, ranging from \$133 ha$^{-1}$ with Cutless to \$181 ha$^{-1}$ with Lew.

Table 11. Yield, test weight, protein and returns over variable costs of grain produced on soil units.

| Year | Soil unit | Grain<br>Yield | Test Weight | Protein | Returns[1] |
|---|---|---|---|---|---|
| | | kg ha$^{-1}$ | kg m$^{-3}$ | g kg$^{-1}$ | \$ ha$^{-1}$ |
| 1987 | Evanston | 2100 a[2] | 805 a | 157.2 a | 206.30 a |
| | Phillips-Kevin | 2452 b | 804 a | 145.1 b | 216.00 a |
| | Telstad-Joplin | 2102 a | 798 b | 141.5 c | 170.50 b |
| 1988 | Gerdrum-Creed | 2128 a | 811 a | 167.1 a | 296.60 a |
| | Joplin-Hillon | 1128 b | 797 c | 167.7 ab | 138.30 b |
| | Phillips-Elloam | 928 b | 804 b | 173.3 c | 106.90 b |
| | Telstad-Joplin | 1001 b | 795 c | 172.5 bc | 118.50 b |

[1] Returns, returns over variable costs.

[2] Values followed by the same letter in a column do not differ significantly at the 1% level of probability according to Student's t test.

Significant cultivar x soil interactions occurred for test weight and protein, but not for returns (P = .13) or yield (P = .11).

Lack of moisture during 1988 resulted in abnormally high protein levels of grain, since nitrogen was assimilated early in the growing season prior to the onset of water stress. Because of elevated levels in 1988, premiums paid for protein were much lower than during 1987. As a result, even though significant soil X cultivar interactions occurred for grain protein, differences in protein did not influence the price paid for grain during 1988 as it had during 1987, and soil X cultivar interactions for returns were not significant.

Table 12. Yield, test weight, protein, and returns over variable costs of grain produced by spring wheat cultivars during 1987-88.

| | | Grain | | | |
|---|---|---|---|---|---|
| Year | Cultivars | Yield | Test weight | Protein | Returns[1] |
| | | kg ha$^{-1}$ | g m$^{-3}$ | g kg$^{-1}$ | \$ ha$^{-1}$ |
| 1987 | Fortuna | 1989 a[2] | 802.1 b | 154.8 a | 191.60 a |
| | Glenman | 2519 c | 786.5 a | 136.7 c | 200.60 a |
| | Lew | 2300 b | 808.6 c | 145.1 b | 198.90 a |
| | Newana | 2063 a | 811.2 c | 155.1 a | 199.30 a |
| | S x C[3] | NS[4] | *** | * | NS |
| 1988 | Cutless | 1089 a | 797.8 b | 184.0 a | 133.40 a |
| | Glenman | 1365 b | 788.2 a | 157.6 d | 174.90 b |
| | Lew | 1402 b | 811.5 c | 163.1 c | 181.30 b |
| | Rambo | 1328 b | 810.5 c | 175.9 b | 170.80 b |
| | S x C | NS | * | *** | NS |

[1] Returns, returns over variable costs.

[2] Values followed by the same letter do not differ significantly at the 1% level of probability according to Student's t test.

[3] S X C, soil X cultivar interaction.

[4] *, ***, NS; $P < .10$, 01, and not significant, respectively.

Grain protein levels were highest for Cutless, although returns were lower than with other cultivars during 1988. In contrast, Cutless generated highest returns among 12 spring wheat cultivars during 1987 (Table 2). This disparity in the Cutless ranking among cultivars in 1987 and 1988 is due to genetic and environmental factors. Cutless matures earlier than the other cultivars planted during 1988, and dry conditions shortened maturation time.

In contrast to other cultivars, Cutless began to shatter prior to harvest, so that a sizeable percentage of grain produced by Cutless was on the ground and was not harvested by the combine. These data suggest that planting cultivars with similar maturity periods will be necessary to avoid yield losses in fields where several cultivars are produced.

The data indicate that test weight and protein differ on contrasting soils in the same field. In some cases, cultivars respond differently to edaphic variation. Farming Soils, Not Fields, where several cultivars are planted according to contrasting soil units in a field, can provide higher returns than planting a single cultivar. Ranking among cultivars based upon test weight and protein content often varies on contrasting soil units, and this variation can influence returns when premiums are paid for high quality grain. Our findings indicate that soils cause different cultivar responses within the same field, and therefore suggest that potential economic benefits could be obtained from planting adapted cultivars on each contrasting soil unit of manageable size.

## Soil Variability and Crop Residue

### Soil X Cultivar Studies,1987

Soils units differed in grain yield and straw production for both spring barley and spring wheat ($P < .01$) (Table 13). The largest amounts of barley straw and grain were produced on the Evanston soil. Grain production was similar on the Telstad and Phillips soil units, while straw production was considerably less on the Telstad soil unit. Highest straw production, but lowest wheat yields, occurred on the Telstad soil unit. The data reveal that relative ranking of the soil units depended on whether grain yield or straw production was considered.

Straw:grain ratios of barley and wheat varied among soil units. Largest ratios occurred on the Telstad soil unit for both crops. Ratios were much less than those reported in the literature (Black et al., 1974, Turelle, 1963) or used by SCS land management planners (Nadwornick, 1989, personal communication). The sampling procedure used during 1987 resulted in artificially low ratios, since plants were cut 13 cm above the soil surface, leaving unharvested straw in the plots. However, since the same procedure was applied to all plots on each soil unit, the relative ranking of soil units was unaffected by the sampling method.

Table 13. Grain yield, straw production, and straw:grain ratios of barley and wheat on three soils in a field.

| Crop | Soil | Grain | Straw | Ratio[1] |
|---|---|---|---|---|
| | | -------- | kg ha | ---------- |
| Barley | Evanston | 3145 a[2] | 1612 a | 0.53 b |
| | Phillips | 2799 b | 1284 b | 0.47 c |
| | Telstad | 2660 b | 1596 a | 0.65 a |
| | S X C[3] | NS[4] | NS | *** |
| Wheat | Evanston | 2712 a | 1493 a | 0.55 a |
| | Phillips | 2619 a | 1390 a | 0.53 a |
| | Telstad | 2256 b | 1668 b | 0.75 b |
| | S X C | ** | * | *** |

[1] This is not a true straw:grain ratio because the crop was harvested 13 cm above the soil surface and the unharvested part was not weighed, but estimated to weigh 15 percent of of the weight of straw which was collected.

[2] Values in the same column followed by the same letter do not differ significantly at the 1% level of probability according to Student's t test.

[3] S X C, Soil X cultivar interaction.

[4] ***, **, and *; P < .01, .05, and .10, respectively.

Spring barley and spring wheat cultivars differed in straw production, grain yield and straw:grain ratios (P < .01) (data not presented). Moreover, significant soil unit X cultivar interactions indicate that soil units influenced the relative amounts of straw and grain produced by different spring wheat cultivars, as well as the straw:grain ratio of both barley and wheat. The data indicate that assuming constant straw:grain ratios for barley and wheat may be inappropriate on different soils.

The data also indicate that straw:grain ratios vary between cultivars, as was concluded by Vogel et al. (1963) in comparing winter wheat cultivars. However, our method of harvesting will result in unusually low straw:grain ratios and will cause exceptionally low values to be reported for plants that are short for any reason (genetic or environmental).

## Soil X Fertility Studies, 1988

Straw production and grain yield were similar between soils in the field where spring barley was grown, but not where spring wheat was grown ($P < .01$) (Table 14). The grain yield capabilities (goals) for Amesha and Brocko soil units are similar according to the USDA-SCS (1972). This may explain why straw production and grain yield were not significantly different between these soil units when barley was grown in 1988. Significant differences did occur in straw production between soil units which differed in grain yield goals by more than 335 kg ha$^{-1}$, as occurred in the wheat field, suggesting that SCS yield goals could be used to rank soil units for straw production within fields.

Soil units did not influence the straw:grain ratio of barley in 1988 (Table 14), although differences had been measured during 1987. Smaller sample number and plot size in 1988 might explain why significant differences between

Table 14. Straw production, grain yields and straw:grain ratios of contrasting soils in three Montana fields.

| Crop | Soil | Straw | Grain | Ratio |
|---|---|---|---|---|
| Soil X Fertilizer Studies | | | | |
| | | kg ha$^{-1}$ | | |
| Barley | Amesha | 2597 a[1] | 2036 a | 1.29 a |
| | Brocko | 2690 a | 2226 a | 1.25 a |
| | S X F[2] | NS | NS | NS |
| Wheat | Ethridge | 1493 a | 331 a | 5.45 ab |
| | Varney | 1390 a | 181 b | 6.38 b |
| | Walbert | 1668 b | 317 a | 3.96 a |
| | S X F | NS | NS | NS |
| Soil X Fertilizer X Cultivar Studies | | | | |
| Wheat | Gerdrum | 3801 a | 2577 a | 1.49 a |
| | Phillips | 1998 b | 1250 b | 1.69 a |
| | Telstad | 2129 b | 1363 b | 1.58 a |
| | S X F | *** | *** | NS |
| | S X C[3] | NS | *** | NS |

[1] Values in the same column followed by the same letter do not differ significantly at the 1% and 10% levels of probability according to Student's t test, as indicated by *** and *, respectively.

[2] S X F, soil X fertilizer interaction.

[3] S X C, soil X cultivar interaction.

soils were not measured, since small sample and plot size reduces the ability to detect differences (Cochran and Cox, 1957). Also, drought can reduce the differences that would occur between contrasting soils in normal years (Ferguson and Gorby, 1966).

A large straw:grain ratio was measured on all soil units in the spring wheat field (Table 14), and contrasting soil units did produce different ratios ($P < .10$). The high straw:grain ratio reflects the dry conditions which persisted throughout the growing season. The data support other research suggesting that higher straw:grain ratios generally occur when water is limiting (Frank et al., 1977).

Fertilizer treatments varied in straw production and grain yield in the wheat field (data not presented). However, significant soil X fertilizer interactions were not measured, indicating that response to fertilizer did not vary on contrasting soil units. No response to fertilizer was observed in the barley field.

### Soil X Fertility X Cultivar Studies,1988

Soil units varied in straw production (Table 14); roughly twice as much straw was produced on Gerdrum than Phillips soil units ($P < .01$). Grain yield also varied on contrasting soils. However, the straw:grain ratio was similar on all soil units in this field, in contrast to differences between soil units measured in other wheat fields. The data indicate that the straw:grain ratio will vary among contrasting soil units in some fields, but not in others.

Fertilizer response varied on contrasting soils for both straw production and grain yield ($P < .01$). Grain yield of different spring wheat cultivars also varied on contrasting soils. However, the straw:grain ratio was not significantly influenced by fertilizer treatment or cultivar type. In this field, soil units, fertilizer treatments, and cultivar types failed to significantly influence the straw:grain ratio. Considering data from all sites during both years, however, soil units and cultivar type tend to influence the straw:grain ratio. Our work suggests that a constant straw:grain ratio for spring barley and spring wheat fields can be assumed in some, but not all, fields comprised of two or more contrasting soil units.

## Procedure for Farming Soils, Not Fields

Several procedures have been suggested for Farming Soils, Not Fields. Fairchild and Hammond (1988) presented a procedure used by Soil Teq, Inc., which manufactures a variable fertilizer spreader being commercially operated. For nonirrigated fields, they suggest first identifying soil patterns in fields using Soil Conservation Service (SCS) soil survey maps and color-infrared aerial photographs. A map based on soil type is then generated by computers. Soil samples are collected from each map unit using the map as a guide. Fertilizer recommendations are made for each map unit based on soil test results and yield goals.

Management maps for irrigated fields are made by collecting soil samples according to a grid system developed for a field. Soil fertility patterns indicated by grid sampling are modified by SCS soil survey reports, and used to develop soil management maps.

A procedure for Farming Soils, Not Fields was used in soil fertility field tests in Montana (Carr et al., 1988). A Soil Variability Map was prepared for each section (260 ha$^{-1}$), starting with an orthophoto map enlarged to 1:10 000 scale. Overlays were developed from a U.S. Geological Survey topography map, a published soil survey map, and prints of color-infrared photographs or satellite images. A Soil Management Map was developed from the Soil Variability Map, following field inspection to interpret the images and verify or modify the maps.

The Soil Management Map was used to guide soil fertility operations in each field and included somewhat permanent information from the Soil Variability Map, as well as information on short-term variation due to residual herbicide effects, localized pest problems and other factors that affect management. Soil samples from specific map units delineated on the Soil Management Map were collected from each field and analyzed for fertilizer recommendations. Yield goals were based upon estimated yields reported in SCS soil survey reports, and were modified by farmer experience. A one-year fertility prescription was determined for each soil in the fields.

A draft procedure for Farming Soils, Not Fields has been developed after evaluating data collected in the field studies (Figure 2). This draft procedure can probably be adopted by certain producers, with some modification.

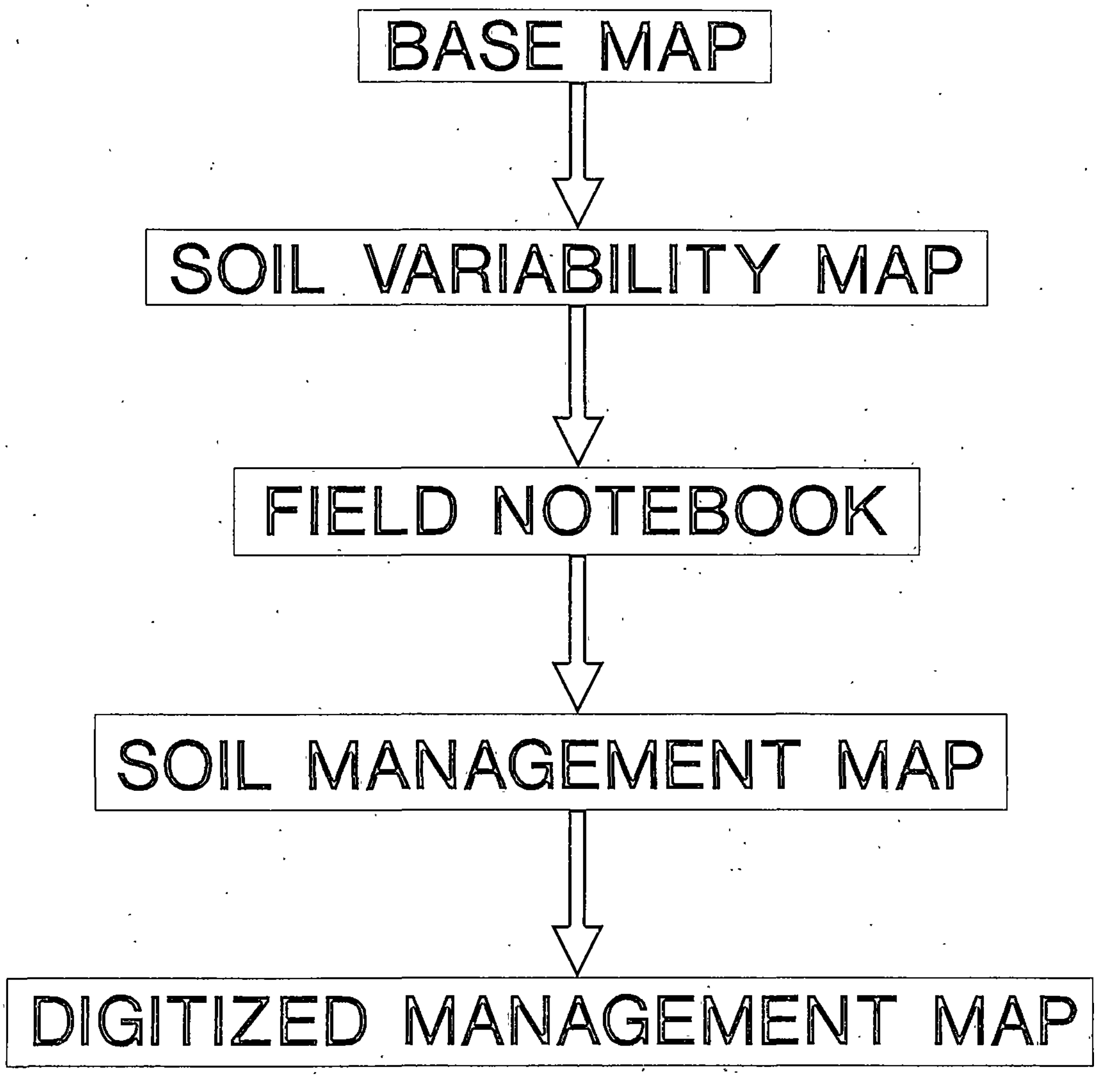

Figure 2. Draft procedure for Farming Soils, Not Fields.

Soil Variability Maps of fields managed by a producer are developed, as described previously. Soil Management Maps and management plans are developed for each field based on field information, soil productivity, historical field records, crop prices, conservation plans, and crop allotment programs.

Soil samples are collected from each map unit indicated on the Soil Management Maps. Fertilizer and pesticide recommendations are developed for each map unit from soil test results and a yield goal established from published SCS soil survey reports, farmer experience and on-farm research plots. Field records, cultivar performance recommendations, on-farm field tests, and interactive computer programs, such as the **F**arms **A**nd **R**esearch Center **M**atching **S**ystem (**FARMS**) developed by Jacobsen et al. (1989) at Montana State University, are used to select cultivars by soil type.

Soil Management Maps are used to guide Farming Soils, Not Fields operations, but different strategies for varying inputs can be used. For example, farmers who choose not to modify equipment can divide large fields into two or three parts, and manage each differently. The same field can be divided into smaller parts and each part managed differently, if existing equipment is modified. Soil Management Maps can also be converted to computer digital form and stored on a microchip. The microchip can be used to guide computer-controlled implements.

Field navigation systems are used to locate where rates of inputs should be changed in fields. Navigation can be done manually where map unit boundaries correspond to changes in topography, and equipment operators are familiar with fields. Dead reckoning or radio-metric systems can also be employed, but neither system is accurate in hilly terrain. Perhaps the most precise location data will be the Global Positioning System (Larson et al., 1988). This system is accurate within inches, and could provide location data for variable fertilizer spreaders every few seconds.

Economic benefits and costs are calculated to evaluate the Farming Soils, Not Fields cropping system. A continuous grain monitor, such as described by Schueller (Reichenberger et al., 1989), could be used to measure crop yields on different map units. Grain samples from each map unit are analyzed for grain quality parameters. Returns over variable costs are determined by subtracting the costs of inputs from total returns from the grain for each soil unit.

Data collected by the continuous grain monitor, along with results of plant tissue analyses, could be used in developing Soil Management Maps. Further refinement of the maps would result from subsequent soil tests results. Soil testing and plant tissue analyses after the first few years of Farming Soils, Not Fields, could be done every few years rather than annually.

Estimates of the cost of the materials needed to produce a Soil Management Map are \$.07 ha$^{-1}$ to \$.15 ha$^{-1}$ if original photographs are available at no cost. An additional cost of \$.25 ha$^{-1}$ to \$.75 ha$^{-1}$ is estimated if the Soil Management Map is digitized. A similar procedure for producing computer maps which guide a fertilizer and herbicide spreader that changes rates on the go is used by Soil Teq Incorporated (STI), a Minnesota company. Total costs including image acquisition, soil sampling, and development of digital Soil Management Maps are \$1.25 ha$^{-1}$ to \$2.50 ha$^{-1}$.

## Break-Even Analysis of Farming Soils, Not Fields

Comparisons were made between the cost of operating the fertilizer spreader developed by STI which can change rates on the go, and one which applies only a uniform rate within a field. Information on the spreaders was provided by Power Farmers Elevator of Montana, owner and operator of both types of units. The MSU Machinery Cost Spread Sheet Program was used to calculate the variable and fixed costs of each unit (Griffith, 1985).

Average cost of owning and operating the STI unit is \$7.45 $ha^{-1}$; estimates range from \$5.93 to \$8.98 $ha^{-1}$, depending on estimates of its useful life (Table 15). Since an additional \$1.85 $ha^{-1}$ is needed to develop the computer map and recommendations used to guide the spreader, average total cost of Farming Soils, Not Fields with the STI unit is \$9.30 $ha^{-1}$. By comparison, average total cost of owning and operating a unit which only applies a uniform rate is \$8.28 $ha^{-1}$. Therefore, based on the information provided and using average costs, the additional cost of using the STI unit is \$1.02 $ha^{-1}$ (\$9.30 - \$8.28).

Table 15. Total cost of applying fertilizer with an STI and conventional spreader.

| | Spreader | | | |
|---|---|---|---|---|
| | STI[1] | STI[2] | Spinner[1] | Spinner[2] |
| TVC | 4.64 | 2.82 | 5.58 | 4.00 |
| TFC | 4.34 | 3.11 | 4.15 | 2.84 |
| TC | 8.98 | 5.93 | 9.73 | 6.84 |
| Mean | 7.45 | | 8.28 | |

[1] Costs were calculated assuming a useful life of 2500 hr.

[2] Costs were calculated assuming a useful life of 5000 hr.

## Research Opportunities

I have described current research focusing on the Farming Soils, Not Fields cropping system. While much of the research is generally supportive of varying inputs by soil type, few reports contain economic comparisons between variable versus uniform applications of inputs. More economic data are needed from properly designed field experiments. The economics of variable versus uniform fertilizer applications is being compared in North Dakota (Danke, 1989, personal communication) and Washington (Hammond, 1989, personal communication), but data to justify varying other inputs is lacking.

Researchers have suggested that Farming Soils, Not Fields will reduce soil and water degradation (Schmitt et al., 1986; Fairchild and Hammond, 1988). However, little data is available on environmental impacts of varying inputs in fields. Field experiments are needed which quantify (1) soil erosion, and (2) groundwater quality, when Farming Soils, Not Fields.

Several inputs are varied simultaneously in a Farming Soils, Not Fields cropping system. Traditional experimental designs and statistical tests may be inappropriate, as is the case with other cropping systems with variable inputs (Lynam et al, 1986; Smith and Francis, 1986). A systems analysis approach would be more appropriate for evaluating Farming Soils, Not Fields, although this approach has not been used in most agricultural research. Methods for analyzing agricultural cropping systems are needed.

Information is lacking on influences of crop allotment programs and conservation plans on Farming Soils, Not Fields. Clearly, government programs will influence management practices in many fields, including those where inputs are varied. Will crop allotment programs, for example, permit farmers to produce different cultivar types in the same field?

New methods of soil sampling and testing should be incorporated into Farming Soils, Not Fields procedures. Soil samples should be collected on a systematic basis rather than a random basis as is often done. Accurate soil tests are also needed for Farming Soils, Not Fields. The Phytoavailability Soil Test, proposed by Skogley and Georgitis (1988) provides more accurate measurements of available K and S in soil samples than methods used currently, and it could be incorporated in Farming Soils, Not Fields procedures in the Northern Great Plains. Other innovative soil tests may be available in other regions of the country.

Farming Soils, Not Fields is an emerging cropping system for increasing the profits of U.S. agriculturalists. Costs of inputs can be reduced, and soil and water resources can be protected from the degradation resulting from over-applying fertilizer. Farming Soils, Not Fields can help U.S. farmers compete with foreign growers on a sustainable basis.

# SUMMARY

Crop yield was measured on contrasting soils in fields managed uniformly. High yielding soils produced roughly twice as much grain as low yielding soils within several fields. Test weight and protein levels also varied among contrasting soils.

Returns were \$4.42 ha$^{-1}$ to \$22.82 ha$^{-1}$ greater when fertilizer rates and formulations were varied by soil rather than a uniform rate and formulation used throughout a field, but overall, returns were not significantly different. However, a recommended fertilizer treatment was not always the optimum economic treatment. In three fields, additional returns of \$54.36 ha$^{-1}$ to \$79.07 ha$^{-1}$ resulted when optimum soil treatments were applied rather than the uniform treatment.

Contrasting soils in the same field produced varying amounts of straw, and different straw:grain ratios, when either barley or wheat were grown. In some fields, varying fertilizer treatments or planting different cultivars influenced the straw:grain ratio.

Barley and wheat yield differed on contrasting soils in many fields. Grain test weight and protein also varied among contrasting soils. Planting two spring wheat

cultivars generated an additional \$4 $ha^{-1}$ compared to planting a single cultivar in one field studied.

A draft procedure for Farming Soils, Not Fields was developed. This procedure could be applied commercially, after some modification.

Additional work is needed which compares the returns from varying inputs according to soil patterns rather than applying inputs uniformly within fields. Statistical procedures which can analyze data when several factors are varied simultaneously are needed. The influence of crop allotment programs and conservation plans on management strategies in which inputs are varied needs to be determined. New methods of soil sampling and improved soil tests are needed for optimum returns to be produced by varying inputs.

Farming Soils, Not Fields enables each soil to be managed according to its productive potential. Production costs can be lowered, and soil and water resources protected, by varying inputs within a field.

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# APPENDICES

# APPENDIX A

## Classification of Soils Studied

Table 16. Subgroup classification of soil series studied.

| Series | Subgroup |
|---|---|
| Abor | Borollic Vertic Camborthid |
| Absher* | Borollic Natrargid |
| Amesha | Borollic Calciorthid |
| Brocko | Borollic Calciorthid |
| Cabbart | Ustic Torriorthent |
| Cargill | Borollic Calciorthid |
| Creed* | Borollic Natrargid |
| Delpoint | Borollic Camborthid |
| Ethridge | Aridic Argiboroll |
| Evanston | Aridic Argiboroll |
| Gerdrum | Borollic Natrargid |
| Hillon** | Ustic Torriorthent |
| Joplin | Aridic Argiboroll |
| Kevin*** | Aridic Argiboroll |
| Phillips | Borollic Paleargid |
| Telstad | Aridic Argiboroll |
| Varney | Aridic Argiboroll |
| Walbert | Ustic Torriorthent |
| Yawdim | Ustic Torriorthent |
| Yetull | Ustic Torripsamment |

*Included in the Gerdrum Soil Management Map Unit.

**Included in the Joplin Soil Management Map Unit.

***Included in the Phillips Soil Management Map Unit.

Table 17. Family classification of soil series studied.

| Series | Family |
|---|---|
| Abor | Fine, montmorillonitic |
| Absher | Fine, montmorillonitic |
| Amesha | Coarse-loamy, mixed |
| Brocko | Coarse-silty, mixed |
| Cabbart | Loamy mixed, frigid (shallow) |
| Cargill | Fine-silty, mixed |
| Creed | Fine, montmorillonitic |
| Delpoint | Fine-loamy, mixed |
| Ethridge | Fine, montmorillonitic |
| Evanston | Fine-loamy, mixed |
| Gerdrum | Fine, montmorillonitic |
| Hillon | Fine-loamy, mixed |
| Joplin | Fine-loamy, mixed |
| Kevin | Fine-loamy, mixed |
| Phillips | Fine, montmorillonitic |
| Telstad | Fine-loamy, mixed |
| Varney | Fine-loamy, mixed |
| Walbert | Loamy mixed, frigid (shallow) |
| Yawdim | Clayey, montmorillonitic (calcareous), frigid, shallow |
| Yetull | Mixed, frigid |

# APPENDIX B

## Yield and Test Weight On Contrasting Soil Units In the Crop Variability Studies

Table 18. Yield and test weight of spring barley samples harvested on contrasting soil units in a field near Havre (a), 1987.

| Soil unit | Sample Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Kevin | 63.0 | 1225.0 | 9.662 | 667.1 |
| Kevin | 56.0 | 631.0 | 8.658 | 689.8 |
| Kevin | 2.0 | 1983.0 | 10.370 | 691.1 |
| Kevin | 3.0 | 2119.0 | 10.400 | 688.5 |
| Kevin | 4.0 | 1895.0 | 9.922 | 686.0 |
| Kevin | 5.0 | 2237.0 | 12.370 | 696.3 |
| Kevin | 6.0 | 1437.0 | 10.180 | 684.7 |
| Kevin | 7.0 | 1418.0 | 10.180 | 684.7 |
| Kevin | 8.0 | 1885.0 | 10.070 | 684.7 |
| Kevin | 9.0 | 1938.0 | 10.270 | 680.8 |
| Kevin | 10.0 | 2166.0 | 10.220 | 686.0 |
| Kevin | 11.0 | 1778.0 | 9.810 | 671.8 |
| Kevin | 12.0 | 2095.0 | 10.440 | 689.8 |
| Kevin | 13.0 | 2097.0 | 9.996 | 692.4 |
| Kevin | 14.0 | 2253.0 | 9.699 | 662.8 |
| Kevin | 15.0 | 2253.0 | 10.330 | 683.4 |
| Kevin | 16.0 | 1958.0 | 9.959 | 673.1 |
| Kevin | 17.0 | 1940.0 | 12.970 | 671.8 |
| Kevin | 18.0 | 1712.0 | 9.847 | 671.8 |
| Kevin | 19.0 | 1300.0 | 10.070 | 665.4 |
| Kevin | 60.0 | 465.0 | 9.587 | 700.1 |
| Kevin | 1.0 | 2124.0 | 10.850 | 688.5 |
| Kevin | 57.0 | 821.0 | 9.104 | 666.7 |
| Kevin | 58.0 | 329.0 | 9.550 | 689.8 |
| Kevin | 59.0 | 602.0 | 10.110 | 688.5 |
| Kevin | 61.0 | 837.0 | 9.959 | 664.1 |
| Kevin | 62.0 | 778.0 | 9.996 | 677.0 |
| Kevin | 20.0 | 1883.0 | 9.922 | 671.8 |
| Kevin | 21.0 | 1772.0 | 10.260 | 673.1 |
| Evanston | 22.0 | 3170.0 | 9.847 | 665.4 |
| Evanston | 31.0 | 3452.0 | 10.030 | 665.4 |
| Evanston | 30.0 | 3532.0 | 9.810 | 691.1 |
| Evanston | 33.0 | 4395.0 | 11.000 | 691.8 |
| Evanston | 34.0 | 4243.0 | 10.220 | 668.0 |
| Evanston | 35.0 | 4506.0 | 10.030 | 667.0 |
| Evanston | 36.0 | 4447.0 | 9.885 | 687.3 |
| Evanston | 37.0 | 6812.0 | 9.773 | 685.3 |
| Evanston | 38.0 | 4552.0 | 10.140 | 677.6 |
| Evanston | 39.0 | 3789.0 | 9.699 | 677.0 |
| Evanston | 29.0 | 3580.0 | 9.922 | 677.6 |
| Evanston | 28.0 | 4042.0 | 9.885 | 644.8 |
| Evanston | 27.0 | 3725.0 | 9.587 | 625.5 |

Table 18--Continued.

| Soil unit | Sample Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Evanston | 26.0 | 3763.0 | 10.330 | 635.1 |
| Evanston | 25.0 | 2977.0 | 9.662 | 686.0 |
| Evanston | 24.0 | 2372.0 | 9.662 | 664.1 |
| Evanston | 23.0 | 3221.0 | 9.996 | 649.9 |
| Evanston | 32.0 | 4093.0 | 11.300 | 675.0 |
| Phillips | 55.0 | 1203.0 | 9.401 | 665.7 |
| Phillips | 47.0 | 1829.0 | 10.030 | 679.5 |
| Phillips | 49.0 | 2401.0 | 9.736 | 677.0 |
| Phillips | 46.0 | 1590.0 | 9.067 | 682.1 |
| Phillips | 51.0 | 2158.0 | 9.104 | 682.1 |
| Phillips | 45.0 | 2298.0 | 9.810 | 682.1 |
| Phillips | 53.0 | 1510.0 | 8.175 | 675.7 |
| Phillips | 48.0 | 1274.0 | 9.773 | 682.1 |
| Phillips | 50.0 | 2140.0 | 9.364 | 670.5 |
| Phillips | 52.0 | 2250.0 | 9.587 | 692.4 |
| Phillips | 54.0 | 1645.0 | 9.587 | 673.1 |
| Phillips | 44.0 | 2310.0 | 9.885 | 677.0 |
| Phillips | 43.0 | 2298.0 | 9.922 | 688.5 |
| Phillips | 42.0 | 2120.0 | 9.587 | 675.7 |
| Phillips | 41.0 | 2333.0 | 9.476 | 653.8 |
| Phillips | 40.0 | 2429.0 | 10.070 | 665.4 |

Table 19. Yield and test weight of spring barley samples harvested on contrasting soil units in a field near Havre (b), 1987.

| Soil unit | Sample Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Telstad | 1.0 | 1830.0 | 9.959 | 701.4 |
| Telstad | 2.0 | 1963.0 | 10.070 | 677.0 |
| Telstad | 3.0 | 2103.0 | 8.956 | 678.2 |
| Telstad | 4.0 | 1272.0 | 9.587 | 678.2 |
| Telstad | 5.0 | 1874.0 | 9.959 | 671.8 |
| Telstad | 6.0 | 1646.0 | 10.110 | 719.4 |
| Telstad | 7.0 | 2330.0 | 10.520 | 688.5 |
| Telstad | 8.0 | 2929.0 | 10.220 | 698.8 |
| Telstad | 9.0 | 4123.0 | 9.847 | 697.6 |
| Telstad | 10.0 | 4658.0 | 9.996 | 713.0 |
| Telstad | 12.0 | 4404.0 | 9.922 | 704.0 |
| Telstad | 13.0 | 4550.0 | 9.996 | 729.7 |
| Telstad | 14.0 | 4640.0 | 9.996 | 707.2 |
| Telstad | 15.0 | 5376.0 | 9.662 | 702.1 |
| Telstad | 16.0 | 5611.0 | 9.922 | 683.4 |
| Telstad | 17.0 | 5598.0 | 9.624 | 691.1 |
| Telstad | 18.0 | 5272.0 | 9.959 | 720.3 |
| Telstad | 19.0 | 5021.0 | 9.810 | 707.8 |
| Telstad | 20.0 | 3923.0 | 9.810 | 702.7 |
| Gerdrum | 21.0 | 3398.0 | 10.330 | 692.4 |
| Gerdrum | 22.0 | 4631.0 | 9.624 | 709.1 |
| Gerdrum | 23.0 | 5656.0 | 9.550 | 704.0 |
| Gerdrum | 24.0 | 5706.0 | 9.922 | 707.8 |
| Gerdrum | 25.0 | 6758.0 | 9.922 | 691.8 |
| Gerdrum | 26.0 | 5327.0 | 9.922 | 692.4 |
| Gerdrum | 27.0 | 4799.0 | 11.220 | 671.2 |
| Gerdrum | 28.0 | 4067.0 | 9.067 | 701.4 |
| Gerdrum | 29.0 | 3055.0 | 8.807 | 683.4 |
| Gerdrum | 30.0 | 2469.0 | 8.733 | 710.4 |
| Gerdrum | 31.0 | 2105.0 | 8.658 | 707.8 |
| Gerdrum | 32.0 | 1737.0 | 8.807 | 705.3 |
| Gerdrum | 33.0 | 1276.0 | 8.101 | 691.1 |
| Gerdrum | 34.0 | 1521.0 | 7.581 | 687.3 |
| Gerdrum | 35.0 | 2817.0 | 9.587 | 704.0 |
| Gerdrum | 36.0 | 2660.0 | 9.810 | 673.1 |
| Gerdrum | 38.0 | 3012.0 | 11.710 | 677.0 |
| Gerdrum | 39.0 | 2861.0 | 11.930 | 689.8 |
| Gerdrum | 40.0 | 2055.0 | 9.179 | 707.8 |
| Gerdrum | 42.0 | 2389.0 | 10.330 | 688.5 |
| Phillips | 43.0 | 2946.0 | 12.000 | 691.1 |
| Phillips | 44.0 | 2081.0 | 9.922 | 707.8 |
| Phillips | 45.0 | 2464.0 | 10.030 | 691.1 |

Table 19--Continued.

| Soil unit | Sample Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Phillips | 46.0 | 2078.0 | 9.290 | 707.8 |
| Phillips | 47.0 | 1888.0 | 9.736 | 697.6 |
| Phillips | 48.0 | 2454.0 | 9.885 | 704.0 |
| Phillips | 49.0 | 2654.0 | 9.067 | 704.0 |
| Phillips | 50.0 | 3142.0 | 10.110 | 700.1 |
| Phillips | 51.0 | 2155.0 | 9.810 | 715.6 |
| Phillips | 52.0 | 2172.0 | 10.370 | 698.8 |
| Phillips | 53.0 | 1900.0 | 9.364 | 683.4 |
| Phillips | 54.0 | 2114.0 | 9.959 | 691.1 |
| Phillips | 55.0 | 1998.0 | 9.067 | 691.1 |
| Phillips | 56.0 | 973.0 | 9.662 | 701.4 |
| Phillips | 57.0 | 928.0 | 10.180 | 693.7 |
| Phillips | 58.0 | 1106.0 | 10.110 | 696.3 |
| Phillips | 59.0 | 1425.0 | 9.662 | 686.0 |
| Phillips | 60.0 | 1266.0 | 9.959 | 675.7 |
| Phillips | 61.0 | 1748.0 | 9.922 | 700.1 |
| Phillips | 62.0 | 1755.0 | 9.699 | 700.1 |
| Phillips | 63.0 | 1995.0 | 10.070 | 682.1 |
| Phillips | 64.0 | 1916.0 | 10.370 | 684.7 |

Table 20. Yield and test weight of spring barley samples harvested on contrasting soil units in a field near Power.

| Soil unit | Sample Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Abor | 1.0 | 1219.0 | 10.660 | 670.5 |
| Abor | 2.0 | 1311.0 | 10.890 | 653.8 |
| Abor | 3.0 | 1228.0 | 10.480 | 657.7 |
| Abor | 4.0 | 1169.0 | 10.400 | 658.9 |
| Abor | 5.0 | 1220.0 | 10.520 | 626.8 |
| Abor | 6.0 | 1365.0 | 10.930 | 669.2 |
| Abor | 7.0 | 1410.0 | 13.190 | 661.5 |
| Abor | 8.0 | 1431.0 | 13.380 | 658.9 |
| Abor | 9.0 | 1889.0 | 13.300 | 674.4 |
| Abor | 10.0 | 1051.0 | 10.700 | 662.8 |
| Abor | 11.0 | 1177.0 | 10.810 | 642.2 |
| Abor | 12.0 | 1560.0 | 10.810 | 639.6 |
| Abor | 13.0 | 963.0 | 9.364 | 646.1 |
| Abor | 14.0 | 570.0 | 9.179 | 664.1 |
| Cargill | 15.0 | 542.0 | 11.260 | 653.8 |
| Cargill | 16.0 | 492.0 | 9.773 | 638.4 |
| Cargill | 17.0 | 939.0 | 9.699 | 648.6 |
| Cargill | 18.0 | 766.0 | 9.476 | 664.1 |
| Cargill | 19.0 | 631.0 | 10.330 | 653.8 |
| Cargill | 20.0 | 957.0 | 9.401 | 646.1 |
| Cargill | 21.0 | 716.0 | 9.030 | 648.6 |
| Cargill | 22.0 | 905.0 | 9.885 | 652.5 |
| Cargill | 23.0 | 868.0 | 12.780 | 643.5 |
| Cargill | 24.0 | 969.0 | 9.736 | 638.4 |
| Cargill | 25.0 | 1084.0 | 13.010 | 643.5 |
| Cargill | 26.0 | 1054.0 | 10.630 | 646.1 |
| Cargill | 27.0 | 839.0 | 11.740 | 646.1 |
| Cargill | 28.0 | 717.0 | 10.030 | 658.9 |
| Cargill | 29.0 | 774.0 | 8.993 | 662.8 |
| Cargill | 30.0 | 845.0 | 9.624 | 652.5 |
| Cargill | 31.0 | 1050.0 | 9.996 | 651.2 |
| Cargill | 32.0 | 799.0 | 9.699 | 674.4 |
| Cargill | 33.0 | 1063.0 | 10.070 | 664.1 |
| Cargill | 34.0 | 1491.0 | 12.970 | 651.2 |
| Cargill | 35.0 | 1061.0 | 9.996 | 658.9 |
| Cargill | 36.0 | 884.0 | 9.810 | 652.5 |
| Cargill | 37.0 | 1196.0 | 10.370 | 639.6 |
| Cargill | 38.0 | 1003.0 | 12.820 | 644.8 |
| Cargill | 39.0 | 922.0 | 10.480 | 639.6 |
| Cargill | 40.0 | 1002.0 | 10.260 | 635.8 |
| Cargill | 41.0 | 1001.0 | 12.490 | 644.8 |
| Cargill | 42.0 | 1240.0 | 12.780 | 613.9 |

Table 20--Continued.

| Soil unit | Sample Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Cargill | 43.0 | 1046.0 | 12.780 | 648.6 |
| Cargill | 44.0 | 1071.0 | 10.400 | 622.9 |
| Cargill | 45.0 | 877.0 | 10.260 | 652.5 |
| Cargill | 46.0 | 970.0 | 9.996 | 639.6 |
| Cargill | 47.0 | 981.0 | 10.330 | 660.2 |

Table 21. Yield and test weight of spring barley samples harvested on contrasting soil units in a field near Whitehall.

| Soil unit | Sample Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Ethridge | 1.0 | 1814.0 | 9.462 | 753.8 |
| Ethridge | 2.0 | 1870.0 | 10.110 | 752.1 |
| Ethridge | 3.0 | 1562.0 | 12.240 | 736.3 |
| Ethridge | 4.0 | 1454.0 | 9.896 | 739.8 |
| Ethridge | 5.0 | 1553.0 | 9.787 | 753.3 |
| Ethridge | 6.0 | 1254.0 | 10.180 | 747.5 |
| Ethridge | 7.0 | 1366.0 | 9.751 | 760.4 |
| Ethridge | 8.0 | 1166.0 | 9.932 | 745.9 |
| Ethridge | 9.0 | 1249.0 | 11.200 | 754.2 |
| Ethridge | 10.0 | 1044.0 | 8.126 | 757.0 |
| Ethridge | 11.0 | 1516.0 | 9.715 | 762.5 |
| Ethridge | 12.0 | 1867.0 | 11.770 | 758.4 |
| Ethridge | 13.0 | 1604.0 | 10.000 | 770.1 |
| Ethridge | 14.0 | 1773.0 | 9.535 | 764.5 |
| Ethridge | 15.0 | 1254.0 | 8.921 | 758.8 |
| Ethridge | 17.0 | 1819.0 | 10.000 | 761.5 |
| Ethridge | 19.0 | 2306.0 | 10.800 | 777.6 |
| Ethridge | 20.0 | 2421.0 | 12.420 | 791.6 |
| Ethridge | 21.0 | 2293.0 | 11.950 | 784.0 |
| Ethridge | 22.0 | 1241.0 | 9.607 | 782.1 |
| Ethridge | 23.0 | 204.1 | 10.180 | 772.2 |
| Ethridge | 24.0 | 2173.0 | 13.040 | 766.4 |
| Varney | 25.0 | 1928.0 | 11.120 | 770.7 |
| Varney | 26.0 | 2284.0 | 13.360 | 784.4 |
| Varney | 27.0 | 2617.0 | 10.800 | 790.5 |
| Varney | 28.0 | 2257.0 | 11.200 | 783.8 |
| Varney | 29.0 | 2534.0 | 11.230 | 788.7 |
| Varney | 30.0 | 2812.0 | 10.830 | 799.2 |
| Varney | 31.0 | 3411.0 | 13.290 | 790.7 |
| Varney | 32.0 | 2895.0 | 10.980 | 789.7 |
| Varney | 33.0 | 2507.0 | 10.620 | 792.9 |
| Varney | 34.0 | 3176.0 | 10.830 | 792.5 |
| Varney | 35.0 | 2884.0 | 10.470 | 793.2 |
| Varney | 36.0 | 2777.0 | 10.470 | 797.2 |
| Varney | 37.0 | 2547.0 | 10.650 | 797.8 |
| Yetull | 38.0 | 3486.0 | 15.390 | 798.8 |
| Yetull | 39.0 | 2260.0 | 11.120 | 791.0 |
| Yetull | 40.0 | 2178.0 | 12.320 | 781.2 |
| Yetull | 41.0 | 2169.0 | 13.220 | 770.0 |
| Yetull | 42.0 | 1595.0 | 10.260 | 747.1 |
| Yetull | 43.0 | 1212.0 | 14.300 | 651.1 |
| Yetull | 44.0 | 2464.0 | 12.210 | 773.4 |

Table 21--Continued.

| Soil unit | Sample Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Yetull | 45.0 | 2507.0 | 12.350 | 784.7 |
| Yetull | 46.0 | 2294.0 | 10.470 | 791.0 |
| Yetull | 47.0 | 2646.0 | 12.210 | 776.7 |
| Yetull | 48.0 | 2318.0 | 10.180 | 778.9 |
| Yetull | 49.0 | 2138.0 | 9.715 | 782.0 |
| Yetull | 50.0 | 2488.0 | 13.980 | 779.3 |
| Yetull | 51.0 | 1520.0 | 10.080 | 773.5 |

# APPENDIX C

## Yield, Test Weight and Protein On Contrasting Soils Units In Soil Fertility Studies

Table 22. Yield and test weight of spring wheat samples harvested on contrasting soil units in a field near Havre (1987).

| Soil unit | Plot Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Phillips | 16.0 | 2091.0 | 7.296 | 785.1 |
| Phillips | 1.0 | 1862.0 | 7.296 | 787.6 |
| Phillips | 9.0 | 2088.0 | 7.296 | 787.6 |
| Phillips | 10.0 | 1907.0 | 7.296 | 786.4 |
| Phillips | 4.0 | 1687.0 | 7.296 | 790.2 |
| Phillips | 11.0 | 1901.0 | 7.296 | 777.3 |
| Phillips | 6.0 | 2157.0 | 7.296 | 774.8 |
| Phillips | 8.0 | 1946.0 | 7.296 | 781.2 |
| Phillips | 3.0 | 2316.0 | 7.296 | 770.9 |
| Phillips | 5.0 | 2018.0 | 7.296 | 787.6 |
| Phillips | 7.0 | 2025.0 | 7.296 | 794.1 |
| Phillips | 12.0 | 1799.0 | 7.296 | 785.1 |
| Phillips | 13.0 | 2057.0 | 7.296 | 786.4 |
| Phillips | 14.0 | 1836.0 | 7.296 | 794.1 |
| Phillips | 15.0 | 2041.0 | 7.296 | 781.2 |
| Phillips | 2.0 | 2054.0 | 7.296 | 776.1 |
| Phillips | 17.0 | 2123.0 | 7.296 | 786.4 |
| Phillips | 24.0 | 1628.0 | 7.296 | 792.8 |
| Phillips | 25.0 | 2205.0 | 7.296 | 777.3 |
| Phillips | 19.0 | 1991.0 | 7.296 | 779.9 |
| Phillips | 26.0 | 2343.0 | 7.296 | 776.1 |
| Phillips | 21.0 | 2077.0 | 7.296 | 774.8 |
| Phillips | 23.0 | 2142.0 | 7.296 | 788.9 |
| Phillips | 18.0 | 1989.0 | 7.296 | 782.5 |
| Phillips | 20.0 | 1644.0 | 5.472 | 786.4 |
| Phillips | 22.0 | 2125.0 | 7.296 | 778.6 |
| Phillips | 27.0 | 1787.0 | 7.296 | 782.5 |
| Phillips | 28.0 | 1769.0 | 7.296 | 773.5 |
| Phillips | 29.0 | 1777.0 | 7.296 | 778.6 |
| Phillips | 30.0 | 1874.0 | 7.296 | 759.3 |
| Phillips | 31.0 | 1783.0 | 7.296 | 763.2 |
| Phillips | 32.0 | 1846.0 | 7.296 | 781.2 |
| Phillips | 48.0 | 2008.0 | 7.296 | 785.1 |
| Phillips | 41.0 | 2405.0 | 7.296 | 792.8 |
| Phillips | 34.0 | 2025.0 | 7.296 | 785.1 |
| Phillips | 42.0 | 2282.0 | 7.296 | 783.8 |
| Phillips | 36.0 | 1881.0 | 5.472 | 797.9 |
| Phillips | 43.0 | 2017.0 | 7.296 | 761.9 |
| Phillips | 38.0 | 2135.0 | 7.296 | 790.2 |
| Phillips | 40.0 | 2333.0 | 7.296 | 791.5 |
| Phillips | 35.0 | 1998.0 | 7.296 | 785.1 |
| Phillips | 37.0 | 2408.0 | 7.296 | 790.2 |

Table 22--Continued.

| Soil unit | Plot Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Phillips | 39.0 | 2470.0 | 7.296 | 790.2 |
| Phillips | 44.0 | 1939.0 | 7.296 | 761.9 |
| Phillips | 45.0 | 1966.0 | 7.296 | 772.2 |
| Phillips | 46.0 | 2166.0 | 7.296 | 772.2 |
| Phillips | 47.0 | 1844.0 | 7.296 | 774.8 |
| Phillips | 33.0 | 2143.0 | 7.296 | 786.4 |
| Phillips | 49.0 | 1987.0 | 7.174 | 785.1 |
| Phillips | 57.0 | 2078.0 | 7.053 | 799.2 |
| Phillips | 50.0 | 2081.0 | 7.174 | 792.8 |
| Phillips | 58.0 | 2270.0 | 6.931 | 777.3 |
| Phillips | 52.0 | 1747.0 | 5.381 | 801.8 |
| Phillips | 59.0 | 2068.0 | 6.931 | 787.6 |
| Phillips | 54.0 | 2551.0 | 7.174 | 797.9 |
| Phillips | 56.0 | 2003.0 | 7.174 | 774.8 |
| Phillips | 51.0 | 2549.0 | 7.174 | 804.4 |
| Phillips | 53.0 | 2169.0 | 7.174 | 806.9 |
| Phillips | 55.0 | 2250.0 | 7.174 | 791.5 |
| Phillips | 60.0 | 2190.0 | 6.931 | 785.1 |
| Phillips | 61.0 | 2552.0 | 7.296 | 779.9 |
| Phillips | 62.0 | 2459.0 | 7.296 | 778.6 |
| Phillips | 63.0 | 2101.0 | 7.296 | 779.9 |
| Phillips | 64.0 | 1897.0 | 7.296 | 790.2 |
| Telstad | 1.0 | 1459.0 | 7.296 | 768.3 |
| Telstad | 2.0 | 1373.0 | 7.296 | 760.6 |
| Telstad | 3.0 | 1594.0 | 7.296 | 751.6 |
| Telstad | 4.0 | 1566.0 | 7.296 | 769.6 |
| Telstad | 5.0 | 1693.0 | 7.296 | 800.5 |
| Telstad | 6.0 | 2278.0 | 7.296 | 770.9 |
| Telstad | 7.0 | 1940.0 | 7.296 | 796.7 |
| Telstad | 8.0 | 1865.0 | 7.296 | 779.9 |
| Telstad | 9.0 | 1838.0 | 7.296 | 786.4 |
| Telstad | 10.0 | 2051.0 | 7.296 | 790.2 |
| Telstad | 11.0 | 2446.0 | 7.296 | 800.5 |
| Telstad | 12.0 | 2166.0 | 7.296 | 797.9 |
| Telstad | 13.0 | 2033.0 | 7.296 | 786.4 |
| Telstad | 15.0 | 2026.0 | 5.928 | 790.2 |
| Telstad | 17.0 | 1751.0 | 7.296 | 758.0 |
| Telstad | 18.0 | 1757.0 | 7.296 | 767.1 |
| Telstad | 19.0 | 1761.0 | 7.296 | 754.2 |
| Telstad | 20.0 | 1885.0 | 7.296 | 770.9 |
| Telstad | 21.0 | 1780.0 | 7.296 | 774.8 |
| Telstad | 22.0 | 1977.0 | 7.296 | 778.6 |
| Telstad | 23.0 | 1920.0 | 7.296 | 781.2 |
| Telstad | 24.0 | 1846.0 | 7.296 | 797.9 |

Table 22--Continued.

| Soil unit | Plot Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Telstad | 25.0 | 2085.0 | 7.296 | 781.2 |
| Telstad | 30.0 | 1312.0 | 3.709 | 787.6 |
| Telstad | 31.0 | 1026.0 | 7.539 | 777.3 |
| Telstad | 32.0 | 1655.0 | 5.654 | 795.4 |
| Telstad | 33.0 | 1636.0 | 7.296 | 792.8 |
| Telstad | 34.0 | 1797.0 | 7.296 | 776.1 |
| Telstad | 35.0 | 1785.0 | 7.296 | 795.4 |
| Telstad | 36.0 | 1791.0 | 7.296 | 777.3 |
| Telstad | 37.0 | 2277.0 | 7.296 | 790.2 |
| Telstad | 38.0 | 2171.0 | 7.296 | 777.3 |
| Telstad | 39.0 | 2123.0 | 7.296 | 776.1 |
| Telstad | 40.0 | 2084.0 | 7.296 | 769.6 |
| Telstad | 41.0 | 2383.0 | 7.296 | 783.8 |
| Telstad | 42.0 | 2209.0 | 7.296 | 785.1 |
| Telstad | 43.0 | 2019.0 | 7.296 | 787.6 |
| Telstad | 44.0 | 2246.0 | 7.296 | 785.1 |
| Telstad | 45.0 | 2034.0 | 7.296 | 782.5 |
| Telstad | 46.0 | 1212.0 | 7.296 | 777.3 |
| Telstad | 47.0 | 1218.0 | 7.296 | 791.5 |
| Telstad | 48.0 | 1441.0 | 7.296 | 791.5 |
| Telstad | 49.0 | 1889.0 | 7.904 | 795.4 |
| Telstad | 50.0 | 2419.0 | 7.904 | 795.4 |
| Telstad | 51.0 | 2119.0 | 7.296 | 792.8 |
| Telstad | 52.0 | 1722.0 | 7.904 | 785.1 |
| Telstad | 53.0 | 2041.0 | 7.904 | 770.9 |
| Telstad | 54.0 | 2241.0 | 7.904 | 772.2 |
| Telstad | 55.0 | 2005.0 | 7.904 | 778.6 |
| Telstad | 56.0 | 1951.0 | 7.904 | 783.8 |
| Telstad | 57.0 | 1923.0 | 7.904 | 795.4 |
| Telstad | 58.0 | 2321.0 | 7.904 | 794.1 |
| Telstad | 59.0 | 2013.0 | 5.928 | 804.4 |
| Telstad | 60.0 | 2070.0 | 7.904 | 786.4 |
| Telstad | 62.0 | 2345.0 | 7.904 | 792.8 |
| Telstad | 63.0 | 1549.0 | 5.092 | 787.6 |
| Telstad | 64.0 | 2243.0 | 7.638 | 794.1 |
| Evanston | 51.0 | 1424.0 | 5.472 | 796.7 |
| Evanston | 1.0 | 1527.0 | 7.296 | 790.2 |
| Evanston | 49.0 | 1208.0 | 7.296 | 803.1 |
| Evanston | 3.0 | 1838.0 | 7.296 | 778.6 |
| Evanston | 4.0 | 1836.0 | 6.840 | 794.1 |
| Evanston | 33.0 | 1416.0 | 7.539 | 790.2 |
| Evanston | 2.0 | 1878.0 | 7.296 | 781.2 |
| Evanston | 20.0 | 1737.0 | 6.384 | 792.8 |
| Evanston | 36.0 | 1711.0 | 7.539 | 791.5 |

Table 22--Continued.

| Soil unit | Plot Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Evanston | 35.0 | 1424.0 | 5.654 | 797.9 |
| Evanston | 34.0 | 1686.0 | 7.539 | 790.2 |
| Evanston | 18.0 | 1692.0 | 7.296 | 785.1 |
| Evanston | 19.0 | 1773.0 | 7.296 | 781.2 |
| Evanston | 50.0 | 1467.0 | 7.296 | 796.7 |
| Evanston | 52.0 | 1733.0 | 7.296 | 803.1 |
| Evanston | 17.0 | 1359.0 | 7.296 | 787.6 |
| Evanston | 6.0 | 1707.0 | 7.296 | 776.1 |
| Evanston | 8.0 | 1878.0 | 7.296 | 791.5 |
| Evanston | 7.0 | 1766.0 | 7.296 | 783.8 |
| Evanston | 5.0 | 1769.0 | 7.296 | 799.2 |
| Evanston | 21.0 | 1872.0 | 7.296 | 795.4 |
| Evanston | 22.0 | 2212.0 | 7.296 | 782.5 |
| Evanston | 56.0 | 2082.0 | 7.296 | 785.1 |
| Evanston | 24.0 | 1554.0 | 7.296 | 786.4 |
| Evanston | 53.0 | 2050.0 | 7.296 | 797.9 |
| Evanston | 55.0 | 2131.0 | 7.296 | 779.9 |
| Evanston | 54.0 | 2209.0 | 7.296 | 797.9 |
| Evanston | 23.0 | 2566.0 | 7.296 | 801.8 |
| Evanston | 37.0 | 2015.0 | 7.539 | 786.4 |
| Evanston | 39.0 | 1513.0 | 7.539 | 772.2 |
| Evanston | 40.0 | 1601.0 | 7.539 | 792.8 |
| Evanston | 38.0 | 1501.0 | 7.539 | 756.8 |
| Evanston | 27.0 | 1719.0 | 7.296 | 794.1 |
| Evanston | 26.0 | 1584.0 | 7.296 | 801.8 |
| Evanston | 25.0 | 2349.0 | 7.296 | 810.8 |
| Evanston | 11.0 | 1682.0 | 7.296 | 791.5 |
| Evanston | 10.0 | 1620.0 | 7.296 | 791.5 |
| Evanston | 28.0 | 1825.0 | 7.296 | 803.1 |
| Evanston | 12.0 | 1676.0 | 7.296 | 792.8 |
| Evanston | 58.0 | 1970.0 | 7.296 | 795.4 |
| Evanston | 41.0 | 2204.0 | 7.539 | 792.8 |
| Evanston | 42.0 | 2739.0 | 7.539 | 803.1 |
| Evanston | 43.0 | 2465.0 | 7.539 | 800.5 |
| Evanston | 44.0 | 2806.0 | 7.539 | 813.4 |
| Evanston | 9.0 | 1090.0 | 7.296 | 791.5 |
| Evanston | 59.0 | 2092.0 | 7.296 | 795.4 |
| Evanston | 57.0 | 2251.0 | 6.840 | 799.2 |
| Evanston | 48.0 | 1602.0 | 7.539 | 781.2 |
| Evanston | 46.0 | 2671.0 | 7.539 | 801.8 |
| Evanston | 45.0 | 2794.0 | 7.539 | 810.8 |
| Evanston | 32.0 | 916.0 | 7.296 | 797.9 |
| Evanston | 47.0 | 2304.0 | 7.539 | 785.1 |
| Evanston | 16.0 | 1466.0 | 7.296 | 801.8 |

Table 22--Continued.

| Soil unit | Plot Number | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| Evanston | 15.0 | 1302.0 | 7.296 | 800.5 |
| Evanston | 14.0 | 728.0 | 7.296 | 803.1 |
| Evanston | 13.0 | 1471.0 | 7.296 | 786.4 |
| Evanston | 30.0 | 2026.0 | 7.296 | 803.1 |
| Evanston | 29.0 | 1642.0 | 7.296 | 795.4 |
| Evanston | 31.0 | 1927.0 | 7.296 | 791.5 |
| Evanston | 62.0 | 1646.0 | 7.296 | 788.9 |
| Evanston | 63.0 | 1695.0 | 7.296 | 790.2 |
| Evanston | 64.0 | 1407.0 | 7.296 | 787.6 |

Table 23. Protein, replication, and fertilizer treatment of spring wheat samples harvested on contrasting soil units in a field near Havre (1987).

| Soil unit | Plot Number | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| Phillips | 16.0 | 135.0 | 1.0 | 16.0 |
| Phillips | 1.0 | 133.0 | 1.0 | 5.0 |
| Phillips | 9.0 | 133.0 | 1.0 | 7.0 |
| Phillips | 10.0 | 130.0 | 1.0 | 10.0 |
| Phillips | 4.0 | 139.0 | 1.0 | 2.0 |
| Phillips | 11.0 | 132.0 | 1.0 | 15.0 |
| Phillips | 6.0 | 138.0 | 1.0 | 9.0 |
| Phillips | 8.0 | 134.0 | 1.0 | 11.0 |
| Phillips | 3.0 | 136.0 | 1.0 | 4.0 |
| Phillips | 5.0 | 134.0 | 1.0 | 3.0 |
| Phillips | 7.0 | 129.0 | 1.0 | 6.0 |
| Phillips | 12.0 | 132.0 | 1.0 | 12.0 |
| Phillips | 13.0 | 129.0 | 1.0 | 13.0 |
| Phillips | 14.0 | 134.0 | 1.0 | 1.0 |
| Phillips | 15.0 | 137.0 | 1.0 | 8.0 |
| Phillips | 2.0 | 135.0 | 1.0 | 14.0 |
| Phillips | 17.0 | 139.0 | 2.0 | 9.0 |
| Phillips | 24.0 | 133.0 | 2.0 | 1.0 |
| Phillips | 25.0 | 137.0 | 2.0 | 4.0 |
| Phillips | 19.0 | 132.0 | 2.0 | 8.0 |
| Phillips | 26.0 | 137.0 | 2.0 | 14.0 |
| Phillips | 21.0 | 133.0 | 2.0 | 10.0 |
| Phillips | 23.0 | 130.0 | 2.0 | 5.0 |
| Phillips | 18.0 | 134.0 | 2.0 | 16.0 |
| Phillips | 20.0 | 134.0 | 2.0 | 7.0 |
| Phillips | 22.0 | 133.0 | 2.0 | 15.0 |
| Phillips | 27.0 | 137.0 | 2.0 | 2.0 |
| Phillips | 28.0 | 134.0 | 2.0 | 13.0 |
| Phillips | 29.0 | 136.0 | 2.0 | 6.0 |
| Phillips | 30.0 | 137.0 | 2.0 | 11.0 |
| Phillips | 31.0 | 137.0 | 2.0 | 12.0 |
| Phillips | 32.0 | 128.0 | 2.0 | 3.0 |
| Phillips | 48.0 | 135.0 | 3.0 | 10.0 |
| Phillips | 41.0 | 132.0 | 3.0 | 11.0 |
| Phillips | 34.0 | 132.0 | 3.0 | 15.0 |
| Phillips | 42.0 | 129.0 | 3.0 | 6.0 |
| Phillips | 36.0 | 131.0 | 3.0 | 12.0 |
| Phillips | 43.0 | 143.0 | 3.0 | 9.0 |
| Phillips | 38.0 | 138.0 | 3.0 | 2.0 |
| Phillips | 40.0 | 133.0 | 3.0 | 13.0 |
| Phillips | 35.0 | 131.0 | 3.0 | 1.0 |
| Phillips | 37.0 | 130.0 | 3.0 | 8.0 |

Table 23--Continued.

| Soil unit | Plot Number | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| Phillips | 39.0 | 132.0 | 3.0 | 16.0 |
| Phillips | 44.0 | 130.0 | 3.0 | 5.0 |
| Phillips | 45.0 | 143.0 | 3.0 | 14.0 |
| Phillips | 46.0 | 140.0 | 3.0 | 4.0 |
| Phillips | 47.0 | 134.0 | 3.0 | 7.0 |
| Phillips | 33.0 | 130.0 | 3.0 | 3.0 |
| Phillips | 49.0 | 138.0 | 4.0 | 6.0 |
| Phillips | 57.0 | 133.0 | 4.0 | 1.0 |
| Phillips | 50.0 | 135.0 | 4.0 | 11.0 |
| Phillips | 58.0 | 132.0 | 4.0 | 8.0 |
| Phillips | 52.0 | 138.0 | 4.0 | 10.0 |
| Phillips | 59.0 | 134.0 | 4.0 | 3.0 |
| Phillips | 54.0 | 134.0 | 4.0 | 4.0 |
| Phillips | 56.0 | 136.0 | 4.0 | 7.0 |
| Phillips | 51.0 | 140.0 | 4.0 | 13.0 |
| Phillips | 53.0 | 131.0 | 4.0 | 14.0 |
| Phillips | 55.0 | 135.0 | 4.0 | 12.0 |
| Phillips | 60.0 | 133.0 | 4.0 | 16.0 |
| Phillips | 61.0 | 137.0 | 4.0 | 9.0 |
| Phillips | 62.0 | 133.0 | 4.0 | 15.0 |
| Phillips | 63.0 | 135.0 | 4.0 | 5.0 |
| Phillips | 64.0 | 139.0 | 4.0 | 2.0 |
| Telstad | 1.0 | 126.0 | 1.0 | 5.0 |
| Telstad | 2.0 | 124.0 | 1.0 | 14.0 |
| Telstad | 3.0 | 128.0 | 1.0 | 4.0 |
| Telstad | 4.0 | 127.0 | 1.0 | 2.0 |
| Telstad | 5.0 | 125.0 | 1.0 | 3.0 |
| Telstad | 6.0 | 133.0 | 1.0 | 9.0 |
| Telstad | 7.0 | 126.0 | 1.0 | 6.0 |
| Telstad | 8.0 | 129.0 | 1.0 | 11.0 |
| Telstad | 9.0 | 125.0 | 1.0 | 7.0 |
| Telstad | 10.0 | 135.0 | 1.0 | 10.0 |
| Telstad | 11.0 | 127.0 | 1.0 | 15.0 |
| Telstad | 12.0 | 131.0 | 1.0 | 12.0 |
| Telstad | 13.0 | 132.0 | 1.0 | 13.0 |
| Telstad | 15.0 | 139.0 | 1.0 | 8.0 |
| Telstad | 17.0 | 139.0 | 2.0 | 9.0 |
| Telstad | 18.0 | 135.0 | 2.0 | 16.0 |
| Telstad | 19.0 | 137.0 | 2.0 | 8.0 |
| Telstad | 20.0 | 129.0 | 2.0 | 7.0 |
| Telstad | 21.0 | 132.0 | 2.0 | 10.0 |
| Telstad | 22.0 | 131.0 | 2.0 | 15.0 |
| Telstad | 23.0 | 129.0 | 2.0 | 5.0 |
| Telstad | 24.0 | 132.0 | 2.0 | 1.0 |

Table 23--Continued.

| Soil unit | Plot Number | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| Telstad | 25.0 | 131.0 | 2.0 | 4.0 |
| Telstad | 30.0 | 135.0 | 2.0 | 11.0 |
| Telstad | 31.0 | 135.0 | 2.0 | 12.0 |
| Telstad | 32.0 | 121.0 | 2.0 | 3.0 |
| Telstad | 33.0 | 130.0 | 3.0 | 3.0 |
| Telstad | 34.0 | 127.0 | 3.0 | 15.0 |
| Telstad | 35.0 | 128.0 | 3.0 | 1.0 |
| Telstad | 36.0 | 131.0 | 3.0 | 12.0 |
| Telstad | 37.0 | 129.0 | 3.0 | 8.0 |
| Telstad | 38.0 | 134.0 | 3.0 | 2.0 |
| Telstad | 39.0 | 131.0 | 3.0 | 16.0 |
| Telstad | 40.0 | 131.0 | 3.0 | 13.0 |
| Telstad | 41.0 | 134.0 | 3.0 | 11.0 |
| Telstad | 42.0 | 128.0 | 3.0 | 6.0 |
| Telstad | 43.0 | 128.0 | 3.0 | 9.0 |
| Telstad | 44.0 | 132.0 | 3.0 | 5.0 |
| Telstad | 45.0 | 136.0 | 3.0 | 14.0 |
| Telstad | 46.0 | 135.0 | 3.0 | 4.0 |
| Telstad | 47.0 | 133.0 | 3.0 | 7.0 |
| Telstad | 48.0 | 132.0 | 3.0 | 10.0 |
| Telstad | 49.0 | 130.0 | 4.0 | 6.0 |
| Telstad | 50.0 | 130.0 | 4.0 | 11.0 |
| Telstad | 51.0 | 130.0 | 4.0 | 13.0 |
| Telstad | 52.0 | 139.0 | 4.0 | 10.0 |
| Telstad | 53.0 | 137.0 | 4.0 | 14.0 |
| Telstad | 54.0 | 134.0 | 4.0 | 4.0 |
| Telstad | 55.0 | 131.0 | 4.0 | 12.0 |
| Telstad | 56.0 | 132.0 | 4.0 | 7.0 |
| Telstad | 57.0 | 129.0 | 4.0 | 1.0 |
| Telstad | 58.0 | 131.0 | 4.0 | 8.0 |
| Telstad | 59.0 | 127.0 | 4.0 | 3.0 |
| Telstad | 60.0 | 126.0 | 4.0 | 16.0 |
| Telstad | 62.0 | 125.0 | 4.0 | 15.0 |
| Telstad | 63.0 | 133.0 | 4.0 | 5.0 |
| Telstad | 64.0 | 132.0 | 4.0 | 2.0 |
| Evanston | 51.0 | 142.0 | 1.0 | 13.0 |
| Evanston | 1.0 | 135.0 | 1.0 | 5.0 |
| Evanston | 49.0 | 136.0 | 1.0 | 6.0 |
| Evanston | 3.0 | 133.0 | 1.0 | 4.0 |
| Evanston | 4.0 | 139.0 | 1.0 | 2.0 |
| Evanston | 33.0 | 133.0 | 1.0 | 3.0 |
| Evanston | 2.0 | 135.0 | 1.0 | 14.0 |
| Evanston | 20.0 | 136.0 | 1.0 | 7.0 |
| Evanston | 36.0 | 136.0 | 1.0 | 12.0 |

Table 23--Continued.

| Soil unit | Plot Number | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| Evanston | 35.0 | 137.0 | 1.0 | 1.0 |
| Evanston | 34.0 | 133.0 | 1.0 | 15.0 |
| Evanston | 18.0 | 132.0 | 1.0 | 16.0 |
| Evanston | 19.0 | 135.0 | 1.0 | 8.0 |
| Evanston | 50.0 | 139.0 | 1.0 | 11.0 |
| Evanston | 52.0 | 143.0 | 1.0 | 10.0 |
| Evanston | 17.0 | 148.0 | 1.0 | 9.0 |
| Evanston | 6.0 | 138.0 | 2.0 | 9.0 |
| Evanston | 8.0 | 132.0 | 2.0 | 11.0 |
| Evanston | 7.0 | 131.0 | 2.0 | 6.0 |
| Evanston | 5.0 | 121.0 | 2.0 | 3.0 |
| Evanston | 21.0 | 134.0 | 2.0 | 10.0 |
| Evanston | 22.0 | 131.0 | 2.0 | 15.0 |
| Evanston | 56.0 | 132.0 | 2.0 | 7.0 |
| Evanston | 24.0 | 139.0 | 2.0 | 1.0 |
| Evanston | 53.0 | 139.0 | 2.0 | 14.0 |
| Evanston | 55.0 | 133.0 | 2.0 | 12.0 |
| Evanston | 54.0 | 136.0 | 2.0 | 4.0 |
| Evanston | 23.0 | 130.0 | 2.0 | 5.0 |
| Evanston | 37.0 | 138.0 | 2.0 | 8.0 |
| Evanston | 39.0 | 143.0 | 2.0 | 16.0 |
| Evanston | 40.0 | 139.0 | 2.0 | 13.0 |
| Evanston | 38.0 | 140.0 | 2.0 | 2.0 |
| Evanston | 27.0 | 132.0 | 3.0 | 2.0 |
| Evanston | 26.0 | 123.0 | 3.0 | 6.0 |
| Evanston | 25.0 | 126.0 | 3.0 | 11.0 |
| Evanston | 11.0 | 143.0 | 3.0 | 15.0 |
| Evanston | 10.0 | 138.0 | 3.0 | 8.0 |
| Evanston | 28.0 | 142.0 | 3.0 | 13.0 |
| Evanston | 12.0 | 140.0 | 3.0 | 12.0 |
| Evanston | 58.0 | 138.0 | 3.0 | 10.0 |
| Evanston | 41.0 | 134.0 | 3.0 | 4.0 |
| Evanston | 42.0 | 139.0 | 3.0 | 14.0 |
| Evanston | 43.0 | 147.0 | 3.0 | 9.0 |
| Evanston | 44.0 | 136.0 | 3.0 | 5.0 |
| Evanston | 9.0 | 138.0 | 3.0 | 1.0 |
| Evanston | 59.0 | 137.0 | 3.0 | 3.0 |
| Evanston | 57.0 | 128.0 | 3.0 | 7.0 |
| Evanston | 48.0 | 144.0 | 4.0 | 10.0 |
| Evanston | 46.0 | 136.0 | 4.0 | 4.0 |
| Evanston | 45.0 | 142.0 | 4.0 | 14.0 |
| Evanston | 32.0 | 139.0 | 4.0 | 3.0 |
| Evanston | 47.0 | 140.0 | 4.0 | 7.0 |
| Evanston | 16.0 | 133.0 | 4.0 | 16.0 |

Table 23--Continued.

| Soil unit | Plot Number | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| Evanston | 15.0 | 145.0 | 4.0 | 8.0 |
| Evanston | 14.0 | 128.0 | 4.0 | 1.0 |
| Evanston | 13.0 | 150.0 | 4.0 | 13.0 |
| Evanston | 30.0 | 136.0 | 4.0 | 11.0 |
| Evanston | 29.0 | 136.0 | 4.0 | 6.0 |
| Evanston | 31.0 | 144.0 | 4.0 | 12.0 |
| Evanston | 62.0 | 131.0 | 4.0 | 15.0 |
| Evanston | 63.0 | 132.0 | 4.0 | 5.0 |
| Evanston | 64.0 | 137.0 | 4.0 | 2.0 |

[1] Fertilizer treatments, as a ratio of recommended N, P, and K (N-P-K), were 1 = 0-0-0, 2 = 1-0-0, 3 = 0-1-0, 4 = 1-1-0, 5 = 1-1-1, 6 = 0.5-1-1, 7 = 0.75-1-1, 8 = 1.25-1-1, 9 = 1.5-1-1, 10 = 1-0.5-1, 11 = 1-1.5-1, 12 = 1-1-0.5, 13 = 1-1-1.5, 14 = 1.5-1.5-1.5, 15 = 1-1-1 plus 20 kg $ha^{-1}$ $CaSO_4$, 16 = treatment 15 plus 20 kg $ha^{-1}$ $Fe_2(SO_4)_3$, 10 kg $ha^{-1}$ $ZnSO_4$ , and 1 kg $ha^{-1}$ $B_2(SO_4)_3$.

Table 24. Yield and test weight of winter wheat samples harvested on contrasting soil units in a field near Power.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 1 | Delpoint | 2984.0 | 8.390 | 812.1 |
| 2 | Delpoint | 3229.0 | 8.390 | 817.2 |
| 3 | Delpoint | 3097.0 | 8.390 | 814.7 |
| 4 | Delpoint | 2315.0 | 8.390 | 772.2 |
| 5 | Delpoint | 2121.0 | 8.390 | 760.6 |
| 6 | Delpoint | 2777.0 | 8.634 | 814.7 |
| 7 | Delpoint | 2210.0 | 8.634 | 805.7 |
| 8 | Delpoint | 2699.0 | 8.634 | 796.7 |
| 9 | Delpoint | 2567.0 | 8.634 | 812.1 |
| 10 | Delpoint | 2134.0 | 8.512 | 812.1 |
| 11 | Delpoint | 2490.0 | 8.512 | 812.1 |
| 12 | Delpoint | 2195.0 | 8.512 | 816.0 |
| 13 | Delpoint | 2443.0 | 8.512 | 808.2 |
| 14 | Delpoint | 1873.0 | 8.512 | 808.2 |
| 15 | Delpoint | 2743.0 | 8.512 | 819.8 |
| 16 | Delpoint | 2709.0 | 8.390 | 816.0 |
| 17 | Delpoint | 3213.0 | 8.269 | 822.4 |
| 18 | Delpoint | 3164.0 | 8.147 | 822.4 |
| 19 | Delpoint | 3081.0 | 8.147 | 822.4 |
| 20 | Delpoint | 2931.0 | 8.147 | 823.7 |
| 21 | Delpoint | 2804.0 | 8.147 | 823.7 |
| 22 | Delpoint | 2683.0 | 8.147 | 822.4 |
| 23 | Delpoint | 2808.0 | 8.147 | 821.1 |
| 24 | Delpoint | 1935.0 | 8.269 | 821.1 |
| 25 | Delpoint | 2717.0 | 8.269 | 819.8 |
| 26 | Delpoint | 2666.0 | 8.147 | 822.4 |
| 27 | Delpoint | 2131.0 | 8.147 | 799.2 |
| 28 | Delpoint | 2991.0 | 8.147 | 823.7 |
| 29 | Delpoint | 2325.0 | 8.147 | 818.5 |
| 30 | Delpoint | 2917.0 | 8.147 | 826.3 |
| 31 | Delpoint | 2674.0 | 8.147 | 821.1 |
| 32 | Delpoint | 2668.0 | 8.147 | 821.1 |
| 33 | Delpoint | 2888.0 | 8.147 | 821.1 |
| 34 | Delpoint | 3123.0 | 8.147 | 825.0 |
| 35 | Delpoint | 2391.0 | 8.147 | 818.5 |
| 36 | Delpoint | 3044.0 | 8.147 | 828.8 |
| 37 | Delpoint | 2981.0 | 8.147 | 818.5 |
| 38 | Delpoint | 2426.0 | 8.147 | 818.5 |
| 39 | Delpoint | 2964.0 | 8.147 | 823.7 |
| 40 | Delpoint | 2795.0 | 8.147 | 823.7 |
| 41 | Delpoint | 2843.0 | 8.147 | 827.5 |
| 42 | Delpoint | 2531.0 | 8.026 | 827.5 |

Table 24--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 43 | Delpoint | 2856.0 | 8.026 | 822.4 |
| 44 | Delpoint | 2810.0 | 8.026 | 828.8 |
| 45 | Delpoint | 2767.0 | 8.026 | 830.1 |
| 46 | Delpoint | 3021.0 | 8.147 | 805.7 |
| 47 | Delpoint | 2797.0 | 8.147 | 825.0 |
| 48 | Delpoint | 2722.0 | 8.147 | 822.4 |
| 49 | Delpoint | 2717.0 | 8.147 | 826.3 |
| 50 | Delpoint | 3067.0 | 8.147 | 819.8 |
| 51 | Delpoint | 3019.0 | 8.390 | 821.1 |
| 52 | Delpoint | 3060.0 | 8.147 | 826.3 |
| 53 | Delpoint | 2945.0 | 8.147 | 823.7 |
| 54 | Delpoint | 2740.0 | 8.026 | 825.0 |
| 55 | Delpoint | 2640.0 | 8.026 | 823.7 |
| 56 | Delpoint | 2573.0 | 8.026 | 817.2 |
| 57 | Delpoint | 2216.0 | 8.147 | 796.7 |
| 58 | Delpoint | 2984.0 | 8.269 | 826.3 |
| 59 | Delpoint | 2372.0 | 8.147 | 816.0 |
| 60 | Delpoint | 2825.0 | 8.147 | 827.5 |
| 61 | Delpoint | 2888.0 | 8.147 | 828.8 |
| 62 | Delpoint | 2945.0 | 8.147 | 828.8 |
| 63 | Delpoint | 2999.0 | 8.147 | 827.5 |
| 64 | Delpoint | 2363.0 | 8.390 | 821.1 |
| 65 | Cabbart | 2058.0 | 8.269 | 800.5 |
| 66 | Cabbart | 2115.0 | 8.390 | 803.1 |
| 67 | Cabbart | 1720.0 | 8.390 | 792.8 |
| 68 | Cabbart | 1557.0 | 8.390 | 797.9 |
| 69 | Cabbart | 1438.0 | 8.634 | 790.2 |
| 70 | Cabbart | 2109.0 | 8.634 | 803.1 |
| 71 | Cabbart | 1898.0 | 8.877 | 795.4 |
| 72 | Cabbart | 1824.0 | 8.634 | 800.5 |
| 73 | Cabbart | 1828.0 | 8.755 | 794.1 |
| 74 | Cabbart | 1849.0 | 8.877 | 791.5 |
| 75 | Cabbart | 1856.0 | 8.877 | 791.5 |
| 76 | Cabbart | 1997.0 | 8.877 | 795.4 |
| 77 | Cabbart | 2125.0 | 8.877 | 800.5 |
| 78 | Cabbart | 1468.0 | 8.998 | 788.9 |
| 79 | Cabbart | 2017.0 | 8.877 | 790.2 |
| 80 | Cabbart | 1928.0 | 8.877 | 790.2 |
| 81 | Cabbart | 2204.0 | 8.269 | 805.7 |
| 82 | Cabbart | 2130.0 | 8.147 | 806.9 |
| 83 | Cabbart | 1972.0 | 8.147 | 806.9 |
| 84 | Cabbart | 2027.0 | 8.147 | 799.2 |
| 85 | Cabbart | 1853.0 | 8.147 | 797.9 |
| 86 | Cabbart | 2150.0 | 8.147 | 797.9 |

Table 24--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 87 | Cabbart | 1868.0 | 8.147 | 806.9 |
| 88 | Cabbart | 1477.0 | 8.026 | 800.5 |
| 89 | Cabbart | 1784.0 | 8.026 | 795.4 |
| 90 | Cabbart | 1729.0 | 8.026 | 805.7 |
| 91 | Cabbart | 1344.0 | 7.904 | 794.1 |
| 92 | Cabbart | 1636.0 | 7.782 | 799.2 |
| 93 | Cabbart | 1328.0 | 8.026 | 785.1 |
| 94 | Cabbart | 1849.0 | 8.026 | 803.1 |
| 95 | Cabbart | 1813.0 | 8.026 | 792.8 |
| 96 | Cabbart | 1655.0 | 8.026 | 803.1 |
| 97 | Cabbart | 2129.0 | 8.269 | 804.4 |
| 98 | Cabbart | 2248.0 | 8.390 | 805.7 |
| 99 | Cabbart | 1618.0 | 8.390 | 797.9 |
| 100 | Cabbart | 1990.0 | 8.269 | 800.5 |
| 101 | Cabbart | 2199.0 | 8.269 | 794.1 |
| 102 | Cabbart | 1935.0 | 8.390 | 799.2 |
| 103 | Cabbart | 2187.0 | 8.390 | 791.5 |
| 104 | Cabbart | 1901.0 | 8.390 | 778.6 |
| 105 | Cabbart | 1985.0 | 8.269 | 782.5 |
| 106 | Cabbart | 1937.0 | 8.269 | 787.6 |
| 107 | Cabbart | 2193.0 | 8.269 | 788.9 |
| 108 | Cabbart | 2035.0 | 8.269 | 774.8 |
| 109 | Cabbart | 2059.0 | 8.269 | 776.1 |
| 110 | Cabbart | 2032.0 | 8.269 | 779.9 |
| 111 | Cabbart | 2137.0 | 8.390 | 790.2 |
| 112 | Cabbart | 2101.0 | 8.390 | 792.8 |
| 113 | Cabbart | 2215.0 | 8.390 | 797.9 |
| 114 | Cabbart | 1959.0 | 8.390 | 774.8 |
| 115 | Cabbart | 2393.0 | 8.390 | 805.7 |
| 116 | Cabbart | 2195.0 | 8.390 | 787.6 |
| 117 | Cabbart | 2158.0 | 8.390 | 785.1 |
| 118 | Cabbart | 2118.0 | 8.390 | 790.2 |
| 119 | Cabbart | 2303.0 | 8.512 | 785.1 |
| 120 | Cabbart | 2345.0 | 8.390 | 797.9 |
| 121 | Cabbart | 1825.0 | 8.390 | 785.1 |
| 122 | Cabbart | 1949.0 | 8.512 | 779.9 |
| 123 | Cabbart | 1902.0 | 8.390 | 778.6 |
| 124 | Cabbart | 2078.0 | 8.634 | 776.1 |
| 125 | Cabbart | 2102.0 | 8.634 | 772.2 |
| 126 | Cabbart | 2291.0 | 8.634 | 790.2 |
| 127 | Cabbart | 2392.0 | 8.512 | 795.4 |
| 128 | Cabbart | 1935.0 | 8.390 | 803.1 |

Table 25. Protein, replication, and fertilizer treatment of winter wheat samples harvested on contrasting soil units in a field near Power.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 1 | Delpoint | 122.0 | 1.000 | 5.000 |
| 2 | Delpoint | 123.0 | 1.000 | 14.00 |
| 3 | Delpoint | 123.0 | 1.000 | 4.000 |
| 4 | Delpoint | 124.0 | 1.000 | 2.000 |
| 5 | Delpoint | 119.0 | 1.000 | 3.000 |
| 6 | Delpoint | 122.0 | 1.000 | 9.000 |
| 7 | Delpoint | 122.0 | 1.000 | 6.000 |
| 8 | Delpoint | 118.0 | 1.000 | 11.00 |
| 9 | Delpoint | 125.0 | 1.000 | 7.000 |
| 10 | Delpoint | 125.0 | 1.000 | 10.00 |
| 11 | Delpoint | 126.0 | 1.000 | 15.00 |
| 12 | Delpoint | 126.0 | 1.000 | 12.00 |
| 13 | Delpoint | 123.0 | 1.000 | 13.00 |
| 14 | Delpoint | 126.0 | 1.000 | 1.000 |
| 15 | Delpoint | 121.0 | 1.000 | 8.000 |
| 16 | Delpoint | 121.0 | 1.000 | 16.00 |
| 17 | Delpoint | 128.0 | 2.000 | 9.000 |
| 18 | Delpoint | 129.0 | 2.000 | 16.00 |
| 19 | Delpoint | 126.0 | 2.000 | 8.000 |
| 20 | Delpoint | 135.0 | 2.000 | 7.000 |
| 21 | Delpoint | 122.0 | 2.000 | 10.00 |
| 22 | Delpoint | 126.0 | 2.000 | 15.00 |
| 23 | Delpoint | 128.0 | 2.000 | 5.000 |
| 24 | Delpoint | 125.0 | 2.000 | 1.000 |
| 25 | Delpoint | 131.0 | 2.000 | 4.000 |
| 26 | Delpoint | 129.0 | 2.000 | 14.00 |
| 27 | Delpoint | 129.0 | 2.000 | 2.000 |
| 28 | Delpoint | 131.0 | 2.000 | 13.00 |
| 29 | Delpoint | 124.0 | 2.000 | 6.000 |
| 30 | Delpoint | 126.0 | 2.000 | 11.00 |
| 31 | Delpoint | 123.0 | 2.000 | 12.00 |
| 32 | Delpoint | 121.0 | 2.000 | 3.000 |
| 33 | Delpoint | 126.0 | 3.000 | 3.000 |
| 34 | Delpoint | 130.0 | 3.000 | 15.00 |
| 35 | Delpoint | 126.0 | 3.000 | 1.000 |
| 36 | Delpoint | 121.0 | 3.000 | 12.00 |
| 37 | Delpoint | 130.0 | 3.000 | 8.000 |
| 38 | Delpoint | 132.0 | 3.000 | 2.000 |
| 39 | Delpoint | 126.0 | 3.000 | 16.00 |
| 40 | Delpoint | 132.0 | 3.000 | 13.00 |
| 41 | Delpoint | 131.0 | 3.000 | 11.00 |
| 42 | Delpoint | 129.0 | 3.000 | 6.000 |

Table 25--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 43 | Delpoint | 133.0 | 3.000 | 9.000 |
| 44 | Delpoint | 132.0 | 3.000 | 5.000 |
| 45 | Delpoint | 136.0 | 3.000 | 14.00 |
| 46 | Delpoint | 131.0 | 3.000 | 4.000 |
| 47 | Delpoint | 126.0 | 3.000 | 7.000 |
| 48 | Delpoint | 125.0 | 3.000 | 10.00 |
| 49 | Delpoint | 130.0 | 4.000 | 6.000 |
| 50 | Delpoint | 159.0 | 4.000 | 11.00 |
| 51 | Delpoint | 132.0 | 4.000 | 13.00 |
| 52 | Delpoint | 129.0 | 4.000 | 10.00 |
| 53 | Delpoint | 131.0 | 4.000 | 14.00 |
| 54 | Delpoint | 129.0 | 4.000 | 4.000 |
| 55 | Delpoint | 128.0 | 4.000 | 12.00 |
| 56 | Delpoint | 129.0 | 4.000 | 7.000 |
| 57 | Delpoint | 125.0 | 4.000 | 1.000 |
| 58 | Delpoint | 130.0 | 4.000 | 8.000 |
| 59 | Delpoint | 116.0 | 4.000 | 3.000 |
| 60 | Delpoint | 128.0 | 4.000 | 16.00 |
| 61 | Delpoint | 129.0 | 4.000 | 9.000 |
| 62 | Delpoint | 125.0 | 4.000 | 15.00 |
| 63 | Delpoint | 124.0 | 4.000 | 5.000 |
| 64 | Delpoint | 135.0 | 4.000 | 2.000 |
| 65 | Cabbart | 127.0 | 1.000 | 5.000 |
| 66 | Cabbart | 134.0 | 1.000 | 14.00 |
| 67 | Cabbart | 133.0 | 1.000 | 4.000 |
| 68 | Cabbart | 129.0 | 1.000 | 2.000 |
| 69 | Cabbart | 133.0 | 1.000 | 3.000 |
| 70 | Cabbart | 127.0 | 1.000 | 9.000 |
| 71 | Cabbart | 129.0 | 1.000 | 6.000 |
| 72 | Cabbart | 128.0 | 1.000 | 11.00 |
| 73 | Cabbart | 126.0 | 1.000 | 7.000 |
| 74 | Cabbart | 128.0 | 1.000 | 10.00 |
| 75 | Cabbart | 135.0 | 1.000 | 15.00 |
| 76 | Cabbart | 130.0 | 1.000 | 12.00 |
| 77 | Cabbart | 127.0 | 1.000 | 13.00 |
| 78 | Cabbart | 128.0 | 1.000 | 1.000 |
| 79 | Cabbart | 135.0 | 1.000 | 8.000 |
| 80 | Cabbart | 132.0 | 1.000 | 16.00 |
| 81 | Cabbart | 129.0 | 2.000 | 9.000 |
| 82 | Cabbart | 127.0 | 2.000 | 16.00 |
| 83 | Cabbart | 130.0 | 2.000 | 8.000 |
| 84 | Cabbart | 128.0 | 2.000 | 7.000 |
| 85 | Cabbart | 130.0 | 2.000 | 10.00 |
| 86 | Cabbart | 130.0 | 2.000 | 15.00 |

Table 25--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 87 | Cabbart | 130.0 | 2.000 | 5.000 |
| 88 | Cabbart | 124.0 | 2.000 | 1.000 |
| 89 | Cabbart | 131.0 | 2.000 | 4.000 |
| 90 | Cabbart | 140.0 | 2.000 | 14.00 |
| 91 | Cabbart | 137.0 | 2.000 | 2.000 |
| 92 | Cabbart | 140.0 | 2.000 | 13.00 |
| 93 | Cabbart | 137.0 | 2.000 | 6.000 |
| 94 | Cabbart | 131.0 | 2.000 | 11.00 |
| 95 | Cabbart | 142.0 | 2.000 | 12.00 |
| 96 | Cabbart | 123.0 | 2.000 | 3.000 |
| 97 | Cabbart | 123.0 | 3.000 | 3.000 |
| 98 | Cabbart | 126.0 | 3.000 | 15.00 |
| 99 | Cabbart | 127.0 | 3.000 | 1.000 |
| 100 | Cabbart | 134.0 | 3.000 | 12.00 |
| 101 | Cabbart | 128.0 | 3.000 | 8.000 |
| 102 | Cabbart | 131.0 | 3.000 | 2.000 |
| 103 | Cabbart | 126.0 | 3.000 | 16.00 |
| 104 | Cabbart | 133.0 | 3.000 | 13.00 |
| 105 | Cabbart | 128.0 | 3.000 | 11.00 |
| 106 | Cabbart | 133.0 | 3.000 | 6.000 |
| 107 | Cabbart | 134.0 | 3.000 | 9.000 |
| 108 | Cabbart | 139.0 | 3.000 | 5.000 |
| 109 | Cabbart | 143.0 | 3.000 | 14.00 |
| 110 | Cabbart | 146.0 | 3.000 | 4.000 |
| 111 | Cabbart | 131.0 | 3.000 | 7.000 |
| 112 | Cabbart | 130.0 | 3.000 | 10.00 |
| 113 | Cabbart | 127.0 | 4.000 | 6.000 |
| 114 | Cabbart | 143.0 | 4.000 | 11.00 |
| 115 | Cabbart | 129.0 | 4.000 | 13.00 |
| 116 | Cabbart | 131.0 | 4.000 | 10.00 |
| 117 | Cabbart | 142.0 | 4.000 | 14.00 |
| 118 | Cabbart | 138.0 | 4.000 | 4.000 |
| 119 | Cabbart | 134.0 | 4.000 | 12.00 |
| 120 | Cabbart | 131.0 | 4.000 | 7.000 |
| 121 | Cabbart | 127.0 | 4.000 | 1.000 |
| 122 | Cabbart | 136.0 | 4.000 | 8.000 |
| 123 | Cabbart | 131.0 | 4.000 | 3.000 |
| 124 | Cabbart | 139.0 | 4.000 | 16.00 |
| 125 | Cabbart | 144.0 | 4.000 | 9.000 |
| 126 | Cabbart | 135.0 | 4.000 | 15.00 |

Table 25--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 127 | Cabbart | 132.0 | 4.000 | 5.000 |
| 128 | Cabbart | 125.0 | 4.000 | 2.000 |

[1] Fertilizer treatments, as a ratio of recommended N, P, and K (N-P-K), were 1 = 0-0-0, 2 = 1-0-0, 3 = 0-1-0, 4 = 1-1-0, 5 = 1-1-1, 6 = 0.5-1-1, 7 = 0.75-1-1, 8 = 1.25-1-1, 9 = 1.5-1-1, 10 = 1-0.5-1, 11 = 1-1.5-1, 12 = 1-1-0.5, 13 = 1-1-1.5, 14 = 1.5-1.5-1.5, 15 = 1-1-1 plus 20 kg $ha^{-1}$ $CaSO_4$, 16 = treatment 15 plus 20 kg $ha^{-1}$ $Fe_2(SO_4)_3$, 10 kg $ha^{-1}$ $ZnSO_4$, and 1 kg $ha^{-1}$ $B_2(SO_4)_3$.

Table 26. Yield and test weight of spring wheat samples harvested on contrasting soil units in a field near Whitehall (1987).

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 1 | Ethridge | 2800.0 | 31.59 | 767.1 |
| 2 | Ethridge | 3000.0 | 31.59 | 767.1 |
| 3 | Ethridge | 3600.0 | 31.59 | 741.3 |
| 4 | Ethridge | 3800.0 | 31.59 | 767.1 |
| 5 | Ethridge | 6200.0 | 31.28 | 772.2 |
| 6 | Ethridge | 6600.0 | 31.28 | 761.9 |
| 7 | Ethridge | 6500.0 | 31.28 | 767.1 |
| 8 | Ethridge | 6500.0 | 31.28 | 772.2 |
| 9 | Ethridge | 4200.0 | 31.28 | 772.2 |
| 10 | Ethridge | 4000.0 | 31.28 | 756.8 |
| 11 | Ethridge | 3900.0 | 31.28 | 772.2 |
| 12 | Ethridge | 4000.0 | 31.28 | 772.2 |
| 13 | Ethridge | 4300.0 | 31.28 | 761.9 |
| 14 | Ethridge | 6200.0 | 31.28 | 772.2 |
| 15 | Ethridge | 5800.0 | 31.28 | 767.1 |
| 16 | Ethridge | 5500.0 | 31.28 | 777.3 |
| 17 | Ethridge | 7700.0 | 31.28 | 777.3 |
| 18 | Ethridge | 8400.0 | 31.28 | 777.3 |
| 19 | Ethridge | 7400.0 | 31.28 | 772.2 |
| 20 | Ethridge | 6700.0 | 31.28 | 782.5 |
| 21 | Ethridge | 9500.0 | 31.28 | 772.2 |
| 22 | Ethridge | 10000.0 | 31.28 | 767.1 |
| 23 | Ethridge | 9800.0 | 31.28 | 767.1 |
| 24 | Ethridge | 9700.0 | 31.28 | 767.1 |
| 25 | Yetull | 9700.0 | 30.97 | 774.8 |
| 26 | Yetull | 7900.0 | 30.97 | 767.1 |
| 27 | Yetull | 8200.0 | 30.97 | 772.2 |
| 28 | Yetull | 7300.0 | 30.97 | 777.3 |
| 29 | Yetull | 6900.0 | 30.66 | 767.1 |
| 30 | Yetull | 7100.0 | 30.66 | 777.3 |
| 31 | Yetull | 7600.0 | 30.66 | 767.1 |
| 32 | Yetull | 7000.0 | 30.66 | 756.8 |
| 33 | Yetull | 4200.0 | 30.97 | 684.7 |
| 34 | Yetull | 4000.0 | 30.66 | 720.7 |
| 35 | Yetull | 5000.0 | 30.97 | 674.4 |
| 36 | Yetull | 5200.0 | 30.97 | 705.3 |
| 37 | Yetull | 4600.0 | 30.97 | 752.9 |
| 38 | Yetull | 4100.0 | 30.97 | 761.9 |
| 39 | Yetull | 4500.0 | 31.28 | 759.3 |
| 40 | Yetull | 4500.0 | 31.28 | 751.6 |
| 41 | Yetull | 6400.0 | 31.28 | 725.9 |
| 42 | Yetull | 6700.0 | 31.28 | 720.7 |

Table 26--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 43 | Yetull | 5900.0 | 31.28 | 772.2 |
| 44 | Yetull | 6100.0 | 31.28 | 736.2 |
| 45 | Yetull | 3100.0 | 30.97 | 741.3 |
| 46 | Yetull | 3200.0 | 30.97 | 741.3 |
| 47 | Yetull | 3300.0 | 30.97 | 741.3 |
| 48 | Yetull | 3500.0 | 30.97 | 828.8 |
| 49 | Varney | 2300.0 | 30.97 | 870.0 |
| 50 | Varney | 2800.0 | 30.97 | 849.4 |
| 51 | Varney | 2200.0 | 30.97 | 695.0 |
| 52 | Varney | 2000.0 | 30.97 | 772.2 |
| 53 | Varney | 7300.0 | 30.97 | 787.6 |
| 54 | Varney | 9200.0 | 30.97 | 782.5 |
| 55 | Varney | 8200.0 | 30.97 | 777.3 |
| 56 | Varney | 9300.0 | 30.97 | 797.9 |
| 57 | Varney | 4700.0 | 30.97 | 803.1 |
| 58 | Varney | 4900.0 | 30.97 | 792.8 |
| 59 | Varney | 5000.0 | 30.97 | 772.2 |
| 60 | Varney | 4700.0 | 30.97 | 782.5 |
| 61 | Varney | 4500.0 | 31.28 | 782.5 |
| 62 | Varney | 4800.0 | 31.28 | 803.1 |
| 63 | Varney | 5600.0 | 30.97 | 695.0 |
| 64 | Varney | 5800.0 | 30.97 | 808.2 |
| 65 | Varney | 6000.0 | 30.97 | 818.5 |
| 66 | Varney | 7600.0 | 30.97 | 818.5 |
| 67 | Varney | 7000.0 | 31.28 | 888.0 |
| 68 | Varney | 9000.0 | 31.28 | 818.5 |
| 69 | Varney | 9999.0 | 30.97 | 839.1 |
| 70 | Varney | 9100.0 | 30.97 | 839.1 |
| 71 | Varney | 9000.0 | 30.97 | 720.7 |
| 72 | Varney | 9000.0 | 30.97 | 859.7 |
| 73 | Yawdim | 6100.0 | 30.97 | 797.9 |
| 74 | Yawdim | 5300.0 | 30.97 | 797.9 |
| 75 | Yawdim | 5800.0 | 30.97 | 797.9 |
| 76 | Yawdim | 5500.0 | 30.97 | 710.4 |
| 77 | Yawdim | 6200.0 | 30.66 | 761.9 |
| 78 | Yawdim | 5200.0 | 30.66 | 787.6 |
| 79 | Yawdim | 7200.0 | 30.66 | 731.0 |
| 80 | Yawdim | 6000.0 | 30.66 | 772.2 |
| 81 | Yawdim | 4400.0 | 30.66 | 885.5 |
| 82 | Yawdim | 5100.0 | 30.66 | 877.7 |
| 83 | Yawdim | 5000.0 | 30.97 | 720.7 |
| 84 | Yawdim | 6600.0 | 30.66 | 882.9 |
| 85 | Yawdim | 5300.0 | 30.97 | 746.5 |
| 86 | Yawdim | 4700.0 | 30.66 | 823.7 |

Table 26--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 87 | Yawdim | 4700.0 | 30.97 | 725.9 |
| 88 | Yawdim | 4500.0 | 30.97 | 736.2 |
| 89 | Yawdim | 7100.0 | 30.97 | 797.9 |
| 90 | Yawdim | 8400.0 | 30.97 | 767.1 |
| 91 | Yawdim | 6900.0 | 30.97 | 772.2 |
| 92 | Yawdim | 8500.0 | 30.97 | 885.5 |
| 93 | Yawdim | 3000.0 | 30.97 | 746.5 |
| 94 | Yawdim | 1900.0 | 30.97 | 803.1 |
| 95 | Yawdim | 2000.0 | 30.97 | 746.5 |
| 96 | Yawdim | 3800.0 | 30.97 | 854.6 |

Table 27. Protein, replicaton, and fertilizer treatments of spring wheat samples harvested on contrasting soil units in a field near Whitehall (1987).

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 1 | Ethridge | 128.0 | 1.000 | 6.000 |
| 2 | Ethridge | 131.0 | 1.000 | 6.000 |
| 3 | Ethridge | 131.0 | 1.000 | 6.000 |
| 4 | Ethridge | 128.0 | 1.000 | 6.000 |
| 5 | Ethridge | 164.0 | 2.000 | 3.000 |
| 6 | Ethridge | 147.0 | 2.000 | 3.000 |
| 7 | Ethridge | 137.0 | 3.000 | 3.000 |
| 8 | Ethridge | 142.0 | 3.000 | 3.000 |
| 9 | Ethridge | 116.0 | 4.000 | 2.000 |
| 10 | Ethridge | 120.0 | 4.000 | 2.000 |
| 11 | Ethridge | 127.0 | 5.000 | 2.000 |
| 12 | Ethridge | 112.0 | 5.000 | 2.000 |
| 13 | Ethridge | 122.0 | 6.000 | 4.000 |
| 14 | Ethridge | 127.0 | 6.000 | 4.000 |
| 15 | Ethridge | 125.0 | 7.000 | 4.000 |
| 16 | Ethridge | 123.0 | 7.000 | 4.000 |
| 17 | Ethridge | 126.0 | 8.000 | 5.000 |
| 18 | Ethridge | 129.0 | 8.000 | 5.000 |
| 19 | Ethridge | 134.0 | 9.000 | 5.000 |
| 20 | Ethridge | 125.0 | 9.000 | 5.000 |
| 21 | Ethridge | 151.0 | 10.00 | 1.000 |
| 22 | Ethridge | 167.0 | 10.00 | 1.000 |
| 23 | Ethridge | 153.0 | 10.00 | 1.000 |
| 24 | Ethridge | 151.0 | 10.00 | 1.000 |
| 25 | Yetull | 140.0 | 11.00 | 1.000 |
| 26 | Yetull | 163.0 | 11.00 | 1.000 |
| 27 | Yetull | 158.0 | 11.00 | 1.000 |
| 28 | Yetull | 142.0 | 11.00 | 1.000 |
| 29 | Yetull | 119.0 | 12.00 | 5.000 |
| 30 | Yetull | 121.0 | 12.00 | 5.000 |
| 31 | Yetull | 132.0 | 13.00 | 5.000 |
| 32 | Yetull | 138.0 | 13.00 | 5.000 |
| 33 | Yetull | 122.0 | 14.00 | 4.000 |
| 34 | Yetull | 118.0 | 14.00 | 4.000 |
| 35 | Yetull | 134.0 | 15.00 | 4.000 |
| 36 | Yetull | 119.0 | 15.00 | 4.000 |
| 37 | Yetull | 125.0 | 16.00 | 2.000 |
| 38 | Yetull | 126.0 | 16.00 | 2.000 |
| 39 | Yetull | 130.0 | 17.00 | 2.000 |
| 40 | Yetull | 135.0 | 17.00 | 2.000 |
| 41 | Yetull | 138.0 | 18.00 | 3.000 |
| 42 | Yetull | 147.0 | 18.00 | 3.000 |

Table 27--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 43 | Yetull | 147.0 | 19.00 | 3.000 |
| 44 | Yetull | 153.0 | 19.00 | 3.000 |
| 45 | Yetull | 136.0 | 20.00 | 6.000 |
| 46 | Yetull | 131.0 | 20.00 | 6.000 |
| 47 | Yetull | 137.0 | 20.00 | 6.000 |
| 48 | Yetull | 135.0 | 20.00 | 6.000 |
| 49 | Varney | 124.0 | 21.00 | 6.000 |
| 50 | Varney | 127.0 | 21.00 | 6.000 |
| 51 | Varney | 124.0 | 21.00 | 6.000 |
| 52 | Varney | 119.0 | 21.00 | 6.000 |
| 53 | Varney | 105.0 | 22.00 | 3.000 |
| 54 | Varney | 114.0 | 22.00 | 3.000 |
| 55 | Varney | 110.0 | 23.00 | 3.000 |
| 56 | Varney | 123.0 | 23.00 | 3.000 |
| 57 | Varney | 115.0 | 24.00 | 2.000 |
| 58 | Varney | 95.00 | 24.00 | 2.000 |
| 59 | Varney | 101.0 | 25.00 | 2.000 |
| 60 | Varney | 99.00 | 25.00 | 2.000 |
| 61 | Varney | 100.0 | 26.00 | 4.000 |
| 62 | Varney | 104.0 | 26.00 | 4.000 |
| 63 | Varney | 112.0 | 27.00 | 4.000 |
| 64 | Varney | 108.0 | 27.00 | 4.000 |
| 65 | Varney | 114.0 | 28.00 | 5.000 |
| 66 | Varney | 113.0 | 28.00 | 5.000 |
| 67 | Varney | 120.0 | 29.00 | 5.000 |
| 68 | Varney | 108.0 | 29.00 | 5.000 |
| 69 | Varney | 125.0 | 30.00 | 1.000 |
| 70 | Varney | 150.0 | 30.00 | 1.000 |
| 71 | Varney | 144.0 | 30.00 | 1.000 |
| 72 | Varney | 136.0 | 30.00 | 1.000 |
| 73 | Yawdim | 166.0 | 31.00 | 1.000 |
| 74 | Yawdim | 176.0 | 31.00 | 1.000 |
| 75 | Yawdim | 163.0 | 31.00 | 1.000 |
| 76 | Yawdim | 164.0 | 31.00 | 1.000 |
| 77 | Yawdim | 133.0 | 32.00 | 5.000 |
| 78 | Yawdim | 122.0 | 32.00 | 5.000 |
| 79 | Yawdim | 122.0 | 33.00 | 5.000 |
| 80 | Yawdim | 121.0 | 33.00 | 5.000 |
| 81 | Yawdim | 117.0 | 34.00 | 4.000 |
| 82 | Yawdim | 106.0 | 34.00 | 4.000 |
| 83 | Yawdim | 113.0 | 35.00 | 4.000 |
| 84 | Yawdim | 111.0 | 35.00 | 4.000 |
| 85 | Yawdim | 103.0 | 36.00 | 2.000 |
| 86 | Yawdim | 110.0 | 36.00 | 2.000 |

Table 27--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 87 | Yawdim | 103.0 | 37.00 | 2.000 |
| 88 | Yawdim | 103.0 | 37.00 | 2.000 |
| 89 | Yawdim | 120.0 | 38.00 | 3.000 |
| 90 | Yawdim | 112.0 | 38.00 | 3.000 |
| 91 | Yawdim | 113.0 | 39.00 | 3.000 |
| 92 | Yawdim | 114.0 | 39.00 | 3.000 |
| 93 | Yawdim | 116.0 | 40.00 | 6.000 |
| 94 | Yawdim | 114.0 | 40.00 | 6.000 |
| 95 | Yawdim | 119.0 | 40.00 | 6.000 |
| 96 | Yawdim | 124.0 | 40.00 | 6.000 |

[1] Fertilizer treatments, expressed as kg $ha^{-1}$ N, P, and K, respectively, were 1 = 140-19-0, 2 = 25-17-0, 3 = 66-7-0, 4 = 45-9-0, 5 = 51-12-0, 6 = 0-0-0.

Table 28. Yield and test weight of spring wheat samples harvested on contrasting soil units in a field near Havre (1988).

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 1 | Gerdrum | 1289.0 | 8.839 | 816.0 |
| 2 | Gerdrum | 1827.0 | 8.727 | 792.8 |
| 3 | Gerdrum | 1632.0 | 8.831 | 818.5 |
| 4 | Gerdrum | 1436.0 | 8.709 | 816.0 |
| 5 | Gerdrum | 1844.0 | 8.648 | 808.2 |
| 6 | Gerdrum | 1904.0 | 8.744 | 800.5 |
| 7 | Gerdrum | 1904.0 | 8.619 | 826.3 |
| 8 | Gerdrum | 1148.0 | 8.671 | 810.8 |
| 9 | Gerdrum | 1464.0 | 8.629 | 808.2 |
| 10 | Gerdrum | 1677.0 | 8.603 | 788.9 |
| 11 | Gerdrum | 1642.0 | 8.790 | 810.8 |
| 12 | Gerdrum | 1339.0 | 8.611 | 799.2 |
| 13 | Gerdrum | 2432.0 | 8.665 | 819.8 |
| 14 | Gerdrum | 2789.0 | 8.696 | 805.7 |
| 15 | Gerdrum | 2680.0 | 8.665 | 826.3 |
| 16 | Gerdrum | 2467.0 | 8.814 | 817.2 |
| 17 | Gerdrum | 2484.0 | 8.586 | 825.0 |
| 18 | Gerdrum | 2104.0 | 8.594 | 800.5 |
| 19 | Gerdrum | 1538.0 | 8.596 | 821.1 |
| 20 | Gerdrum | 1263.0 | 8.628 | 814.7 |
| 21 | Gerdrum | 1876.0 | 8.678 | 817.2 |
| 22 | Gerdrum | 1550.0 | 8.448 | 796.7 |
| 23 | Gerdrum | 1595.0 | 8.828 | 821.1 |
| 24 | Gerdrum | 1255.0 | 8.752 | 804.4 |
| 25 | Gerdrum | 2262.0 | 8.652 | 825.0 |
| 26 | Gerdrum | 2217.0 | 8.714 | 797.9 |
| 27 | Gerdrum | 2068.0 | 8.684 | 819.8 |
| 28 | Gerdrum | 2042.0 | 8.514 | 809.5 |
| 29 | Phillips | 956.0 | 8.431 | 816.0 |
| 30 | Phillips | 1127.0 | 8.667 | 795.4 |
| 31 | Phillips | 1131.0 | 8.716 | 819.8 |
| 32 | Phillips | 895.7 | 8.651 | 809.5 |
| 33 | Phillips | 1241.0 | 8.691 | 819.8 |
| 34 | Phillips | 903.0 | 8.624 | 786.4 |
| 35 | Phillips | 1066.0 | 8.329 | 809.5 |
| 36 | Phillips | 931.0 | 8.678 | 803.1 |
| 37 | Phillips | 1084.0 | 8.739 | 810.8 |
| 38 | Phillips | 861.3 | 8.726 | 785.1 |
| 39 | Phillips | 855.3 | 8.696 | 817.2 |
| 40 | Phillips | 452.0 | 8.660 | 777.3 |
| 41 | Phillips | 556.0 | 8.641 | 797.9 |
| 42 | Phillips | 799.0 | 8.665 | 791.5 |

Table 28--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | m | kg $m^{-3}$ |
| 43 | Phillips | 915.3 | 8.696 | 814.7 |
| 44 | Phillips | 633.3 | 8.722 | 794.1 |
| 45 | Phillips | 596.3 | 8.679 | 816.0 |
| 46 | Phillips | 759.7 | 8.929 | 790.2 |
| 47 | Phillips | 1023.0 | 8.744 | 813.4 |
| 48 | Phillips | 748.3 | 8.672 | 803.1 |
| 49 | Phillips | 555.0 | 8.698 | 795.4 |
| 50 | Phillips | 709.0 | 8.665 | 803.1 |
| 51 | Phillips | 1095.0 | 8.744 | 813.4 |
| 52 | Phillips | 613.0 | 8.770 | 803.1 |
| 53 | Phillips | 514.0 | 8.297 | 818.5 |
| 54 | Phillips | 468.0 | 8.678 | 791.5 |
| 55 | Phillips | 631.0 | 8.641 | 813.4 |
| 56 | Phillips | 397.0 | 8.611 | 796.7 |
| 57 | Telstad | 928.7 | 8.606 | 817.2 |
| 58 | Telstad | 863.7 | 8.665 | 785.1 |
| 59 | Telstad | 876.0 | 8.622 | 806.9 |
| 60 | Telstad | 461.0 | 8.575 | 776.1 |
| 61 | Telstad | 890.3 | 8.765 | 805.7 |
| 62 | Telstad | 645.0 | 8.716 | 776.1 |
| 63 | Telstad | 1021.0 | 8.716 | 817.2 |
| 64 | Telstad | 702.7 | 8.698 | 791.5 |
| 65 | Telstad | 910.0 | 8.782 | 818.5 |
| 66 | Telstad | 958.0 | 8.765 | 785.1 |
| 67 | Telstad | 917.3 | 8.716 | 782.5 |
| 68 | Telstad | 581.3 | 8.716 | 777.3 |
| 69 | Telstad | 1003.0 | 8.629 | 772.2 |
| 70 | Telstad | 839.7 | 8.665 | 794.1 |
| 71 | Telstad | 898.3 | 8.714 | 803.1 |
| 72 | Telstad | 600.3 | 8.587 | 786.4 |
| 73 | Telstad | 938.7 | 7.980 | 805.7 |
| 74 | Telstad | 1050.0 | 8.616 | 792.8 |
| 75 | Telstad | 1021.0 | 8.647 | 806.9 |
| 76 | Telstad | 837.3 | 8.574 | 803.1 |
| 77 | Telstad | 791.3 | 8.639 | 799.2 |
| 78 | Telstad | 894.0 | 8.648 | 791.5 |
| 79 | Telstad | 1039.0 | 8.586 | 810.8 |
| 80 | Telstad | 641.3 | 8.489 | 777.3 |
| 81 | Telstad | 844.0 | 8.652 | 799.2 |
| 82 | Telstad | 1043.0 | 8.412 | 785.1 |
| 83 | Telstad | 1115.0 | 8.684 | 806.9 |
| 84 | Telstad | 861.3 | 8.624 | 799.2 |
| 85 | Joplin | 765.3 | 8.628 | 810.8 |
| 86 | Joplin | 931.0 | 8.251 | 779.9 |

Table 28--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | m | kg $m^{-3}$ |
| 87 | Joplin | 1085.0 | 8.665 | 813.4 |
| 88 | Joplin | 796.7 | 8.497 | 797.9 |
| 89 | Joplin | 821.0 | 8.683 | 816.0 |
| 90 | Joplin | 823.0 | 8.637 | 768.3 |
| 91 | Joplin | 989.7 | 8.574 | 809.5 |
| 92 | Joplin | 769.0 | 8.418 | 787.6 |
| 93 | Joplin | 963.3 | 8.611 | 794.1 |
| 94 | Joplin | 1001.0 | 8.696 | 770.9 |
| 95 | Joplin | 855.7 | 8.546 | 810.8 |
| 96 | Joplin | 818.0 | 8.557 | 785.1 |
| 97 | Joplin | 877.0 | 8.628 | 812.1 |
| 98 | Joplin | 881.7 | 8.549 | 781.2 |
| 99 | Joplin | 1166.0 | 8.555 | 797.9 |
| 100 | Joplin | 900.3 | 8.652 | 782.5 |
| 101 | Joplin | 1073.0 | 8.484 | 813.4 |
| 102 | Joplin | 1242.0 | 8.628 | 767.1 |
| 103 | Joplin | 1198.0 | 8.696 | 808.2 |
| 104 | Joplin | 955.3 | 8.598 | 803.1 |
| 105 | Joplin | 1103.0 | 8.637 | 818.5 |
| 106 | Joplin | 1116.0 | 8.703 | 786.4 |
| 107 | Joplin | 1121.0 | 8.660 | 808.2 |
| 108 | Joplin | 1025.0 | 8.616 | 816.0 |
| 109 | Joplin | 958.3 | 7.999 | 817.2 |
| 110 | Joplin | 1103.0 | 8.714 | 779.9 |
| 111 | Joplin | 981.3 | 8.714 | 795.4 |
| 112 | Joplin | 793.0 | 8.508 | 797.9 |

Table 29. Protein, replication, and fertilizer treatment of spring wheat samples harvested on contrasting soil units in a field near Havre (1988).

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 1 | Gerdrum | 163.0 | 1.000 | 1.000 |
| 2 | Gerdrum | 149.0 | 2.000 | 1.000 |
| 3 | Gerdrum | 161.0 | 3.000 | 1.000 |
| 4 | Gerdrum | 184.7 | 4.000 | 1.000 |
| 5 | Gerdrum | 173.7 | 1.000 | 2.000 |
| 6 | Gerdrum | 158.3 | 2.000 | 2.000 |
| 7 | Gerdrum | 165.7 | 3.000 | 2.000 |
| 8 | Gerdrum | 187.7 | 4.000 | 2.000 |
| 9 | Gerdrum | 173.7 | 1.000 | 3.000 |
| 10 | Gerdrum | 159.0 | 2.000 | 3.000 |
| 11 | Gerdrum | 162.3 | 3.000 | 3.000 |
| 12 | Gerdrum | 178.3 | 4.000 | 3.000 |
| 13 | Gerdrum | 168.3 | 1.000 | 4.000 |
| 14 | Gerdrum | 156.7 | 2.000 | 4.000 |
| 15 | Gerdrum | 163.7 | 3.000 | 4.000 |
| 16 | Gerdrum | 171.3 | 4.000 | 4.000 |
| 17 | Gerdrum | 168.0 | 1.000 | 5.000 |
| 18 | Gerdrum | 153.3 | 2.000 | 5.000 |
| 19 | Gerdrum | 164.3 | 3.000 | 5.000 |
| 20 | Gerdrum | 182.3 | 4.000 | 5.000 |
| 21 | Gerdrum | 174.7 | 1.000 | 6.000 |
| 22 | Gerdrum | 159.3 | 2.000 | 6.000 |
| 23 | Gerdrum | 165.7 | 3.000 | 6.000 |
| 24 | Gerdrum | 184.3 | 4.000 | 6.000 |
| 25 | Gerdrum | 166.7 | 1.000 | 7.000 |
| 26 | Gerdrum | 151.7 | 2.000 | 7.000 |
| 27 | Gerdrum | 158.3 | 3.000 | 7.000 |
| 28 | Gerdrum | 172.7 | 4.000 | 7.000 |
| 29 | Phillips | 180.0 | 1.000 | 1.000 |
| 30 | Phillips | 155.7 | 2.000 | 1.000 |
| 31 | Phillips | 161.0 | 3.000 | 1.000 |
| 32 | Phillips | 184.3 | 4.000 | 1.000 |
| 33 | Phillips | 177.0 | 1.000 | 2.000 |
| 34 | Phillips | 161.7 | 2.000 | 2.000 |
| 35 | Phillips | 167.7 | 3.000 | 2.000 |
| 36 | Phillips | 185.7 | 4.000 | 2.000 |
| 37 | Phillips | 174.7 | 1.000 | 3.000 |
| 38 | Phillips | 162.7 | 2.000 | 3.000 |
| 39 | Phillips | 167.0 | 3.000 | 3.000 |
| 40 | Phillips | 188.0 | 4.000 | 3.000 |
| 41 | Phillips | 181.0 | 1.000 | 4.000 |
| 42 | Phillips | 160.3 | 2.000 | 4.000 |

Table 29--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 43 | Phillips | 162.7 | 3.000 | 4.000 |
| 44 | Phillips | 184.3 | 4.000 | 4.000 |
| 45 | Phillips | 180.7 | 1.000 | 5.000 |
| 46 | Phillips | 160.3 | 2.000 | 5.000 |
| 47 | Phillips | 164.7 | 3.000 | 5.000 |
| 48 | Phillips | 186.7 | 4.000 | 5.000 |
| 49 | Phillips | 183.3 | 1.000 | 6.000 |
| 50 | Phillips | 166.0 | 2.000 | 6.000 |
| 51 | Phillips | 160.0 | 3.000 | 6.000 |
| 52 | Phillips | 186.7 | 4.000 | 6.000 |
| 53 | Phillips | 185.0 | 1.000 | 7.000 |
| 54 | Phillips | 169.3 | 2.000 | 7.000 |
| 55 | Phillips | 167.7 | 3.000 | 7.000 |
| 56 | Phillips | 188.7 | 4.000 | 7.000 |
| 57 | Telstad | 178.0 | 1.000 | 1.000 |
| 58 | Telstad | 159.0 | 2.000 | 1.000 |
| 59 | Telstad | 167.3 | 3.000 | 1.000 |
| 60 | Telstad | 189.7 | 4.000 | 1.000 |
| 61 | Telstad | 178.7 | 1.000 | 2.000 |
| 62 | Telstad | 159.0 | 2.000 | 2.000 |
| 63 | Telstad | 169.3 | 3.000 | 2.000 |
| 64 | Telstad | 188.7 | 4.000 | 2.000 |
| 65 | Telstad | 176.7 | 1.000 | 3.000 |
| 66 | Telstad | 155.3 | 2.000 | 3.000 |
| 67 | Telstad | 162.3 | 3.000 | 3.000 |
| 68 | Telstad | 187.0 | 4.000 | 3.000 |
| 69 | Telstad | 179.0 | 1.000 | 4.000 |
| 70 | Telstad | 165.3 | 2.000 | 4.000 |
| 71 | Telstad | 169.0 | 3.000 | 4.000 |
| 72 | Telstad | 188.7 | 4.000 | 4.000 |
| 73 | Telstad | 180.0 | 1.000 | 5.000 |
| 74 | Telstad | 159.0 | 2.000 | 5.000 |
| 75 | Telstad | 164.3 | 3.000 | 5.000 |
| 76 | Telstad | 187.7 | 4.000 | 5.000 |
| 77 | Telstad | 179.7 | 1.000 | 6.000 |
| 78 | Telstad | 156.7 | 2.000 | 6.000 |
| 79 | Telstad | 162.0 | 3.000 | 6.000 |
| 80 | Telstad | 185.3 | 4.000 | 6.000 |
| 81 | Telstad | 177.3 | 1.000 | 7.000 |
| 82 | Telstad | 158.0 | 2.000 | 7.000 |
| 83 | Telstad | 162.7 | 3.000 | 7.000 |
| 84 | Telstad | 184.7 | 4.000 | 7.000 |
| 85 | Joplin | 178.0 | 1.000 | 1.000 |
| 86 | Joplin | 159.3 | 2.000 | 1.000 |

Table 29--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 87 | Joplin | 166.3 | 3.000 | 1.000 |
| 88 | Joplin | 186.0 | 4.000 | 1.000 |
| 89 | Joplin | 178.0 | 1.000 | 2.000 |
| 90 | Joplin | 158.0 | 2.000 | 2.000 |
| 91 | Joplin | 165.0 | 3.000 | 2.000 |
| 92 | Joplin | 183.0 | 4.000 | 2.000 |
| 93 | Joplin | 172.3 | 1.000 | 3.000 |
| 94 | Joplin | 158.7 | 2.000 | 3.000 |
| 95 | Joplin | 162.7 | 3.000 | 3.000 |
| 96 | Joplin | 181.7 | 4.000 | 3.000 |
| 97 | Joplin | 176.0 | 1.000 | 4.000 |
| 98 | Joplin | 149.7 | 2.000 | 4.000 |
| 99 | Joplin | 153.0 | 3.000 | 4.000 |
| 100 | Joplin | 179.7 | 4.000 | 4.000 |
| 101 | Joplin | 170.7 | 1.000 | 5.000 |
| 102 | Joplin | 148.3 | 2.000 | 5.000 |
| 103 | Joplin | 154.3 | 3.000 | 5.000 |
| 104 | Joplin | 178.7 | 4.000 | 5.000 |
| 105 | Joplin | 175.7 | 1.000 | 6.000 |
| 106 | Joplin | 146.7 | 2.000 | 6.000 |
| 107 | Joplin | 152.3 | 3.000 | 6.000 |
| 108 | Joplin | 177.3 | 4.000 | 6.000 |
| 109 | Joplin | 175.0 | 1.000 | 7.000 |
| 110 | Joplin | 156.0 | 2.000 | 7.000 |
| 111 | Joplin | 165.0 | 3.000 | 7.000 |
| 112 | Joplin | 187.0 | 4.000 | 7.000 |

[1] Fertilizer treatments, expressed as kg $ha^{-1}$ N, P, and K, respectively, were 1 = 67-11-9, 2 = 0-0-0, 3 = 15-11-0, 4 = 28-11-0, 5 = 45-11-0, 6 = 11-11-0, 7 = 56-11-0.

Table 30. Yield and test weight of spring barley samples harvested on contrasting soil units in a field near Townsend.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 1 | Amesha | 2693.0 | 12.33 | 674.4 |
| 2 | Amesha | 2974.0 | 12.40 | 692.4 |
| 3 | Amesha | 2266.0 | 12.48 | 670.5 |
| 4 | Amesha | 2624.0 | 12.41 | 675.7 |
| 5 | Brocko | 2265.0 | 12.44 | 679.5 |
| 6 | Brocko | 2586.0 | 12.56 | 668.0 |
| 7 | Brocko | 2491.0 | 12.46 | 649.9 |
| 8 | Brocko | 2399.0 | 12.43 | 658.9 |
| 9 | Amesha | 2269.0 | 12.54 | 661.5 |
| 10 | Amesha | 2181.0 | 12.36 | 669.2 |
| 11 | Amesha | 2281.0 | 12.30 | 669.2 |
| 12 | Amesha | 2339.0 | 12.23 | 674.4 |
| 13 | Brocko | 2488.0 | 12.52 | 675.7 |
| 14 | Brocko | 2659.0 | 12.30 | 679.5 |
| 15 | Brocko | 2567.0 | 12.53 | 692.4 |
| 16 | Brocko | 2495.0 | 12.36 | 695.0 |
| 17 | Amesha | 1983.0 | 12.45 | 644.8 |
| 18 | Amesha | 2096.0 | 12.18 | 664.1 |
| 19 | Amesha | 2682.0 | 12.43 | 688.5 |
| 20 | Amesha | 2875.0 | 12.35 | 687.3 |
| 21 | Brocko | 2720.0 | 12.53 | 686.0 |
| 22 | Brocko | 2787.0 | 12.50 | 683.4 |
| 23 | Brocko | 2856.0 | 12.62 | 687.3 |
| 24 | Brocko | 2794.0 | 12.27 | 680.8 |
| 25 | Amesha | 2359.0 | 12.44 | 670.5 |
| 26 | Amesha | 2429.0 | 12.04 | 670.5 |
| 27 | Amesha | 2063.0 | 12.40 | 664.1 |
| 28 | Amesha | 1862.0 | 12.36 | 642.2 |
| 29 | Brocko | 2823.0 | 11.99 | 689.8 |
| 30 | Brocko | 2814.0 | 12.48 | 691.1 |
| 31 | Brocko | 2823.0 | 12.05 | 689.8 |
| 32 | Brocko | 2702.0 | 12.27 | 640.9 |

Table 31. Protein, replication, and fertilizer treatment of spring wheat samples harvested on contrasting soil units in a field near Townsend.

| Sample Number | Soil Unit | Rep | Fertilizer Treatment[1] |
|---|---|---|---|
| | | g kg$^{-1}$ | |
| 1 | Amesha | 1.000 | 1.000 |
| 2 | Amesha | 1.000 | 2.000 |
| 3 | Amesha | 1.000 | 3.000 |
| 4 | Amesha | 1.000 | 4.000 |
| 5 | Brocko | 1.000 | 1.000 |
| 6 | Brocko | 1.000 | 2.000 |
| 7 | Brocko | 1.000 | 3.000 |
| 8 | Brocko | 1.000 | 4.000 |
| 9 | Amesha | 2.000 | 1.000 |
| 10 | Amesha | 2.000 | 2.000 |
| 11 | Amesha | 2.000 | 3.000 |
| 12 | Amesha | 2.000 | 4.000 |
| 13 | Brocko | 2.000 | 1.000 |
| 14 | Brocko | 2.000 | 2.000 |
| 15 | Brocko | 2.000 | 3.000 |
| 16 | Brocko | 2.000 | 4.000 |
| 17 | Amesha | 3.000 | 1.000 |
| 18 | Amesha | 3.000 | 2.000 |
| 19 | Amesha | 3.000 | 3.000 |
| 20 | Amesha | 3.000 | 4.000 |
| 21 | Brocko | 3.000 | 1.000 |
| 22 | Brocko | 3.000 | 2.000 |
| 23 | Brocko | 3.000 | 3.000 |
| 24 | Brocko | 3.000 | 4.000 |
| 25 | Amesha | 4.000 | 1.000 |
| 26 | Amesha | 4.000 | 2.000 |
| 27 | Amesha | 4.000 | 3.000 |
| 28 | Amesha | 4.000 | 4.000 |
| 29 | Brocko | 4.000 | 1.000 |
| 30 | Brocko | 4.000 | 2.000 |
| 31 | Brocko | 4.000 | 3.000 |
| 32 | Brocko | 4.000 | 4.000 |

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[1] Fertilizer treatments, expressed as kg ha$^{-1}$ N, P, and K, respectively, were 1 = 0-36-0, 2 = 8-11-34, 3 = 17-5-27, 4 = 0-0-0.

Table 32. Yield and test weight of spring wheat samples harvested on contrasting soil units in a field near Whitehall (1988).

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 1 | Walbert | 323.5 | 12.46 | 772.2 |
| 2 | Walbert | 243.8 | 12.23 | 749.0 |
| 3 | Walbert | 295.7 | 12.05 | 767.1 |
| 4 | Walbert | 63.80 | 12.05 | 761.9 |
| 5 | Walbert | 179.9 | 12.05 | 782.5 |
| 6 | Walbert | 374.5 | 12.35 | 767.1 |
| 7 | Walbert | 292.1 | 12.08 | 751.6 |
| 8 | Walbert | 294.0 | 12.46 | 772.2 |
| 9 | Walbert | 308.5 | 12.08 | 761.9 |
| 10 | Walbert | 507.1 | 12.23 | 772.2 |
| 11 | Walbert | 393.0 | 12.23 | 756.8 |
| 12 | Walbert | 536.7 | 12.17 | 746.5 |
| 13 | Walbert | 262.1 | 12.23 | 756.8 |
| 14 | Walbert | 179.2 | 12.17 | 761.9 |
| 15 | Walbert | 298.0 | 12.31 | 792.8 |
| 16 | Walbert | 378.0 | 12.05 | 823.7 |
| 17 | Walbert | 230.5 | 12.49 | 749.0 |
| 18 | Walbert | 561.2 | 11.87 | 782.5 |
| 19 | Walbert | 508.5 | 12.36 | 761.9 |
| 20 | Walbert | 218.1 | 12.35 | 782.5 |
| 21 | Varney | 334.4 | 11.95 | 751.6 |
| 22 | Varney | 370.6 | 11.82 | 746.5 |
| 23 | Varney | 532.5 | 11.94 | 754.2 |
| 24 | Varney | 252.6 | 11.69 | 720.7 |
| 25 | Varney | 322.5 | 11.79 | 777.3 |
| 26 | Varney | 585.7 | 11.97 | 746.5 |
| 27 | Varney | 689.8 | 11.79 | 773.5 |
| 28 | Varney | 531.4 | 11.87 | 813.4 |
| 29 | Varney | 498.2 | 11.69 | 754.2 |
| 30 | Varney | 293.4 | 11.78 | 782.5 |
| 31 | Varney | 815.0 | 11.94 | 803.1 |
| 32 | Varney | 946.0 | 11.92 | 751.6 |
| 33 | Varney | 842.7 | 11.97 | 761.9 |
| 34 | Varney | 524.1 | 11.54 | 741.3 |
| 35 | Varney | 208.9 | 11.69 | 759.3 |
| 36 | Varney | 514.5 | 12.23 | 751.6 |
| 37 | Varney | 688.8 | 11.90 | 772.2 |
| 38 | Varney | 417.6 | 11.97 | 773.5 |
| 39 | Varney | 424.5 | 11.92 | 720.7 |
| 40 | Varney | 295.2 | 12.10 | 761.9 |
| 41 | Ethridge | 180.8 | 12.28 | 747.7 |
| 42 | Ethridge | 134.5 | 12.05 | 747.7 |

Table 32--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 43 | Ethridge | 244.2 | 14.94 | 747.7 |
| 44 | Ethridge | 166.1 | 11.97 | 747.7 |
| 45 | Ethridge | 61.60 | 12.00 | 747.7 |
| 46 | Ethridge | 188.1 | 11.54 | 747.7 |
| 47 | Ethridge | 419.0 | 11.90 | 747.7 |
| 48 | Ethridge | 284.1 | 11.95 | 747.7 |
| 49 | Ethridge | 252.4 | 12.04 | 747.7 |
| 50 | Ethridge | 257.4 | 11.69 | 747.7 |
| 51 | Ethridge | 127.3 | 12.08 | 747.7 |
| 52 | Ethridge | 115.2 | 11.78 | 747.7 |
| 53 | Ethridge | 134.7 | 11.82 | 747.7 |
| 54 | Ethridge | 119.6 | 12.18 | 747.7 |
| 55 | Ethridge | 152.0 | 11.97 | 747.7 |
| 56 | Ethridge | 257.3 | 11.96 | 747.7 |
| 57 | Ethridge | 182.0 | 12.12 | 747.7 |
| 58 | Ethridge | 305.5 | 11.88 | 747.7 |
| 59 | Ethridge | 195.0 | 12.08 | 747.7 |
| 60 | Ethridge | 199.2 | 11.94 | 747.7 |

Table 33. Protein, replication, and fertilizer treatment of spring wheat samples harvested on contrasting soil units in a field near Whitehall (1988).

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 1 | Walbert | 183.0 | 1.000 | 1.000 |
| 2 | Walbert | 189.0 | 1.000 | 2.000 |
| 3 | Walbert | 187.0 | 1.000 | 3.000 |
| 4 | Walbert | 194.0 | 1.000 | 4.000 |
| 5 | Walbert | 160.0 | 1.000 | 5.000 |
| 6 | Walbert | 154.0 | 2.000 | 1.000 |
| 7 | Walbert | 186.0 | 2.000 | 2.000 |
| 8 | Walbert | 167.0 | 2.000 | 3.000 |
| 9 | Walbert | 189.0 | 2.000 | 4.000 |
| 10 | Walbert | 170.0 | 2.000 | 5.000 |
| 11 | Walbert | 162.0 | 3.000 | 1.000 |
| 12 | Walbert | 182.0 | 3.000 | 2.000 |
| 13 | Walbert | 176.0 | 3.000 | 3.000 |
| 14 | Walbert | 190.0 | 3.000 | 4.000 |
| 15 | Walbert | 150.0 | 3.000 | 5.000 |
| 16 | Walbert | 121.0 | 4.000 | 1.000 |
| 17 | Walbert | 187.0 | 4.000 | 2.000 |
| 18 | Walbert | 156.0 | 4.000 | 3.000 |
| 19 | Walbert | 174.0 | 4.000 | 4.000 |
| 20 | Walbert | 150.0 | 4.000 | 5.000 |
| 21 | Varney | 188.0 | 1.000 | 1.000 |
| 22 | Varney | 185.0 | 1.000 | 2.000 |
| 23 | Varney | 186.0 | 1.000 | 3.000 |
| 24 | Varney | 188.0 | 1.000 | 4.000 |
| 25 | Varney | 160.0 | 1.000 | 5.000 |
| 26 | Varney | 183.0 | 2.000 | 1.000 |
| 27 | Varney | 190.0 | 2.000 | 2.000 |
| 28 | Varney | 187.0 | 2.000 | 3.000 |
| 29 | Varney | 191.0 | 2.000 | 4.000 |
| 30 | Varney | 153.0 | 2.000 | 5.000 |
| 31 | Varney | 183.0 | 3.000 | 1.000 |
| 32 | Varney | 175.0 | 3.000 | 2.000 |
| 33 | Varney | 169.0 | 3.000 | 3.000 |
| 34 | Varney | 183.0 | 3.000 | 4.000 |
| 35 | Varney | 175.0 | 3.000 | 5.000 |
| 36 | Varney | 189.0 | 4.000 | 1.000 |
| 37 | Varney | 181.0 | 4.000 | 2.000 |
| 38 | Varney | 189.0 | 4.000 | 3.000 |
| 39 | Varney | 188.0 | 4.000 | 4.000 |
| 40 | Varney | 169.0 | 4.000 | 5.000 |
| 41 | Ethridge | 189.0 | 1.000 | 1.000 |
| 42 | Ethridge | 189.0 | 1.000 | 2.000 |

Table 33--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 43 | Ethridge | 183.0 | 1.000 | 3.000 |
| 44 | Ethridge | 194.0 | 1.000 | 4.000 |
| 45 | Ethridge | 174.0 | 1.000 | 5.000 |
| 46 | Ethridge | 183.0 | 2.000 | 1.000 |
| 47 | Ethridge | 186.0 | 2.000 | 2.000 |
| 48 | Ethridge | 183.0 | 2.000 | 3.000 |
| 49 | Ethridge | 191.0 | 2.000 | 4.000 |
| 50 | Ethridge | 167.0 | 2.000 | 5.000 |
| 51 | Ethridge | 184.0 | 3.000 | 1.000 |
| 52 | Ethridge | 183.0 | 3.000 | 2.000 |
| 53 | Ethridge | 186.0 | 3.000 | 3.000 |
| 54 | Ethridge | 190.0 | 3.000 | 4.000 |
| 55 | Ethridge | 186.0 | 3.000 | 5.000 |
| 56 | Ethridge | 189.0 | 4.000 | 1.000 |
| 57 | Ethridge | 189.0 | 4.000 | 2.000 |
| 58 | Ethridge | 192.0 | 4.000 | 3.000 |
| 59 | Ethridge | 190.0 | 4.000 | 4.000 |
| 60 | Ethridge | 171.0 | 4.000 | 5.000 |

[1] Fertilizer treatments, expressed as kg ha$^{-1}$ N, P, and K, respectively, were 1 = 134-0-0, 2 = 121-0-0, 3 = 74-0-0, 4 = 111-0-0, 5 = 0-0-0.

## APPENDIX D

### Yield, Test Weight, and Protein On Contrasting Soil Units in Crop X Soil Studies

Table 34. Yield and test weight of spring barley samples harvested on contrasting soil units in a field near Havre (1987).

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 1 | Evanston | 1008.0 | 3.623 | 683.4 |
| 2 | Evanston | 1173.0 | 2.601 | 606.2 |
| 3 | Evanston | 948.0 | 3.205 | 678.3 |
| 4 | Evanston | 1544.0 | 4.273 | 684.7 |
| 5 | Evanston | 1654.0 | 4.366 | 687.3 |
| 6 | Evanston | 911.0 | 2.601 | 671.8 |
| 7 | Evanston | 1036.0 | 4.134 | 661.5 |
| 8 | Evanston | 1390.0 | 4.459 | 648.7 |
| 9 | Evanston | 1352.0 | 4.459 | 680.8 |
| 10 | Evanston | 688.0 | 2.973 | 630.6 |
| 11 | Evanston | 1508.0 | 4.320 | 670.5 |
| 12 | Evanston | 1500.0 | 4.459 | 666.7 |
| 13 | Evanston | 931.0 | 3.809 | 677.0 |
| 14 | Evanston | 1655.0 | 4.320 | 593.3 |
| 15 | Evanston | 1167.0 | 4.366 | 673.1 |
| 16 | Evanston | 1698.0 | 4.366 | 677.0 |
| 17 | Evanston | 1137.0 | 2.973 | 691.1 |
| 18 | Evanston | 1597.0 | 4.273 | 689.8 |
| 19 | Evanston | 1009.0 | 2.880 | 675.7 |
| 20 | Evanston | 1647.0 | 4.273 | 657.7 |
| 21 | Evanston | 835.0 | 4.041 | 668.0 |
| 22 | Evanston | 837.0 | 4.366 | 620.3 |
| 23 | Evanston | 1537.0 | 3.484 | 666.7 |
| 24 | Evanston | 1423.0 | 3.809 | 666.7 |
| 25 | Evanston | 907.0 | 3.902 | 675.7 |
| 26 | Evanston | 815.0 | 1.858 | 590.7 |
| 27 | Evanston | 905.0 | 2.880 | 675.7 |
| 28 | Evanston | 1604.0 | 4.459 | 675.7 |
| 29 | Evanston | 1096.0 | 2.973 | 692.4 |
| 30 | Evanston | 1543.0 | 4.366 | 674.4 |
| 31 | Evanston | 1307.0 | 4.227 | 658.9 |
| 32 | Evanston | 1339.0 | 4.366 | 648.7 |
| 33 | Evanston | 1235.0 | 3.902 | 671.8 |
| 34 | Evanston | 811.0 | 4.320 | 604.9 |
| 35 | Evanston | 1074.0 | 3.159 | 658.9 |
| 36 | Evanston | 1497.0 | 4.366 | 662.8 |
| 37 | Evanston | 823.0 | 2.741 | 689.8 |
| 38 | Evanston | 1297.0 | 2.926 | 610.0 |
| 39 | Evanston | 1206.0 | 4.459 | 674.4 |
| 40 | Evanston | 724.0 | 2.137 | 665.4 |
| 41 | Evanston | 1380.0 | 4.041 | 673.1 |
| 42 | Evanston | 920.0 | 3.205 | 677.0 |

Table 34--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 43 | Evanston | 853.0 | 3.809 | 666.7 |
| 44 | Evanston | 952.0 | 4.459 | 647.4 |
| 45 | Evanston | 1287.0 | 4.366 | 673.1 |
| 46 | Evanston | 604.0 | 4.366 | 593.3 |
| 47 | Evanston | 1179.0 | 4.320 | 655.1 |
| 48 | Evanston | 973.0 | 4.320 | 658.9 |
| 49 | Telstad | 759.0 | 3.902 | 638.3 |
| 50 | Telstad | 1121.0 | 3.252 | 550.8 |
| 51 | Telstad | 563.0 | 2.787 | 646.1 |
| 52 | Telstad | 1631.0 | 4.413 | 629.3 |
| 53 | Telstad | 1726.0 | 4.459 | 647.4 |
| 54 | Telstad | 952.0 | 3.205 | 639.6 |
| 55 | Telstad | 715.0 | 2.694 | 637.1 |
| 56 | Telstad | 1437.0 | 4.459 | 619.0 |
| 57 | Telstad | 984.0 | 4.413 | 626.8 |
| 58 | Telstad | 559.0 | 3.066 | 549.5 |
| 59 | Telstad | 1093.0 | 2.648 | 629.3 |
| 60 | Telstad | 1471.0 | 4.366 | 616.5 |
| 61 | Telstad | 360.0 | 2.415 | 651.2 |
| 62 | Telstad | 1078.0 | 3.577 | 540.5 |
| 63 | Telstad | 808.0 | 4.273 | 642.2 |
| 64 | Telstad | 1396.0 | 4.320 | 639.6 |
| 65 | Telstad | 673.0 | 2.880 | 648.7 |
| 66 | Telstad | 1301.0 | 4.366 | 629.3 |
| 67 | Telstad | 557.0 | 2.555 | 639.6 |
| 68 | Telstad | 1053.0 | 4.181 | 610.0 |
| 69 | Telstad | 857.0 | 4.366 | 628.1 |
| 70 | Telstad | 310.0 | 2.787 | 592.0 |
| 71 | Telstad | 861.0 | 2.555 | 634.5 |
| 72 | Telstad | 878.0 | 3.298 | 619.0 |
| 73 | Telstad | 556.0 | 2.322 | 649.9 |
| 74 | Telstad | 904.0 | 2.415 | 566.3 |
| 75 | Telstad | 636.0 | 2.880 | 638.3 |
| 76 | Telstad | 1156.0 | 4.459 | 622.9 |
| 77 | Telstad | 1008.0 | 3.391 | 647.4 |
| 78 | Telstad | 1253.0 | 4.413 | 637.1 |
| 79 | Telstad | 1005.0 | 4.181 | 635.8 |
| 80 | Telstad | 1376.0 | 4.413 | 608.8 |
| 81 | Telstad | 742.0 | 3.066 | 633.2 |
| 82 | Telstad | 466.0 | 4.273 | 553.4 |
| 83 | Telstad | 1057.0 | 3.252 | 637.1 |
| 84 | Telstad | 1449.0 | 4.459 | 621.6 |
| 85 | Telstad | 301.0 | 2.137 | 652.5 |
| 86 | Telstad | 920.0 | 2.973 | 567.6 |

Table 34--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 87 | Telstad | 839.0 | 4.459 | 638.3 |
| 88 | Telstad | 906.0 | 2.926 | 646.1 |
| 89 | Telstad | 1277.0 | 4.320 | 653.8 |
| 90 | Telstad | 915.0 | 3.298 | 648.7 |
| 91 | Telstad | 699.0 | 2.694 | 602.3 |
| 92 | Telstad | 1528.0 | 4.459 | 625.5 |
| 93 | Telstad | 1001.0 | 4.459 | 633.2 |
| 94 | Telstad | 361.0 | 3.019 | 593.3 |
| 95 | Telstad | 1417.0 | 4.459 | 631.9 |
| 96 | Telstad | 1556.0 | 4.459 | 629.3 |
| 97 | Phillips | 919.0 | 3.530 | 677.0 |
| 98 | Phillips | 788.0 | 2.137 | 612.6 |
| 99 | Phillips | 614.0 | 2.926 | 666.7 |
| 100 | Phillips | 1430.0 | 4.459 | 661.5 |
| 101 | Phillips | 1197.0 | 4.459 | 684.7 |
| 102 | Phillips | 932.0 | 3.066 | 668.0 |
| 103 | Phillips | 742.0 | 2.880 | 666.7 |
| 104 | Phillips | 1332.0 | 4.366 | 660.2 |
| 105 | Phillips | 982.0 | 4.459 | 661.5 |
| 106 | Phillips | 829.0 | 4.181 | 606.2 |
| 107 | Phillips | 1294.0 | 4.041 | 649.9 |
| 108 | Phillips | 1258.0 | 4.459 | 640.9 |
| 109 | Phillips | 450.0 | 2.322 | 669.2 |
| 110 | Phillips | 1192.0 | 3.623 | 588.2 |
| 111 | Phillips | 1167.0 | 4.459 | 661.5 |
| 112 | Phillips | 1358.0 | 4.366 | 657.7 |
| 113 | Phillips | 827.0 | 2.926 | 669.2 |
| 114 | Phillips | 1260.0 | 4.459 | 668.0 |
| 115 | Phillips | 721.0 | 2.648 | 660.2 |
| 116 | Phillips | 1346.0 | 4.413 | 649.9 |
| 117 | Phillips | 1199.0 | 4.459 | 662.8 |
| 118 | Phillips | 780.0 | 4.366 | 616.5 |
| 119 | Phillips | 1101.0 | 2.973 | 648.7 |
| 120 | Phillips | 1378.0 | 4.088 | 644.8 |
| 121 | Phillips | 867.0 | 3.995 | 656.4 |
| 122 | Phillips | 695.0 | 2.044 | 615.2 |
| 123 | Phillips | 652.0 | 2.880 | 669.2 |
| 124 | Phillips | 1608.0 | 4.459 | 662.8 |
| 125 | Phillips | 1056.0 | 3.112 | 675.7 |
| 126 | Phillips | 1361.0 | 4.459 | 668.0 |
| 127 | Phillips | 987.0 | 3.809 | 668.0 |
| 128 | Phillips | 1152.0 | 4.459 | 661.5 |
| 129 | Phillips | 1202.0 | 4.273 | 670.5 |
| 130 | Phillips | 535.0 | 4.366 | 622.9 |

Table 34--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 131 | Phillips | 1096.0 | 3.019 | 656.4 |
| 132 | Phillips | 1335.0 | 4.227 | 646.1 |
| 133 | Phillips | 764.0 | 2.694 | 674.4 |
| 134 | Phillips | 1316.0 | 4.088 | 603.6 |
| 135 | Phillips | 1128.0 | 4.459 | 680.8 |
| 136 | Phillips | 1011.0 | 3.066 | 657.7 |
| 137 | Phillips | 1360.0 | 4.459 | 680.8 |
| 138 | Phillips | 900.0 | 3.205 | 671.8 |
| 139 | Phillips | 811.0 | 2.880 | 666.7 |
| 140 | Phillips | 1190.0 | 4.459 | 673.1 |
| 141 | Phillips | 1129.0 | 3.855 | 669.2 |
| 142 | Phillips | 606.0 | 4.227 | 626.8 |
| 143 | Phillips | 1299.0 | 4.320 | 664.1 |
| 144 | Phillips | 1279.0 | 4.459 | 666.7 |

Table 35. Protein, replication, and cultivar of spring barley samples harvested on contrasting soil units in a field near Havre (1987).

| Sample Number | Soil Unit | Protein | Rep | Cultivar[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 1 | Evanston | 133.0 | 1.000 | 1.000 |
| 2 | Evanston | 120.0 | 1.000 | 2.000 |
| 3 | Evanston | 147.0 | 1.000 | 3.000 |
| 4 | Evanston | 127.0 | 1.000 | 4.000 |
| 5 | Evanston | 127.0 | 1.000 | 5.000 |
| 6 | Evanston | 142.0 | 1.000 | 6.000 |
| 7 | Evanston | 133.0 | 1.000 | 7.000 |
| 8 | Evanston | 133.0 | 1.000 | 8.000 |
| 9 | Evanston | 141.0 | 1.000 | 9.000 |
| 10 | Evanston | 131.0 | 1.000 | 10.00 |
| 11 | Evanston | 139.0 | 1.000 | 11.00 |
| 12 | Evanston | 133.0 | 1.000 | 12.00 |
| 13 | Evanston | 139.0 | 2.000 | 1.000 |
| 14 | Evanston | 107.0 | 2.000 | 2.000 |
| 15 | Evanston | 148.0 | 2.000 | 3.000 |
| 16 | Evanston | 128.0 | 2.000 | 4.000 |
| 17 | Evanston | 136.0 | 2.000 | 5.000 |
| 18 | Evanston | 127.0 | 2.000 | 6.000 |
| 19 | Evanston | 138.0 | 2.000 | 7.000 |
| 20 | Evanston | 129.0 | 2.000 | 8.000 |
| 21 | Evanston | 156.0 | 2.000 | 9.000 |
| 22 | Evanston | 128.0 | 2.000 | 10.00 |
| 23 | Evanston | 134.0 | 2.000 | 11.00 |
| 24 | Evanston | 127.0 | 2.000 | 12.00 |
| 25 | Evanston | 140.0 | 3.000 | 1.000 |
| 26 | Evanston | 120.0 | 3.000 | 2.000 |
| 27 | Evanston | 148.0 | 3.000 | 3.000 |
| 28 | Evanston | 131.0 | 3.000 | 4.000 |
| 29 | Evanston | 135.0 | 3.000 | 5.000 |
| 30 | Evanston | 134.0 | 3.000 | 6.000 |
| 31 | Evanston | 133.0 | 3.000 | 7.000 |
| 32 | Evanston | 133.0 | 3.000 | 8.000 |
| 33 | Evanston | 141.0 | 3.000 | 9.000 |
| 34 | Evanston | 126.0 | 3.000 | 10.00 |
| 35 | Evanston | 140.0 | 3.000 | 11.00 |
| 36 | Evanston | 127.0 | 3.000 | 12.00 |
| 37 | Evanston | 130.0 | 4.000 | 1.000 |
| 38 | Evanston | 113.0 | 4.000 | 2.000 |
| 39 | Evanston | 151.0 | 4.000 | 3.000 |
| 40 | Evanston | 137.0 | 4.000 | 4.000 |
| 41 | Evanston | 129.0 | 4.000 | 5.000 |
| 42 | Evanston | 140.0 | 4.000 | 6.000 |

Table 35--Continued.

| Sample Number | Soil Unit | Protein | Rep | Cultivar[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 43 | Evanston | 136.0 | 4.000 | 7.000 |
| 44 | Evanston | 131.0 | 4.000 | 8.000 |
| 45 | Evanston | 143.0 | 4.000 | 9.000 |
| 46 | Evanston | 125.0 | 4.000 | 10.00 |
| 47 | Evanston | 121.0 | 4.000 | 11.00 |
| 48 | Evanston | 134.0 | 4.000 | 12.00 |
| 49 | Telstad | 121.0 | 1.000 | 1.000 |
| 50 | Telstad | 98.00 | 1.000 | 2.000 |
| 51 | Telstad | 133.0 | 1.000 | 3.000 |
| 52 | Telstad | 106.0 | 1.000 | 4.000 |
| 53 | Telstad | 103.0 | 1.000 | 5.000 |
| 54 | Telstad | 123.0 | 1.000 | 6.000 |
| 55 | Telstad | 129.0 | 1.000 | 7.000 |
| 56 | Telstad | 116.0 | 1.000 | 8.000 |
| 57 | Telstad | 135.0 | 1.000 | 9.000 |
| 58 | Telstad | 120.0 | 1.000 | 10.00 |
| 59 | Telstad | 122.0 | 1.000 | 11.00 |
| 60 | Telstad | 111.0 | 1.000 | 12.00 |
| 61 | Telstad | 128.0 | 2.000 | 1.000 |
| 62 | Telstad | 104.0 | 2.000 | 2.000 |
| 63 | Telstad | 125.0 | 2.000 | 3.000 |
| 64 | Telstad | 107.0 | 2.000 | 4.000 |
| 65 | Telstad | 119.0 | 2.000 | 5.000 |
| 66 | Telstad | 113.0 | 2.000 | 6.000 |
| 67 | Telstad | 128.0 | 2.000 | 7.000 |
| 68 | Telstad | 111.0 | 2.000 | 8.000 |
| 69 | Telstad | 120.0 | 2.000 | 9.000 |
| 70 | Telstad | 118.0 | 2.000 | 10.00 |
| 71 | Telstad | 118.0 | 2.000 | 11.00 |
| 72 | Telstad | 114.0 | 2.000 | 12.00 |
| 73 | Telstad | 128.0 | 3.000 | 1.000 |
| 74 | Telstad | 103.0 | 3.000 | 2.000 |
| 75 | Telstad | 130.0 | 3.000 | 3.000 |
| 76 | Telstad | 113.0 | 3.000 | 4.000 |
| 77 | Telstad | 106.0 | 3.000 | 5.000 |
| 78 | Telstad | 108.0 | 3.000 | 6.000 |
| 79 | Telstad | 120.0 | 3.000 | 7.000 |
| 80 | Telstad | 109.0 | 3.000 | 8.000 |
| 81 | Telstad | 133.0 | 3.000 | 9.000 |
| 82 | Telstad | 115.0 | 3.000 | 10.00 |
| 83 | Telstad | 114.0 | 3.000 | 11.00 |
| 84 | Telstad | 107.0 | 3.000 | 12.00 |
| 85 | Telstad | 124.0 | 4.000 | 1.000 |
| 86 | Telstad | 105.0 | 4.000 | 2.000 |

Table 35--Continued.

| Sample Number | Soil Unit | Protein | Rep | Cultivar[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 87 | Telstad | 129.0 | 4.000 | 3.000 |
| 88 | Telstad | 116.0 | 4.000 | 4.000 |
| 89 | Telstad | 115.0 | 4.000 | 5.000 |
| 90 | Telstad | 110.0 | 4.000 | 6.000 |
| 91 | Telstad | 129.0 | 4.000 | 7.000 |
| 92 | Telstad | 110.0 | 4.000 | 8.000 |
| 93 | Telstad | 120.0 | 4.000 | 9.000 |
| 94 | Telstad | 116.0 | 4.000 | 10.00 |
| 95 | Telstad | 115.0 | 4.000 | 11.00 |
| 96 | Telstad | 102.0 | 4.000 | 12.00 |
| 97 | Phillips | 135.0 | 1.000 | 1.000 |
| 98 | Phillips | 117.0 | 1.000 | 2.000 |
| 99 | Phillips | 142.0 | 1.000 | 3.000 |
| 100 | Phillips | 128.0 | 1.000 | 4.000 |
| 101 | Phillips | 129.0 | 1.000 | 5.000 |
| 102 | Phillips | 136.0 | 1.000 | 6.000 |
| 103 | Phillips | 133.0 | 1.000 | 7.000 |
| 104 | Phillips | 127.0 | 1.000 | 8.000 |
| 105 | Phillips | 135.0 | 1.000 | 9.000 |
| 106 | Phillips | 122.0 | 1.000 | 10.00 |
| 107 | Phillips | 135.0 | 1.000 | 11.00 |
| 108 | Phillips | 121.0 | 1.000 | 12.00 |
| 109 | Phillips | 140.0 | 2.000 | 1.000 |
| 110 | Phillips | 111.0 | 2.000 | 2.000 |
| 111 | Phillips | 148.0 | 2.000 | 3.000 |
| 112 | Phillips | 129.0 | 2.000 | 4.000 |
| 113 | Phillips | 137.0 | 2.000 | 5.000 |
| 114 | Phillips | 123.0 | 2.000 | 6.000 |
| 115 | Phillips | 139.0 | 2.000 | 7.000 |
| 116 | Phillips | 123.0 | 2.000 | 8.000 |
| 117 | Phillips | 136.0 | 2.000 | 9.000 |
| 118 | Phillips | 124.0 | 2.000 | 10.00 |
| 119 | Phillips | 142.0 | 2.000 | 11.00 |
| 120 | Phillips | 121.0 | 2.000 | 12.00 |
| 121 | Phillips | 130.0 | 3.000 | 1.000 |
| 122 | Phillips | 115.0 | 3.000 | 2.000 |
| 123 | Phillips | 142.0 | 3.000 | 3.000 |
| 124 | Phillips | 123.0 | 3.000 | 4.000 |
| 125 | Phillips | 130.0 | 3.000 | 5.000 |
| 126 | Phillips | 129.0 | 3.000 | 6.000 |
| 127 | Phillips | 128.0 | 3.000 | 7.000 |
| 128 | Phillips | 117.0 | 3.000 | 8.000 |
| 129 | Phillips | 141.0 | 3.000 | 9.000 |
| 130 | Phillips | 119.0 | 3.000 | 10.00 |

Table 35--Continued.

| Sample Number | Soil Unit | Protein | Rep | Cultivar[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 131 | Phillips | 134.0 | 3.000 | 11.00 |
| 132 | Phillips | 119.0 | 3.000 | 12.00 |
| 133 | Phillips | 125.0 | 4.000 | 1.000 |
| 134 | Phillips | 108.0 | 4.000 | 2.000 |
| 135 | Phillips | 132.0 | 4.000 | 3.000 |
| 136 | Phillips | 121.0 | 4.000 | 4.000 |
| 137 | Phillips | 121.0 | 4.000 | 5.000 |
| 138 | Phillips | 122.0 | 4.000 | 6.000 |
| 139 | Phillips | 130.0 | 4.000 | 7.000 |
| 140 | Phillips | 113.0 | 4.000 | 8.000 |
| 141 | Phillips | 131.0 | 4.000 | 9.000 |
| 142 | Phillips | 116.0 | 4.000 | 10.00 |
| 143 | Phillips | 120.0 | 4.000 | 11.00 |
| 144 | Phillips | 109.0 | 4.000 | 12.00 |

[1] Cultivars were 1 = Hector, 2 = Steptoe, 3 = Piroline, 4 = Clark, 5 = Lewis, 6 = Gallatin, 7 = Bowman, 8 = Harrington, 9 = Kimberly, 10 = Hazen, 11 = MT 81616, 12 = MT 81161.

Table 36. Yield and test weight of spring wheat samples harvested on contrasting soil units in a field near Havre (1987).

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 1 | Evanston | 846.0 | 4.181 | 817.3 |
| 2 | Evanston | 922.0 | 4.088 | 819.8 |
| 3 | Evanston | 878.0 | 4.088 | 814.7 |
| 4 | Evanston | 1148.0 | 4.459 | 830.1 |
| 5 | Evanston | 1235.0 | 4.459 | 808.2 |
| 6 | Evanston | 770.0 | 3.344 | 817.3 |
| 7 | Evanston | 1040.0 | 3.298 | 818.5 |
| 8 | Evanston | 847.0 | 4.459 | 812.1 |
| 9 | Evanston | 1368.0 | 4.413 | 814.7 |
| 10 | Evanston | 635.0 | 3.066 | 803.1 |
| 11 | Evanston | 842.0 | 2.973 | 812.1 |
| 12 | Evanston | 1022.0 | 4.459 | 827.5 |
| 13 | Evanston | 1047.0 | 4.459 | 818.5 |
| 14 | Evanston | 1109.0 | 4.459 | 813.4 |
| 15 | Evanston | 797.0 | 3.019 | 804.4 |
| 16 | Evanston | 1315.0 | 4.459 | 812.1 |
| 17 | Evanston | 1563.0 | 4.459 | 792.8 |
| 18 | Evanston | 1109.0 | 4.320 | 812.1 |
| 19 | Evanston | 1443.0 | 4.459 | 801.8 |
| 20 | Evanston | 851.0 | 3.112 | 810.8 |
| 21 | Evanston | 1363.0 | 3.623 | 813.4 |
| 22 | Evanston | 1095.0 | 4.459 | 804.4 |
| 23 | Evanston | 1124.0 | 3.716 | 809.5 |
| 24 | Evanston | 1072.0 | 4.366 | 830.1 |
| 25 | Evanston | 1387.0 | 4.459 | 819.8 |
| 26 | Evanston | 1208.0 | 4.041 | 807.0 |
| 27 | Evanston | 1060.0 | 4.459 | 808.2 |
| 28 | Evanston | 1059.0 | 3.344 | 812.1 |
| 29 | Evanston | 1516.0 | 4.413 | 797.9 |
| 30 | Evanston | 856.0 | 3.252 | 808.2 |
| 31 | Evanston | 1398.0 | 4.459 | 803.1 |
| 32 | Evanston | 1387.0 | 4.366 | 810.8 |
| 33 | Evanston | 1350.0 | 4.320 | 799.2 |
| 34 | Evanston | 1050.0 | 4.366 | 788.9 |
| 35 | Evanston | 1458.0 | 4.088 | 809.5 |
| 36 | Evanston | 1095.0 | 3.019 | 837.8 |
| 37 | Evanston | 870.0 | 2.926 | 818.5 |
| 38 | Evanston | 830.0 | 4.366 | 805.7 |
| 39 | Evanston | 951.0 | 3.948 | 805.7 |
| 40 | Evanston | 1137.0 | 4.459 | 816.0 |
| 41 | Evanston | 1151.0 | 4.227 | 785.1 |
| 42 | Evanston | 786.0 | 4.320 | 805.7 |

Table 3.6--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | $kg\ m^{-3}$ |
| 43 | Evanston | 1075.0 | 4.366 | 794.1 |
| 44 | Evanston | 1034.0 | 3.716 | 809.5 |
| 45 | Evanston | 1371.0 | 4.413 | 817.3 |
| 46 | Evanston | 695.0 | 3.995 | 786.4 |
| 47 | Evanston | 885.0 | 3.577 | 797.9 |
| 48 | Evanston | 968.0 | 3.019 | 827.5 |
| 49 | Telstad | 1022.0 | 4.459 | 778.6 |
| 50 | Telstad | 1029.0 | 4.459 | 758.0 |
| 51 | Telstad | 1087.0 | 4.413 | 741.3 |
| 52 | Telstad | 1238.0 | 4.459 | 754.2 |
| 53 | Telstad | 1459.0 | 4.459 | 743.9 |
| 54 | Telstad | 1153.0 | 4.459 | 770.9 |
| 55 | Telstad | 1350.0 | 3.902 | 767.0 |
| 56 | Telstad | 1383.0 | 4.413 | 790.2 |
| 57 | Telstad | 1448.0 | 4.459 | 759.3 |
| 58 | Telstad | 886.0 | 4.366 | 747.8 |
| 59 | Telstad | 1299.0 | 4.459 | 745.2 |
| 60 | Telstad | 1232.0 | 4.459 | 781.2 |
| 61 | Telstad | 867.0 | 4.413 | 768.3 |
| 62 | Telstad | 805.0 | 4.459 | 752.9 |
| 63 | Telstad | 758.0 | 4.366 | 759.3 |
| 64 | Telstad | 894.0 | 4.366 | 776.1 |
| 65 | Telstad | 995.0 | 4.459 | 743.9 |
| 66 | Telstad | 576.0 | 4.366 | 750.3 |
| 67 | Telstad | 918.0 | 4.413 | 754.2 |
| 68 | Telstad | 910.0 | 4.366 | 752.9 |
| 69 | Telstad | 792.0 | 4.366 | 777.3 |
| 70 | Telstad | 559.0 | 4.459 | 724.6 |
| 71 | Telstad | 951.0 | 4.320 | 755.5 |
| 72 | Telstad | 1113.0 | 4.413 | 773.5 |
| 73 | Telstad | 789.0 | 4.459 | 768.3 |
| 74 | Telstad | 1239.0 | 4.459 | 782.5 |
| 75 | Telstad | 984.0 | 4.459 | 755.5 |
| 76 | Telstad | 989.0 | 4.459 | 770.9 |
| 77 | Telstad | 1134.0 | 4.413 | 731.0 |
| 78 | Telstad | 613.0 | 4.366 | 751.6 |
| 79 | Telstad | 1438.0 | 4.459 | 765.8 |
| 80 | Telstad | 1249.0 | 4.459 | 768.3 |
| 81 | Telstad | 568.0 | 4.320 | 761.9 |
| 82 | Telstad | 452.0 | 4.459 | 742.6 |
| 83 | Telstad | 1010.0 | 4.413 | 746.5 |
| 84 | Telstad | 934.0 | 4.459 | 779.9 |
| 85 | Telstad | 899.0 | 4.413 | 774.8 |
| 86 | Telstad | 1103.0 | 4.413 | 777.3 |

Table 36--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 87 | Telstad | 826.0 | 4.459 | 746.5 |
| 88 | Telstad | 1097.0 | 4.459 | 765.8 |
| 89 | Telstad | 1286.0 | 4.413 | 738.7 |
| 90 | Telstad | 945.0 | 4.459 | 770.9 |
| 91 | Telstad | 1087.0 | 4.366 | 767.0 |
| 92 | Telstad | 935.0 | 4.273 | 759.3 |
| 93 | Telstad | 693.0 | 4.273 | 749.0 |
| 94 | Telstad | 710.0 | 4.366 | 736.2 |
| 95 | Telstad | 1091.0 | 4.459 | 764.5 |
| 96 | Telstad | 1012.0 | 4.459 | 783.8 |
| 97 | Phillips | 1164.0 | 4.366 | 816.0 |
| 98 | Phillips | 985.0 | 4.459 | 803.1 |
| 99 | Phillips | 1106.0 | 4.459 | 799.2 |
| 100 | Phillips | 1218.0 | 4.459 | 807.0 |
| 101 | Phillips | 1478.0 | 4.459 | 788.9 |
| 102 | Phillips | 1013.0 | 4.134 | 800.5 |
| 103 | Phillips | 496.0 | 4.227 | 782.5 |
| 104 | Phillips | 1101.0 | 4.459 | 800.5 |
| 105 | Phillips | 1011.0 | 4.459 | 787.6 |
| 106 | Phillips | 823.0 | 4.459 | 779.9 |
| 107 | Phillips | 1142.0 | 4.459 | 800.5 |
| 108 | Phillips | 1250.0 | 4.459 | 819.8 |
| 109 | Phillips | 1099.0 | 4.459 | 813.4 |
| 110 | Phillips | 1132.0 | 4.459 | 805.7 |
| 111 | Phillips | 1052.0 | 4.366 | 795.4 |
| 112 | Phillips | 1203.0 | 4.459 | 803.1 |
| 113 | Phillips | 1369.0 | 4.413 | 777.3 |
| 114 | Phillips | 1056.0 | 4.459 | 801.8 |
| 115 | Phillips | 1052.0 | 4.134 | 788.9 |
| 116 | Phillips | 1263.0 | 4.459 | 796.7 |
| 117 | Phillips | 1159.0 | 4.459 | 796.7 |
| 118 | Phillips | 660.0 | 4.459 | 781.2 |
| 119 | Phillips | 1234.0 | 4.413 | 796.7 |
| 120 | Phillips | 1396.0 | 4.366 | 825.0 |
| 121 | Phillips | 1175.0 | 4.459 | 799.2 |
| 122 | Phillips | 976.0 | 4.413 | 810.8 |
| 123 | Phillips | 1219.0 | 4.413 | 800.5 |
| 124 | Phillips | 1332.0 | 4.459 | 812.1 |
| 125 | Phillips | 1406.0 | 4.413 | 786.4 |
| 126 | Phillips | 1165.0 | 4.459 | 808.2 |
| 127 | Phillips | 1294.0 | 4.459 | 794.1 |
| 128 | Phillips | 1562.0 | 4.459 | 808.2 |
| 129 | Phillips | 1335.0 | 4.459 | 805.7 |
| 130 | Phillips | 854.0 | 4.459 | 781.2 |

Table 36--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 131 | Phillips | 1301.0 | 4.459 | 804.4 |
| 132 | Phillips | 1395.0 | 4.366 | 825.0 |
| 133 | Phillips | 1077.0 | 4.459 | 814.7 |
| 134 | Phillips | 1236.0 | 4.459 | 797.9 |
| 135 | Phillips | 972.0 | 4.459 | 803.1 |
| 136 | Phillips | 1094.0 | 4.459 | 812.1 |
| 137 | Phillips | 1565.0 | 4.413 | 796.7 |
| 138 | Phillips | 1056.0 | 4.459 | 803.1 |
| 139 | Phillips | 1374.0 | 4.459 | 800.5 |
| 140 | Phillips | 1251.0 | 4.320 | 800.5 |
| 141 | Phillips | 1216.0 | 4.366 | 799.2 |
| 142 | Phillips | 885.0 | 4.459 | 785.1 |
| 143 | Phillips | 1249.0 | 4.413 | 804.4 |
| 144 | Phillips | 1269.0 | 4.459 | 826.3 |

Table 37. Protein, replication, and spring wheat cultivar of samples harvested on contrasting soil units in a field near Havre (1987).

| Sample Number | Soil Unit | Protein | Rep | Cultivar[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 1 | Evanston | 161.0 | 1.000 | 1.000 |
| 2 | Evanston | 152.0 | 1.000 | 2.000 |
| 3 | Evanston | 153.0 | 1.000 | 3.000 |
| 4 | Evanston | 126.0 | 1.000 | 4.000 |
| 5 | Evanston | 125.0 | 1.000 | 5.000 |
| 6 | Evanston | 144.0 | 1.000 | 6.000 |
| 7 | Evanston | 132.0 | 1.000 | 7.000 |
| 8 | Evanston | 144.0 | 1.000 | 8.000 |
| 9 | Evanston | 127.0 | 1.000 | 9.000 |
| 10 | Evanston | 137.0 | 1.000 | 10.00 |
| 11 | Evanston | 166.0 | 1.000 | 11.00 |
| 12 | Evanston | 129.0 | 1.000 | 12.00 |
| 13 | Evanston | 153.0 | 2.000 | 1.000 |
| 14 | Evanston | 156.0 | 2.000 | 2.000 |
| 15 | Evanston | 165.0 | 2.000 | 3.000 |
| 16 | Evanston | 140.0 | 2.000 | 4.000 |
| 17 | Evanston | 133.0 | 2.000 | 5.000 |
| 18 | Evanston | 149.0 | 2.000 | 6.000 |
| 19 | Evanston | 139.0 | 2.000 | 7.000 |
| 20 | Evanston | 145.0 | 2.000 | 8.000 |
| 21 | Evanston | 127.0 | 2.000 | 9.000 |
| 22 | Evanston | 126.0 | 2.000 | 10.00 |
| 23 | Evanston | 161.0 | 2.000 | 11.00 |
| 24 | Evanston | 131.0 | 2.000 | 12.00 |
| 25 | Evanston | 146.0 | 3.000 | 1.000 |
| 26 | Evanston | 148.0 | 3.000 | 2.000 |
| 27 | Evanston | 151.0 | 3.000 | 3.000 |
| 28 | Evanston | 140.0 | 3.000 | 4.000 |
| 29 | Evanston | 126.0 | 3.000 | 5.000 |
| 30 | Evanston | 149.0 | 3.000 | 6.000 |
| 31 | Evanston | 131.0 | 3.000 | 7.000 |
| 32 | Evanston | 148.0 | 3.000 | 8.000 |
| 33 | Evanston | 123.0 | 3.000 | 9.000 |
| 34 | Evanston | 131.0 | 3.000 | 10.00 |
| 35 | Evanston | 159.0 | 3.000 | 11.00 |
| 36 | Evanston | 134.0 | 3.000 | 12.00 |
| 37 | Evanston | 156.0 | 4.000 | 1.000 |
| 38 | Evanston | 155.0 | 4.000 | 2.000 |
| 39 | Evanston | 157.0 | 4.000 | 3.000 |
| 40 | Evanston | 144.0 | 4.000 | 4.000 |
| 41 | Evanston | 130.0 | 4.000 | 5.000 |
| 42 | Evanston | 153.0 | 4.000 | 6.000 |

Table 37--Continued.

| Sample Number | Soil Unit | Protein | Rep | Cultivar[1] |
|---|---|---|---|---|
| | | g $kg^{-1}$ | | |
| 43 | Evanston | 139.0 | 4.000 | 7.000 |
| 44 | Evanston | 149.0 | 4.000 | 8.000 |
| 45 | Evanston | 119.0 | 4.000 | 9.000 |
| 46 | Evanston | 137.0 | 4.000 | 10.00 |
| 47 | Evanston | 163.0 | 4.000 | 11.00 |
| 48 | Evanston | 135.0 | 4.000 | 12.00 |
| 49 | Telstad | 138.0 | 1.000 | 1.000 |
| 50 | Telstad | 133.0 | 1.000 | 2.000 |
| 51 | Telstad | 137.0 | 1.000 | 3.000 |
| 52 | Telstad | 117.0 | 1.000 | 4.000 |
| 53 | Telstad | 115.0 | 1.000 | 5.000 |
| 54 | Telstad | 122.0 | 1.000 | 6.000 |
| 55 | Telstad | 120.0 | 1.000 | 7.000 |
| 56 | Telstad | 130.0 | 1.000 | 8.000 |
| 57 | Telstad | 108.0 | 1.000 | 9.000 |
| 58 | Telstad | 120.0 | 1.000 | 10.00 |
| 59 | Telstad | 140.0 | 1.000 | 11.00 |
| 60 | Telstad | 112.0 | 1.000 | 12.00 |
| 61 | Telstad | 135.0 | 2.000 | 1.000 |
| 62 | Telstad | 135.0 | 2.000 | 2.000 |
| 63 | Telstad | 138.0 | 2.000 | 3.000 |
| 64 | Telstad | 124.0 | 2.000 | 4.000 |
| 65 | Telstad | 118.0 | 2.000 | 5.000 |
| 66 | Telstad | 142.0 | 2.000 | 6.000 |
| 67 | Telstad | 133.0 | 2.000 | 7.000 |
| 68 | Telstad | 125.0 | 2.000 | 8.000 |
| 69 | Telstad | 118.0 | 2.000 | 9.000 |
| 70 | Telstad | 121.0 | 2.000 | 10.00 |
| 71 | Telstad | 137.0 | 2.000 | 11.00 |
| 72 | Telstad | 117.0 | 2.000 | 12.00 |
| 73 | Telstad | 137.0 | 3.000 | 1.000 |
| 74 | Telstad | 137.0 | 3.000 | 2.000 |
| 75 | Telstad | 130.0 | 3.000 | 3.000 |
| 76 | Telstad | 126.0 | 3.000 | 4.000 |
| 77 | Telstad | 119.0 | 3.000 | 5.000 |
| 78 | Telstad | 147.0 | 3.000 | 6.000 |
| 79 | Telstad | 116.0 | 3.000 | 7.000 |
| 80 | Telstad | 132.0 | 3.000 | 8.000 |
| 81 | Telstad | 117.0 | 3.000 | 9.000 |
| 82 | Telstad | 128.0 | 3.000 | 10.00 |
| 83 | Telstad | 145.0 | 3.000 | 11.00 |
| 84 | Telstad | 117.0 | 3.000 | 12.00 |
| 85 | Telstad | 131.0 | 4.000 | 1.000 |
| 86 | Telstad | 130.0 | 4.000 | 2.000 |

Table 37--Continued.

| Sample Number | Soil Unit | Protein | Rep | Cultivar[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 87 | Telstad | 137.0 | 4.000 | 3.000 |
| 88 | Telstad | 118.0 | 4.000 | 4.000 |
| 89 | Telstad | 117.0 | 4.000 | 5.000 |
| 90 | Telstad | 124.0 | 4.000 | 6.000 |
| 91 | Telstad | 127.0 | 4.000 | 7.000 |
| 92 | Telstad | 129.0 | 4.000 | 8.000 |
| 93 | Telstad | 113.0 | 4.000 | 9.000 |
| 94 | Telstad | 126.0 | 4.000 | 10.00 |
| 95 | Telstad | 133.0 | 4.000 | 11.00 |
| 96 | Telstad | 113.0 | 4.000 | 12.00 |
| 97 | Phillips | 144.0 | 1.000 | 1.000 |
| 98 | Phillips | 146.0 | 1.000 | 2.000 |
| 99 | Phillips | 151.0 | 1.000 | 3.000 |
| 100 | Phillips | 132.0 | 1.000 | 4.000 |
| 101 | Phillips | 128.0 | 1.000 | 5.000 |
| 102 | Phillips | 149.0 | 1.000 | 6.000 |
| 103 | Phillips | 140.0 | 1.000 | 7.000 |
| 104 | Phillips | 144.0 | 1.000 | 8.000 |
| 105 | Phillips | 125.0 | 1.000 | 9.000 |
| 106 | Phillips | 143.0 | 1.000 | 10.00 |
| 107 | Phillips | 162.0 | 1.000 | 11.00 |
| 108 | Phillips | 131.0 | 1.000 | 12.00 |
| 109 | Phillips | 146.0 | 2.000 | 1.000 |
| 110 | Phillips | 150.0 | 2.000 | 2.000 |
| 111 | Phillips | 157.0 | 2.000 | 3.000 |
| 112 | Phillips | 141.0 | 2.000 | 4.000 |
| 113 | Phillips | 131.0 | 2.000 | 5.000 |
| 114 | Phillips | 143.0 | 2.000 | 6.000 |
| 115 | Phillips | 140.0 | 2.000 | 7.000 |
| 116 | Phillips | 145.0 | 2.000 | 8.000 |
| 117 | Phillips | 122.0 | 2.000 | 9.000 |
| 118 | Phillips | 131.0 | 2.000 | 10.00 |
| 119 | Phillips | 162.0 | 2.000 | 11.00 |
| 120 | Phillips | 131.0 | 2.000 | 12.00 |
| 121 | Phillips | 152.0 | 3.000 | 1.000 |
| 122 | Phillips | 146.0 | 3.000 | 2.000 |
| 123 | Phillips | 157.0 | 3.000 | 3.000 |
| 124 | Phillips | 141.0 | 3.000 | 4.000 |
| 125 | Phillips | 127.0 | 3.000 | 5.000 |
| 126 | Phillips | 146.0 | 3.000 | 6.000 |
| 127 | Phillips | 131.0 | 3.000 | 7.000 |
| 128 | Phillips | 141.0 | 3.000 | 8.000 |
| 129 | Phillips | 121.0 | 3.000 | 9.000 |
| 130 | Phillips | 131.0 | 3.000 | 10.00 |

Table 37--Continued.

| Sample Number | Soil Unit | Protein | Rep | Cultivar[1] |
|---|---|---|---|---|
| | | g kg$^{-1}$ | | |
| 131 | Phillips | 158.0 | 3.000 | 11.00 |
| 132 | Phillips | 131.0 | 3.000 | 12.00 |
| 133 | Phillips | 155.0 | 4.000 | 1.000 |
| 134 | Phillips | 154.0 | 4.000 | 2.000 |
| 135 | Phillips | 157.0 | 4.000 | 3.000 |
| 136 | Phillips | 134.0 | 4.000 | 4.000 |
| 137 | Phillips | 133.0 | 4.000 | 5.000 |
| 138 | Phillips | 148.0 | 4.000 | 6.000 |
| 139 | Phillips | 136.0 | 4.000 | 7.000 |
| 140 | Phillips | 144.0 | 4.000 | 8.000 |
| 141 | Phillips | 124.0 | 4.000 | 9.000 |
| 142 | Phillips | 138.0 | 4.000 | 10.00 |
| 143 | Phillips | 160.0 | 4.000 | 11.00 |
| 144 | Phillips | 140.0 | 4.000 | 12.00 |

[1] Cultivars were 1 = Newana, 2 = Pondera, 3 = Fortuna, 4 = Lew, 5 = Glenman, 6 = Success, 7 = Wheaton, 8 = Copper, 9 = Treasure, 10 = NK 751, 11 = Cutless, 12 = MT 7926.

# APPENDIX E

## Yield, Test Weight, and Protein On Contrasting Soil Units At Havre In Crop X Fertilizer X Soil Unit Studies

Table 38. Yield and test weight of spring wheat samples harvested on contrasting soil units in a field near Havre (1987).

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 1 | Phillips | 1857.0 | 7.296 | 792.8 |
| 2 | Phillips | 1750.0 | 7.296 | 776.1 |
| 3 | Phillips | 2086.0 | 7.539 | 774.8 |
| 4 | Phillips | 2456.0 | 7.296 | 774.8 |
| 5 | Phillips | 1551.0 | 7.296 | 804.4 |
| 6 | Phillips | 1737.0 | 7.539 | 804.4 |
| 7 | Phillips | 1591.0 | 7.296 | 797.9 |
| 8 | Phillips | 1536.0 | 7.296 | 797.9 |
| 9 | Phillips | 1763.0 | 7.296 | 816.0 |
| 10 | Phillips | 1834.0 | 7.296 | 813.4 |
| 11 | Phillips | 1426.0 | 7.296 | 810.8 |
| 12 | Phillips | 1887.0 | 7.539 | 810.8 |
| 13 | Phillips | 1194.0 | 7.296 | 808.2 |
| 14 | Phillips | 1914.0 | 7.296 | 805.7 |
| 15 | Phillips | 2208.0 | 7.539 | 797.9 |
| 16 | Phillips | 1839.0 | 7.296 | 796.7 |
| 17 | Phillips | 2212.0 | 7.296 | 786.4 |
| 18 | Phillips | 1677.0 | 7.296 | 809.5 |
| 19 | Phillips | 1839.0 | 7.539 | 791.5 |
| 20 | Phillips | 2230.0 | 7.296 | 788.9 |
| 21 | Phillips | 1502.0 | 7.296 | 794.1 |
| 22 | Phillips | 1712.0 | 7.296 | 803.1 |
| 23 | Phillips | 1938.0 | 7.296 | 800.5 |
| 24 | Phillips | 1533.0 | 7.539 | 818.5 |
| 25 | Phillips | 1797.0 | 7.539 | 818.5 |
| 26 | Phillips | 1411.0 | 7.296 | 804.4 |
| 27 | Phillips | 1709.0 | 7.296 | 814.7 |
| 28 | Phillips | 1504.0 | 7.296 | 814.7 |
| 29 | Phillips | 2220.0 | 7.296 | 792.8 |
| 30 | Phillips | 2179.0 | 7.539 | 806.9 |
| 31 | Phillips | 1731.0 | 7.296 | 795.4 |
| 32 | Phillips | 1928.0 | 7.296 | 805.7 |
| 33 | Phillips | 1655.0 | 7.296 | 794.1 |
| 34 | Phillips | 1936.0 | 7.296 | 782.5 |
| 35 | Phillips | 2411.0 | 7.539 | 796.7 |
| 36 | Phillips | 2217.0 | 7.296 | 800.5 |
| 37 | Phillips | 1525.0 | 7.296 | 797.9 |
| 38 | Phillips | 1552.0 | 7.296 | 797.9 |
| 39 | Phillips | 1663.0 | 7.296 | 806.9 |
| 40 | Phillips | 1738.0 | 7.539 | 799.2 |
| 41 | Phillips | 1387.0 | 7.296 | 817.2 |
| 42 | Phillips | 1770.0 | 7.539 | 818.5 |

Table 38--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 43 | Phillips | 1460.0 | 7.296 | 816.0 |
| 44 | Phillips | 1460.0 | 7.296 | 806.9 |
| 45 | Phillips | 1916.0 | 7.539 | 817.2 |
| 46 | Phillips | 2116.0 | 7.296 | 816.0 |
| 47 | Phillips | 1843.0 | 7.296 | 795.4 |
| 48 | Phillips | 1748.0 | 7.296 | 799.2 |
| 49 | Phillips | 1572.0 | 7.539 | 805.7 |
| 50 | Phillips | 2096.0 | 7.296 | 781.2 |
| 51 | Phillips | 1999.0 | 7.296 | 788.9 |
| 52 | Phillips | 2813.0 | 7.539 | 804.4 |
| 53 | Phillips | 1506.0 | 7.296 | 805.7 |
| 54 | Phillips | 1822.0 | 7.539 | 810.8 |
| 55 | Phillips | 1600.0 | 7.296 | 808.2 |
| 56 | Phillips | 1530.0 | 7.296 | 804.4 |
| 57 | Phillips | 1726.0 | 7.539 | 822.4 |
| 58 | Phillips | 1514.0 | 7.296 | 810.8 |
| 59 | Phillips | 1543.0 | 7.296 | 818.5 |
| 60 | Phillips | 1660.0 | 7.296 | 814.7 |
| 61 | Phillips | 1722.0 | 7.296 | 817.2 |
| 62 | Phillips | 2211.0 | 7.296 | 826.3 |
| 63 | Phillips | 2378.0 | 7.539 | 823.7 |
| 64 | Phillips | 2033.0 | 7.296 | 803.1 |
| 65 | Telstad | 1293.0 | 7.053 | 781.2 |
| 66 | Telstad | 1599.0 | 7.539 | 765.8 |
| 67 | Telstad | 1480.0 | 7.296 | 763.2 |
| 68 | Telstad | 2035.0 | 8.147 | 795.4 |
| 69 | Telstad | 1207.0 | 7.296 | 804.4 |
| 70 | Telstad | 1155.0 | 7.053 | 794.1 |
| 71 | Telstad | 1705.0 | 8.147 | 795.4 |
| 72 | Telstad | 1317.0 | 7.539 | 797.9 |
| 73 | Telstad | 1253.0 | 7.539 | 813.4 |
| 74 | Telstad | 1885.0 | 8.147 | 808.2 |
| 75 | Telstad | 1193.0 | 7.053 | 804.4 |
| 76 | Telstad | 1582.0 | 7.296 | 797.9 |
| 77 | Telstad | 2117.0 | 8.147 | 814.7 |
| 78 | Telstad | 1868.0 | 7.296 | 810.8 |
| 79 | Telstad | 1411.0 | 7.539 | 796.7 |
| 80 | Telstad | 1414.0 | 7.053 | 791.5 |
| 81 | Telstad | 1556.0 | 7.539 | 785.1 |
| 82 | Telstad | 1567.0 | 7.053 | 772.2 |
| 83 | Telstad | 1501.0 | 7.296 | 761.9 |
| 84 | Telstad | 1923.0 | 8.147 | 785.1 |
| 85 | Telstad | 1245.0 | 7.053 | 799.2 |
| 86 | Telstad | 1622.0 | 8.147 | 800.5 |

Table 38--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 87 | Telstad | 1278.0 | 7.539 | 801.8 |
| 88 | Telstad | 1281.0 | 7.296 | 790.2 |
| 89 | Telstad | 1231.0 | 7.296 | 816.0 |
| 90 | Telstad | 1259.0 | 7.539 | 803.1 |
| 91 | Telstad | 1383.0 | 8.147 | 808.2 |
| 92 | Telstad | 1243.0 | 7.053 | 800.5 |
| 93 | Telstad | 1837.0 | 8.147 | 812.1 |
| 94 | Telstad | 1483.0 | 7.296 | 785.1 |
| 95 | Telstad | 1827.0 | 7.053 | 803.1 |
| 96 | Telstad | 1347.0 | 7.539 | 790.2 |
| 97 | Telstad | 1721.0 | 7.053 | 803.1 |
| 98 | Telstad | 2129.0 | 7.539 | 772.2 |
| 99 | Telstad | 1748.0 | 7.296 | 774.8 |
| 100 | Telstad | 1696.0 | 8.147 | 777.3 |
| 101 | Telstad | 1411.0 | 7.539 | 803.1 |
| 102 | Telstad | 1598.0 | 7.053 | 808.2 |
| 103 | Telstad | 1365.0 | 8.147 | 803.1 |
| 104 | Telstad | 1153.0 | 7.296 | 794.1 |
| 105 | Telstad | 1321.0 | 8.147 | 821.1 |
| 106 | Telstad | 1239.0 | 7.296 | 805.7 |
| 107 | Telstad | 1685.0 | 7.053 | 819.8 |
| 108 | Telstad | 1857.0 | 7.539 | 806.9 |
| 109 | Telstad | 1322.0 | 7.296 | 800.5 |
| 110 | Telstad | 1596.0 | 8.147 | 795.4 |
| 111 | Telstad | 1755.0 | 7.539 | 796.7 |
| 112 | Telstad | 1955.0 | 7.053 | 805.7 |
| 113 | Telstad | 1479.0 | 8.147 | 787.6 |
| 114 | Telstad | 2110.0 | 7.539 | 783.8 |
| 115 | Telstad | 2206.0 | 7.053 | 805.7 |
| 116 | Telstad | 1782.0 | 7.296 | 772.2 |
| 117 | Telstad | 1546.0 | 7.539 | 812.1 |
| 118 | Telstad | 1427.0 | 7.296 | 794.1 |
| 119 | Telstad | 1616.0 | 8.147 | 790.2 |
| 120 | Telstad | 1943.0 | 7.053 | 810.8 |
| 121 | Telstad | 1562.0 | 5.472 | 821.1 |
| 122 | Telstad | 1548.0 | 5.730 | 818.5 |
| 123 | Telstad | 1307.0 | 8.147 | 804.4 |
| 124 | Telstad | 1743.0 | 7.053 | 826.3 |
| 125 | Telstad | 1415.0 | 7.053 | 794.1 |
| 126 | Telstad | 1552.0 | 7.296 | 792.8 |
| 127 | Telstad | 1872.0 | 7.539 | 801.8 |
| 128 | Evanston | 1555.0 | 7.296 | 800.5 |
| 129 | Evanston | 1984.0 | 7.296 | 788.9 |
| 130 | Evanston | 2428.0 | 7.539 | 800.5 |

Table 38--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 131 | Evanston | 1717.0 | 5.928 | 783.8 |
| 132 | Evanston | 1099.0 | 7.296 | 808.2 |
| 133 | Evanston | 1580.0 | 7.539 | 804.4 |
| 134 | Evanston | 1441.0 | 7.296 | 801.8 |
| 135 | Evanston | 1268.0 | 7.296 | 800.5 |
| 136 | Evanston | 1210.0 | 7.296 | 826.3 |
| 137 | Evanston | 1622.0 | 7.296 | 813.4 |
| 138 | Evanston | 1405.0 | 7.296 | 809.5 |
| 139 | Evanston | 1768.0 | 7.539 | 813.4 |
| 140 | Evanston | 1287.0 | 7.539 | 817.2 |
| 141 | Evanston | 1971.0 | 7.296 | 823.7 |
| 142 | Evanston | 1654.0 | 7.296 | 813.4 |
| 143 | Evanston | 1702.0 | 7.296 | 816.0 |
| 144 | Evanston | 954.0 | 5.472 | 797.9 |
| 145 | Evanston | 1599.0 | 6.840 | 790.2 |
| 146 | Evanston | 1683.0 | 5.654 | 799.2 |
| 147 | Evanston | 942.0 | 7.296 | 796.7 |
| 148 | Evanston | 1521.0 | 7.296 | 803.1 |
| 149 | Evanston | 1291.0 | 7.296 | 803.1 |
| 150 | Evanston | 1515.0 | 7.539 | 808.2 |
| 151 | Evanston | 1291.0 | 7.539 | 812.1 |
| 152 | Evanston | 1731.0 | 7.296 | 816.0 |
| 153 | Evanston | 1776.0 | 7.296 | 806.9 |
| 154 | Evanston | 1222.0 | 7.296 | 806.9 |
| 155 | Evanston | 962.0 | 7.296 | 813.4 |
| 156 | Evanston | 1460.0 | 7.539 | 816.0 |
| 157 | Evanston | 1330.0 | 7.296 | 817.2 |
| 158 | Evanston | 1550.0 | 7.296 | 810.8 |
| 159 | Evanston | 1363.0 | 5.472 | 812.1 |
| 160 | Evanston | 1082.0 | 5.654 | 779.9 |
| 161 | Evanston | 1287.0 | 6.840 | 778.6 |
| 162 | Evanston | 1073.0 | 7.296 | 809.5 |
| 163 | Evanston | 1088.0 | 7.296 | 797.9 |
| 164 | Evanston | 1640.0 | 7.296 | 812.1 |
| 165 | Evanston | 1381.0 | 7.539 | 800.5 |
| 166 | Evanston | 929.0 | 7.296 | 792.8 |
| 167 | Evanston | 1168.0 | 7.539 | 813.4 |
| 168 | Evanston | 1811.0 | 7.539 | 778.6 |
| 169 | Evanston | 1922.0 | 7.296 | 806.9 |
| 170 | Evanston | 1243.0 | 7.539 | 816.0 |
| 171 | Evanston | 1963.0 | 7.296 | 825.0 |
| 172 | Evanston | 1425.0 | 7.296 | 821.1 |
| 173 | Evanston | 1067.0 | 7.296 | 810.8 |
| 174 | Evanston | 972.0 | 3.648 | 772.2 |

Table 38--Continued.

| Sample Number | Soil Unit | Yield | Area | Test Weight |
|---|---|---|---|---|
| | | g | $m^2$ | kg $m^{-3}$ |
| 175 | Evanston | 1026.0 | 3.648 | 772.2 |
| 176 | Evanston | 1433.0 | 7.296 | 803.1 |
| 177 | Evanston | 1686.0 | 7.539 | 801.8 |
| 178 | Evanston | 1524.0 | 7.296 | 799.2 |
| 179 | Evanston | 1517.0 | 7.296 | 800.5 |
| 180 | Evanston | 1430.0 | 7.539 | 818.5 |
| 181 | Evanston | 1396.0 | 7.296 | 797.9 |
| 182 | Evanston | 1533.0 | 7.296 | 817.2 |
| 183 | Evanston | 1561.0 | 7.296 | 818.5 |
| 184 | Evanston | 899.0 | 7.296 | 823.7 |
| 185 | Evanston | 1651.0 | 7.296 | 814.7 |
| 186 | Evanston | 2042.0 | 7.296 | 826.3 |
| 187 | Evanston | 2056.0 | 7.539 | 825.0 |

Table 39. Protein, replication, fertilizer treatment, and spring wheat cultivar samples harvested on contrasting soil units in a field near Havre (1987).

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] | Cultivar[2] |
|---|---|---|---|---|---|
| | | g $kg^{-1}$ | | | |
| 1 | Phillips | 131.0 | 1.00 | 1.00 | 1.00 |
| 2 | Phillips | 139.0 | 1.00 | 2.00 | 1.00 |
| 3 | Phillips | 132.0 | 1.00 | 3.00 | 1.00 |
| 4 | Phillips | 130.0 | 1.00 | 4.00 | 1.00 |
| 5 | Phillips | 151.0 | 1.00 | 1.00 | 2.00 |
| 6 | Phillips | 152.0 | 1.00 | 2.00 | 2.00 |
| 7 | Phillips | 155.0 | 1.00 | 3.00 | 2.00 |
| 8 | Phillips | 150.0 | 1.00 | 4.00 | 2.00 |
| 9 | Phillips | 148.0 | 1.00 | 1.00 | 3.00 |
| 10 | Phillips | 149.0 | 1.00 | 2.00 | 3.00 |
| 11 | Phillips | 148.0 | 1.00 | 3.00 | 3.00 |
| 12 | Phillips | 153.0 | 1.00 | 4.00 | 3.00 |
| 13 | Phillips | 139.0 | 1.00 | 1.00 | 4.00 |
| 14 | Phillips | 145.0 | 1.00 | 2.00 | 4.00 |
| 15 | Phillips | 139.0 | 1.00 | 3.00 | 4.00 |
| 16 | Phillips | 148.0 | 1.00 | 4.00 | 4.00 |
| 17 | Phillips | 129.0 | 2.00 | 1.00 | 1.00 |
| 18 | Phillips | 149.0 | 2.00 | 2.00 | 1.00 |
| 19 | Phillips | 135.0 | 2.00 | 3.00 | 1.00 |
| 20 | Phillips | 134.0 | 2.00 | 4.00 | 1.00 |
| 21 | Phillips | 157.0 | 2.00 | 1.00 | 2.00 |
| 22 | Phillips | 149.0 | 2.00 | 2.00 | 2.00 |
| 23 | Phillips | 148.0 | 2.00 | 3.00 | 2.00 |
| 24 | Phillips | 147.0 | 2.00 | 4.00 | 2.00 |
| 25 | Phillips | 148.0 | 2.00 | 1.00 | 3.00 |
| 26 | Phillips | 152.0 | 2.00 | 2.00 | 3.00 |
| 27 | Phillips | 145.0 | 2.00 | 3.00 | 3.00 |
| 28 | Phillips | 148.0 | 2.00 | 4.00 | 3.00 |
| 29 | Phillips | 134.0 | 2.00 | 1.00 | 4.00 |
| 30 | Phillips | 140.0 | 2.00 | 2.00 | 4.00 |
| 31 | Phillips | 137.0 | 2.00 | 3.00 | 4.00 |
| 32 | Phillips | 140.0 | 2.00 | 4.00 | 4.00 |
| 33 | Phillips | 128.0 | 3.00 | 1.00 | 1.00 |
| 34 | Phillips | 137.0 | 3.00 | 2.00 | 1.00 |
| 35 | Phillips | 123.0 | 3.00 | 3.00 | 1.00 |
| 36 | Phillips | 138.0 | 3.00 | 4.00 | 1.00 |
| 37 | Phillips | 155.0 | 3.00 | 1.00 | 2.00 |
| 38 | Phillips | 152.0 | 3.00 | 2.00 | 2.00 |
| 39 | Phillips | 156.0 | 3.00 | 3.00 | 2.00 |
| 40 | Phillips | 146.0 | 3.00 | 4.00 | 2.00 |
| 41 | Phillips | 165.0 | 3.00 | 1.00 | 3.00 |

Table 39--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] | Cultivar[2] |
|---|---|---|---|---|---|
| | | g kg$^{-1}$ | | | |
| 42 | Phillips | 151.0 | 3.00 | 2.00 | 3.00 |
| 43 | Phillips | 153.0 | 3.00 | 3.00 | 3.00 |
| 44 | Phillips | 151.0 | 3.00 | 4.00 | 3.00 |
| 45 | Phillips | 142.0 | 3.00 | 1.00 | 4.00 |
| 46 | Phillips | 144.0 | 3.00 | 2.00 | 4.00 |
| 47 | Phillips | 153.0 | 3.00 | 3.00 | 4.00 |
| 48 | Phillips | 140.0 | 3.00 | 4.00 | 4.00 |
| 49 | Phillips | 134.0 | 4.00 | 1.00 | 1.00 |
| 50 | Phillips | 136.0 | 4.00 | 2.00 | 1.00 |
| 51 | Phillips | 131.0 | 4.00 | 3.00 | 1.00 |
| 52 | Phillips | 127.0 | 4.00 | 4.00 | 1.00 |
| 53 | Phillips | 156.0 | 4.00 | 1.00 | 2.00 |
| 54 | Phillips | 151.0 | 4.00 | 2.00 | 2.00 |
| 55 | Phillips | 157.0 | 4.00 | 3.00 | 2.00 |
| 56 | Phillips | 162.0 | 4.00 | 4.00 | 2.00 |
| 57 | Phillips | 159.0 | 4.00 | 1.00 | 3.00 |
| 58 | Phillips | 149.0 | 4.00 | 2.00 | 3.00 |
| 59 | Phillips | 151.0 | 4.00 | 3.00 | 3.00 |
| 60 | Phillips | 164.0 | 4.00 | 4.00 | 3.00 |
| 61 | Phillips | 139.0 | 4.00 | 1.00 | 4.00 |
| 62 | Phillips | 144.0 | 4.00 | 2.00 | 4.00 |
| 63 | Phillips | 141.0 | 4.00 | 3.00 | 4.00 |
| 64 | Phillips | 147.0 | 4.00 | 4.00 | 4.00 |
| 65 | Telstad | 126.0 | 1.00 | 1.00 | 1.00 |
| 66 | Telstad | 136.0 | 1.00 | 2.00 | 1.00 |
| 67 | Telstad | 132.0 | 1.00 | 3.00 | 1.00 |
| 68 | Telstad | 132.0 | 1.00 | 4.00 | 1.00 |
| 69 | Telstad | 142.0 | 1.00 | 1.00 | 2.00 |
| 70 | Telstad | 152.0 | 1.00 | 2.00 | 2.00 |
| 71 | Telstad | 145.0 | 1.00 | 3.00 | 2.00 |
| 72 | Telstad | 149.0 | 1.00 | 4.00 | 2.00 |
| 73 | Telstad | 141.0 | 1.00 | 1.00 | 3.00 |
| 74 | Telstad | 144.0 | 1.00 | 2.00 | 3.00 |
| 75 | Telstad | 142.0 | 1.00 | 3.00 | 3.00 |
| 76 | Telstad | 148.0 | 1.00 | 4.00 | 3.00 |
| 77 | Telstad | 139.0 | 1.00 | 1.00 | 4.00 |
| 78 | Telstad | 141.0 | 1.00 | 2.00 | 4.00 |
| 79 | Telstad | 144.0 | 1.00 | 3.00 | 4.00 |
| 80 | Telstad | 149.0 | 1.00 | 4.00 | 4.00 |
| 81 | Telstad | 121.0 | 2.00 | 1.00 | 1.00 |
| 82 | Telstad | 133.0 | 2.00 | 2.00 | 1.00 |
| 83 | Telstad | 136.0 | 2.00 | 3.00 | 1.00 |
| 84 | Telstad | 130.0 | 2.00 | 4.00 | 1.00 |
| 85 | Telstad | 141.0 | 2.00 | 1.00 | 2.00 |

Table 39--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] | Cultivar[2] |
|---|---|---|---|---|---|
| | | g $kg^{-1}$ | | | |
| 86 | Telstad | 146.0 | 2.00 | 2.00 | 2.00 |
| 87 | Telstad | 148.0 | 2.00 | 3.00 | 2.00 |
| 88 | Telstad | 150.0 | 2.00 | 4.00 | 2.00 |
| 89 | Telstad | 145.0 | 2.00 | 1.00 | 3.00 |
| 90 | Telstad | 149.0 | 2.00 | 2.00 | 3.00 |
| 91 | Telstad | 146.0 | 2.00 | 3.00 | 3.00 |
| 92 | Telstad | 149.0 | 2.00 | 4.00 | 3.00 |
| 93 | Telstad | 133.0 | 2.00 | 1.00 | 4.00 |
| 94 | Telstad | 148.0 | 2.00 | 2.00 | 4.00 |
| 95 | Telstad | 137.0 | 2.00 | 3.00 | 4.00 |
| 96 | Telstad | 142.0 | 2.00 | 4.00 | 4.00 |
| 97 | Telstad | 136.0 | 3.00 | 1.00 | 1.00 |
| 98 | Telstad | 133.0 | 3.00 | 2.00 | 1.00 |
| 99 | Telstad | 131.0 | 3.00 | 3.00 | 1.00 |
| 100 | Telstad | 132.0 | 3.00 | 4.00 | 1.00 |
| 101 | Telstad | 141.0 | 3.00 | 1.00 | 2.00 |
| 102 | Telstad | 144.0 | 3.00 | 2.00 | 2.00 |
| 103 | Telstad | 146.0 | 3.00 | 3.00 | 2.00 |
| 104 | Telstad | 148.0 | 3.00 | 4.00 | 2.00 |
| 105 | Telstad | 139.0 | 3.00 | 1.00 | 3.00 |
| 106 | Telstad | 147.0 | 3.00 | 2.00 | 3.00 |
| 107 | Telstad | 150.0 | 3.00 | 3.00 | 3.00 |
| 108 | Telstad | 144.0 | 3.00 | 4.00 | 3.00 |
| 109 | Telstad | 135.0 | 3.00 | 1.00 | 4.00 |
| 110 | Telstad | 142.0 | 3.00 | 2.00 | 4.00 |
| 111 | Telstad | 144.0 | 3.00 | 3.00 | 4.00 |
| 112 | Telstad | 140.0 | 3.00 | 4.00 | 4.00 |
| 113 | Telstad | 131.0 | 4.00 | 1.00 | 1.00 |
| 114 | Telstad | 126.0 | 4.00 | 2.00 | 1.00 |
| 115 | Telstad | 130.0 | 4.00 | 3.00 | 1.00 |
| 116 | Telstad | 134.0 | 4.00 | 4.00 | 1.00 |
| 117 | Telstad | 145.0 | 4.00 | 1.00 | 2.00 |
| 118 | Telstad | 148.0 | 4.00 | 2.00 | 2.00 |
| 119 | Telstad | 148.0 | 4.00 | 3.00 | 2.00 |
| 120 | Telstad | 153.0 | 4.00 | 4.00 | 2.00 |
| 121 | Telstad | 148.0 | 4.00 | 1.00 | 3.00 |
| 122 | Telstad | 153.0 | 4.00 | 2.00 | 3.00 |
| 123 | Telstad | 154.0 | 4.00 | 4.00 | 3.00 |
| 124 | Telstad | 145.0 | 4.00 | 1.00 | 4.00 |
| 125 | Telstad | 145.0 | 4.00 | 2.00 | 4.00 |
| 126 | Telstad | 139.0 | 4.00 | 3.00 | 4.00 |
| 127 | Telstad | 141.0 | 4.00 | 4.00 | 4.00 |
| 128 | Evanston | 140.0 | 1.00 | 1.00 | 1.00 |
| 129 | Evanston | 140.0 | 1.00 | 2.00 | 1.00 |

Table 39--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] | Cultivar[2] |
|---|---|---|---|---|---|
| | | $g\ kg^{-1}$ | | | |
| 130 | Evanston | 136.0 | 1.00 | 3.00 | 1.00 |
| 131 | Evanston | 151.0 | 1.00 | 4.00 | 1.00 |
| 132 | Evanston | 144.0 | 1.00 | 1.00 | 2.00 |
| 133 | Evanston | 167.0 | 1.00 | 2.00 | 2.00 |
| 134 | Evanston | 166.0 | 1.00 | 3.00 | 2.00 |
| 135 | Evanston | 176.0 | 1.00 | 4.00 | 2.00 |
| 136 | Evanston | 166.0 | 1.00 | 1.00 | 3.00 |
| 137 | Evanston | 165.0 | 1.00 | 2.00 | 3.00 |
| 138 | Evanston | 168.0 | 1.00 | 3.00 | 3.00 |
| 139 | Evanston | 172.0 | 1.00 | 4.00 | 3.00 |
| 140 | Evanston | 148.0 | 1.00 | 1.00 | 4.00 |
| 141 | Evanston | 149.0 | 1.00 | 2.00 | 4.00 |
| 142 | Evanston | 157.0 | 1.00 | 3.00 | 4.00 |
| 143 | Evanston | 157.0 | 1.00 | 4.00 | 4.00 |
| 144 | Evanston | 138.0 | 2.00 | 1.00 | 1.00 |
| 145 | Evanston | 144.0 | 2.00 | 2.00 | 1.00 |
| 146 | Evanston | 139.0 | 2.00 | 3.00 | 1.00 |
| 147 | Evanston | 157.0 | 2.00 | 1.00 | 2.00 |
| 148 | Evanston | 171.0 | 2.00 | 2.00 | 2.00 |
| 149 | Evanston | 157.0 | 2.00 | 3.00 | 2.00 |
| 150 | Evanston | 172.0 | 2.00 | 4.00 | 2.00 |
| 151 | Evanston | 163.0 | 2.00 | 1.00 | 3.00 |
| 152 | Evanston | 162.0 | 2.00 | 2.00 | 3.00 |
| 153 | Evanston | 167.0 | 2.00 | 3.00 | 3.00 |
| 154 | Evanston | 175.0 | 2.00 | 4.00 | 3.00 |
| 155 | Evanston | 150.0 | 2.00 | 1.00 | 4.00 |
| 156 | Evanston | 157.0 | 2.00 | 2.00 | 4.00 |
| 157 | Evanston | 149.0 | 2.00 | 3.00 | 4.00 |
| 158 | Evanston | 150.0 | 2.00 | 4.00 | 4.00 |
| 159 | Evanston | 166.0 | 3.00 | 1.00 | 1.00 |
| 160 | Evanston | 149.0 | 3.00 | 3.00 | 1.00 |
| 161 | Evanston | 148.0 | 3.00 | 4.00 | 1.00 |
| 162 | Evanston | 167.0 | 3.00 | 1.00 | 2.00 |
| 163 | Evanston | 176.0 | 3.00 | 2.00 | 2.00 |
| 164 | Evanston | 162.0 | 3.00 | 3.00 | 2.00 |
| 165 | Evanston | 163.0 | 3.00 | 4.00 | 2.00 |
| 166 | Evanston | 172.0 | 3.00 | 1.00 | 3.00 |
| 167 | Evanston | 166.0 | 3.00 | 2.00 | 3.00 |
| 168 | Evanston | 150.0 | 3.00 | 3.00 | 3.00 |
| 169 | Evanston | 161.0 | 3.00 | 4.00 | 3.00 |
| 170 | Evanston | 162.0 | 3.00 | 1.00 | 4.00 |
| 171 | Evanston | 151.0 | 3.00 | 2.00 | 4.00 |
| 172 | Evanston | 149.0 | 3.00 | 3.00 | 4.00 |
| 173 | Evanston | 150.0 | 3.00 | 4.00 | 4.00 |

Table 39--Continued.

| Sample Number | Soil Unit | Protein | Rep | Fertilizer Treatment[1] | Cultivar[2] |
|---|---|---|---|---|---|
| | | g $kg^{-1}$ | | | |
| 174 | Evanston | 143.0 | 4.00 | 1.00 | 1.00 |
| 175 | Evanston | 150.0 | 4.00 | 3.00 | 1.00 |
| 176 | Evanston | 163.0 | 4.00 | 1.00 | 2.00 |
| 177 | Evanston | 170.0 | 4.00 | 2.00 | 2.00 |
| 178 | Evanston | 162.0 | 4.00 | 3.00 | 2.00 |
| 179 | Evanston | 169.0 | 4.00 | 4.00 | 2.00 |
| 180 | Evanston | 163.0 | 4.00 | 1.00 | 3.00 |
| 181 | Evanston | 170.0 | 4.00 | 2.00 | 3.00 |
| 182 | Evanston | 177.0 | 4.00 | 3.00 | 3.00 |
| 183 | Evanston | 167.0 | 4.00 | 4.00 | 3.00 |
| 184 | Evanston | 146.0 | 4.00 | 1.00 | 4.00 |
| 185 | Evanston | 155.0 | 4.00 | 4.00 | 4.00 |
| 186 | Evanston | 151.0 | 4.00 | 2.00 | 4.00 |
| 187 | Evanston | 149.0 | 4.00 | 3.00 | 4.00 |

[1] Fertilizer treatments, as a ratio of recommended N, P, and K (N-P-K), were 1 = 0-1-1, 2 = 1-1-1, 3 = 0.75-1-1, 4 = 1.25-1-1.

[2] Cultivars were 1 = Glenman, 2 = Newana, 3 = Fortuna, 4 = Lew.

# APPENDIX F

## Grain Yield and Straw Production On Contrasting Soil Units

Table 40. Grain yield and straw production of spring barley samples harvested on contrasting soil units in a field near Havre (1987).

| Sample | | ---- Yield ----- | | | |
|---|---|---|---|---|---|
| Number | Soil Unit | Grain | Straw | Rep | Cultivar |
| | | ------ g | ------- | | |
| 1 | Evanston | 1008.0 | 482.0 | 1.0 | 1.0 |
| 2 | Evanston | 1173.0 | 425.3 | 1.0 | 2.0 |
| 3 | Evanston | 948.0 | 482.0 | 1.0 | 3.0 |
| 4 | Evanston | 1544.0 | 708.8 | 1.0 | 4.0 |
| 5 | Evanston | 1654.0 | 708.8 | 1.0 | 5.0 |
| 6 | Evanston | 911.0 | 510.3 | 1.0 | 6.0 |
| 7 | Evanston | 1036.0 | 538.7 | 1.0 | 7.0 |
| 8 | Evanston | 1390.0 | 737.1 | 1.0 | 8.0 |
| 9 | Evanston | 1352.0 | 878.9 | 1.0 | 9.0 |
| 10 | Evanston | 688.0 | 453.6 | 1.0 | 10.0 |
| 11 | Evanston | 1508.0 | 737.1 | 1.0 | 11.0 |
| 12 | Evanston | 1500.0 | 765.5 | 1.0 | 12.0 |
| 13 | Evanston | 931.0 | 652.1 | 2.0 | 1.0 |
| 14 | Evanston | 1655.0 | 680.4 | 2.0 | 2.0 |
| 15 | Evanston | 1167.0 | 623.7 | 2.0 | 3.0 |
| 16 | Evanston | 1698.0 | 822.2 | 2.0 | 4.0 |
| 17 | Evanston | 1137.0 | 510.3 | 2.0 | 5.0 |
| 18 | Evanston | 1597.0 | 822.2 | 2.0 | 6.0 |
| 19 | Evanston | 1009.0 | 538.7 | 2.0 | 7.0 |
| 20 | Evanston | 1647.0 | 878.9 | 2.0 | 8.0 |
| 21 | Evanston | 835.0 | 708.8 | 2.0 | 9.0 |
| 22 | Evanston | 837.0 | 680.4 | 2.0 | 10.0 |
| 23 | Evanston | 1537.0 | 708.8 | 2.0 | 11.0 |
| 24 | Evanston | 1423.0 | 708.8 | 2.0 | 12.0 |
| 25 | Evanston | 907.0 | 510.3 | 3.0 | 1.0 |
| 26 | Evanston | 815.0 | 255.2 | 3.0 | 2.0 |
| 27 | Evanston | 905.0 | 453.6 | 3.0 | 3.0 |
| 28 | Evanston | 1604.0 | 793.8 | 3.0 | 4.0 |
| 29 | Evanston | 1096.0 | 482.0 | 3.0 | 5.0 |
| 30 | Evanston | 1543.0 | 822.2 | 3.0 | 6.0 |
| 31 | Evanston | 1307.0 | 765.5 | 3.0 | 7.0 |
| 32 | Evanston | 1339.0 | 708.8 | 3.0 | 8.0 |
| 33 | Evanston | 1235.0 | 765.5 | 3.0 | 9.0 |
| 34 | Evanston | 811.0 | 567.0 | 3.0 | 10.0 |
| 35 | Evanston | 1074.0 | 482.0 | 3.0 | 11.0 |
| 36 | Evanston | 1497.0 | 680.4 | 3.0 | 12.0 |
| 37 | Evanston | 823.0 | 510.3 | 4.0 | 1.0 |
| 38 | Evanston | 1297.0 | 453.6 | 4.0 | 2.0 |
| 39 | Evanston | 1206.0 | 652.1 | 4.0 | 3.0 |
| 40 | Evanston | 724.0 | 425.3 | 4.0 | 4.0 |
| 41 | Evanston | 1380.0 | 595.4 | 4.0 | 5.0 |
| 42 | Evanston | 920.0 | 425.3 | 4.0 | 6.0 |

Table 40--Continued.

| Sample Number | Soil Unit | ---- Yield ----- |  | Rep | Cultivar |
|---|---|---|---|---|---|
|  |  | Grain | Straw |  |  |
|  |  | ------ g ------- |  |  |  |
| 43 | Evanston | 853.0 | 425.3 | 4.0 | 7.0 |
| 44 | Evanston | 952.0 | 482.0 | 4.0 | 8.0 |
| 45 | Evanston | 1287.0 | 878.9 | 4.0 | 9.0 |
| 46 | Evanston | 604.0 | 425.3 | 4.0 | 10.0 |
| 47 | Evanston | 1179.0 | 510.3 | 4.0 | 11.0 |
| 48 | Evanston | 973.0 | 482.0 | 4.0 | 12.0 |
| 49 | Telstad | 759.0 | 510.3 | 1.0 | 1.0 |
| 50 | Telstad | 1121.0 | 482.0 | 1.0 | 2.0 |
| 51 | Telstad | 563.0 | 368.6 | 1.0 | 3.0 |
| 52 | Telstad | 1631.0 | 765.5 | 1.0 | 4.0 |
| 53 | Telstad | 1726.0 | 822.2 | 1.0 | 5.0 |
| 54 | Telstad | 952.0 | 623.7 | 1.0 | 6.0 |
| 55 | Telstad | 715.0 | 368.6 | 1.0 | 7.0 |
| 56 | Telstad | 1437.0 | 737.1 | 1.0 | 8.0 |
| 57 | Telstad | 984.0 | 822.2 | 1.0 | 9.0 |
| 58 | Telstad | 559.0 | 425.3 | 1.0 | 10.0 |
| 59 | Telstad | 1093.0 | 652.1 | 1.0 | 11.0 |
| 60 | Telstad | 1471.0 | 765.5 | 1.0 | 12.0 |
| 61 | Telstad | 360.0 | 311.9 | 2.0 | 1.0 |
| 62 | Telstad | 1078.0 | 425.3 | 2.0 | 2.0 |
| 63 | Telstad | 808.0 | 538.7 | 2.0 | 3.0 |
| 64 | Telstad | 1396.0 | 765.5 | 2.0 | 4.0 |
| 65 | Telstad | 673.0 | 311.9 | 2.0 | 5.0 |
| 66 | Telstad | 1301.0 | 793.8 | 2.0 | 6.0 |
| 67 | Telstad | 557.0 | 340.2 | 2.0 | 7.0 |
| 68 | Telstad | 1053.0 | 567.0 | 2.0 | 8.0 |
| 69 | Telstad | 857.0 | 708.8 | 2.0 | 9.0 |
| 70 | Telstad | 310.0 | 425.3 | 2.0 | 10.0 |
| 71 | Telstad | 861.0 | 368.6 | 2.0 | 11.0 |
| 72 | Telstad | 878.0 | 595.4 | 2.0 | 12.0 |
| 73 | Telstad | 556.0 | 370.9 | 3.0 | 1.0 |
| 74 | Telstad | 904.0 | 368.6 | 3.0 | 2.0 |
| 75 | Telstad | 636.0 | 368.6 | 3.0 | 3.0 |
| 76 | Telstad | 1156.0 | 510.3 | 3.0 | 4.0 |
| 77 | Telstad | 1008.0 | 396.9 | 3.0 | 5.0 |
| 78 | Telstad | 1253.0 | 708.8 | 3.0 | 6.0 |
| 79 | Telstad | 1005.0 | 822.2 | 3.0 | 7.0 |
| 80 | Telstad | 1376.0 | 822.2 | 3.0 | 8.0 |
| 81 | Telstad | 742.0 | 652.1 | 3.0 | 9.0 |
| 82 | Telstad | 466.0 | 652.1 | 3.0 | 10.0 |
| 83 | Telstad | 1057.0 | 567.0 | 3.0 | 11.0 |
| 84 | Telstad | 1449.0 | 878.9 | 3.0 | 12.0 |
| 85 | Telstad | 301.0 | 341.2 | 4.0 | 1.0 |
| 86 | Telstad | 920.0 | 340.2 | 4.0 | 2.0 |

Table 40--Continued.

| Sample Number | Soil Unit | ---- Yield ----- Grain | Straw | Rep | Cultivar |
|---|---|---|---|---|---|
| | | ------ g ------- | | | |
| 87 | Telstad | 839.0 | 453.6 | 4.0 | 3.0 |
| 88 | Telstad | 906.0 | 538.7 | 4.0 | 4.0 |
| 89 | Telstad | 1277.0 | 652.1 | 4.0 | 5.0 |
| 90 | Telstad | 915.0 | 567.0 | 4.0 | 6.0 |
| 91 | Telstad | 699.0 | 510.3 | 4.0 | 7.0 |
| 92 | Telstad | 1528.0 | 822.2 | 4.0 | 8.0 |
| 93 | Telstad | 1001.0 | 850.5 | 4.0 | 9.0 |
| 94 | Telstad | 361.0 | 425.3 | 4.0 | 10.0 |
| 95 | Telstad | 1417.0 | 737.1 | 4.0 | 11.0 |
| 96 | Telstad | 1556.0 | 878.9 | 4.0 | 12.0 |
| 97 | Phillips | 919.0 | 425.3 | 1.0 | 1.0 |
| 98 | Phillips | 788.0 | 255.2 | 1.0 | 2.0 |
| 99 | Phillips | 614.0 | 255.2 | 1.0 | 3.0 |
| 100 | Phillips | 1430.0 | 680.4 | 1.0 | 4.0 |
| 101 | Phillips | 1197.0 | 453.6 | 1.0 | 5.0 |
| 102 | Phillips | 932.0 | 425.3 | 1.0 | 6.0 |
| 103 | Phillips | 742.0 | 425.3 | 1.0 | 7.0 |
| 104 | Phillips | 1332.0 | 680.4 | 1.0 | 8.0 |
| 105 | Phillips | 982.0 | 567.0 | 1.0 | 9.0 |
| 106 | Phillips | 829.0 | 425.3 | 1.0 | 10.0 |
| 107 | Phillips | 1294.0 | 538.7 | 1.0 | 11.0 |
| 108 | Phillips | 1258.0 | 595.4 | 1.0 | 12.0 |
| 109 | Phillips | 450.0 | 198.5 | 2.0 | 1.0 |
| 110 | Phillips | 1192.0 | 368.6 | 2.0 | 2.0 |
| 111 | Phillips | 1167.0 | 538.7 | 2.0 | 3.0 |
| 112 | Phillips | 1358.0 | 567.0 | 2.0 | 4.0 |
| 113 | Phillips | 827.0 | 425.3 | 2.0 | 5.0 |
| 114 | Phillips | 1260.0 | 680.4 | 2.0 | 6.0 |
| 115 | Phillips | 721.0 | 311.9 | 2.0 | 7.0 |
| 116 | Phillips | 1346.0 | 652.1 | 2.0 | 8.0 |
| 117 | Phillips | 1199.0 | 878.9 | 2.0 | 9.0 |
| 118 | Phillips | 780.0 | 482.0 | 2.0 | 10.0 |
| 119 | Phillips | 1101.0 | 482.0 | 2.0 | 11.0 |
| 120 | Phillips | 1378.0 | 595.4 | 2.0 | 12.0 |
| 121 | Phillips | 867.0 | 425.3 | 3.0 | 1.0 |
| 122 | Phillips | 695.0 | 170.1 | 3.0 | 2.0 |
| 123 | Phillips | 652.0 | 311.9 | 3.0 | 3.0 |
| 124 | Phillips | 1608.0 | 652.1 | 3.0 | 4.0 |
| 125 | Phillips | 1056.0 | 368.6 | 3.0 | 5.0 |
| 126 | Phillips | 1361.0 | 680.4 | 3.0 | 6.0 |
| 127 | Phillips | 987.0 | 453.6 | 3.0 | 7.0 |
| 128 | Phillips | 1152.0 | 510.3 | 3.0 | 8.0 |
| 129 | Phillips | 1202.0 | 680.4 | 3.0 | 9.0 |
| 130 | Phillips | 535.0 | 368.6 | 3.0 | 10.0 |

Table 40--Continued.

| Sample Number | Soil Unit | ---- Yield ----- Grain | Straw | Rep | Cultivar |
|---|---|---|---|---|---|
| | | ------ g ------- | | | |
| 131 | Phillips | 1096.0 | 567.0 | 3.0 | 11.0 |
| 132 | Phillips | 1335.0 | 538.7 | 3.0 | 12.0 |
| 133 | Phillips | 764.0 | 311.9 | 4.0 | 1.0 |
| 134 | Phillips | 1316.0 | 311.9 | 4.0 | 2.0 |
| 135 | Phillips | 1128.0 | 538.7 | 4.0 | 3.0 |
| 136 | Phillips | 1011.0 | 482.0 | 4.0 | 4.0 |
| 137 | Phillips | 1360.0 | 623.7 | 4.0 | 5.0 |
| 138 | Phillips | 900.0 | 283.5 | 4.0 | 6.0 |
| 139 | Phillips | 811.0 | 453.6 | 4.0 | 7.0 |
| 140 | Phillips | 1190.0 | 595.4 | 4.0 | 8.0 |
| 141 | Phillips | 1129.0 | 737.1 | 4.0 | 9.0 |
| 142 | Phillips | 606.0 | 368.6 | 4.0 | 10.0 |
| 143 | Phillips | 1299.0 | 510.3 | 4.0 | 11.0 |
| 144 | Phillips | 1279.0 | 623.7 | 4.0 | 12.0 |

[1] Cultivars were 1 = Hector, 2 = Steptoe, 3 = Piroline, 4 = Clark, 5 = Lewis, 6 = Gallatin, 7 = Bowman, 8 = Harrington, 9 = Kimberly, 10 = Hazen, 11 = MT 81616, 12 = MT 81161.

Table 41. Grain yield and straw production of spring wheat samples harvested on contrasting soil units in a field near Havre (1987).

| Sample Number | Soil Unit | ---- Yield ----- | | Rep | Cultivar |
|---|---|---|---|---|---|
| | | Grain | Straw | | |
| | | ------ g ------- | | | |
| 1 | Evanston | 846.0 | 482.0 | 1.0 | 1.0 |
| 2 | Evanston | 922.0 | 482.0 | 1.0 | 2.0 |
| 3 | Evanston | 878.0 | 623.7 | 1.0 | 3.0 |
| 4 | Evanston | 1148.0 | 708.8 | 1.0 | 4.0 |
| 5 | Evanston | 1235.0 | 595.4 | 1.0 | 5.0 |
| 6 | Evanston | 770.0 | 482.0 | 1.0 | 6.0 |
| 7 | Evanston | 1040.0 | 453.6 | 1.0 | 7.0 |
| 8 | Evanston | 847.0 | 368.6 | 1.0 | 8.0 |
| 9 | Evanston | 1368.0 | 708.8 | 1.0 | 9.0 |
| 10 | Evanston | 635.0 | 283.5 | 1.0 | 10.0 |
| 11 | Evanston | 842.0 | 396.9 | 1.0 | 11.0 |
| 12 | Evanston | 1022.0 | 567.0 | 1.0 | 12.0 |
| 13 | Evanston | 1047.0 | 652.1 | 2.0 | 1.0 |
| 14 | Evanston | 1109.0 | 567.0 | 2.0 | 2.0 |
| 15 | Evanston | 797.0 | 595.4 | 2.0 | 3.0 |
| 16 | Evanston | 1315.0 | 935.6 | 2.0 | 4.0 |
| 17 | Evanston | 1563.0 | 737.1 | 2.0 | 5.0 |
| 18 | Evanston | 1109.0 | 737.1 | 2.0 | 6.0 |
| 19 | Evanston | 1443.0 | 680.4 | 2.0 | 7.0 |
| 20 | Evanston | 851.0 | 368.6 | 2.0 | 8.0 |
| 21 | Evanston | 1363.0 | 623.7 | 2.0 | 9.0 |
| 22 | Evanston | 1095.0 | 567.0 | 2.0 | 10.0 |
| 23 | Evanston | 1124.0 | 652.1 | 2.0 | 11.0 |
| 24 | Evanston | 1072.0 | 680.4 | 2.0 | 12.0 |
| 25 | Evanston | 1387.0 | 765.5 | 3.0 | 1.0 |
| 26 | Evanston | 1208.0 | 680.4 | 3.0 | 2.0 |
| 27 | Evanston | 1060.0 | 822.2 | 3.0 | 3.0 |
| 28 | Evanston | 1059.0 | 765.5 | 3.0 | 4.0 |
| 29 | Evanston | 1516.0 | 793.8 | 3.0 | 5.0 |
| 30 | Evanston | 856.0 | 538.7 | 3.0 | 6.0 |
| 31 | Evanston | 1398.0 | 708.8 | 3.0 | 7.0 |
| 32 | Evanston | 1387.0 | 680.4 | 3.0 | 8.0 |
| 33 | Evanston | 1350.0 | 708.8 | 3.0 | 9.0 |
| 34 | Evanston | 1050.0 | 538.7 | 3.0 | 10.0 |
| 35 | Evanston | 1458.0 | 737.1 | 3.0 | 11.0 |
| 36 | Evanston | 1095.0 | 453.6 | 3.0 | 12.0 |
| 37 | Evanston | 870.0 | 425.3 | 4.0 | 1.0 |
| 38 | Evanston | 830.0 | 453.6 | 4.0 | 2.0 |
| 39 | Evanston | 951.0 | 652.1 | 4.0 | 3.0 |
| 40 | Evanston | 1137.0 | 1191.0 | 4.0 | 4.0 |
| 41 | Evanston | 1151.0 | 510.3 | 4.0 | 5.0 |
| 42 | Evanston | 786.0 | 453.6 | 4.0 | 6.0 |

Table 41.--Continued.

| Sample Number | Soil Unit | ---- Yield ----- | | Rep | Cultivar |
|---|---|---|---|---|---|
| | | Grain | Straw | | |
| | | ------ g ------- | | | |
| 43 | Evanston | 1075.0 | 567.0 | 4.0 | 7.0 |
| 44 | Evanston | 1034.0 | 482.0 | 4.0 | 8.0 |
| 45 | Evanston | 1371.0 | 680.4 | 4.0 | 9.0 |
| 46 | Evanston | 695.0 | 283.5 | 4.0 | 10.0 |
| 47 | Evanston | 885.0 | 538.7 | 4.0 | 11.0 |
| 48 | Evanston | 968.0 | 368.6 | 4.0 | 12.0 |
| 49 | Telstad | 1022.0 | 708.8 | 1.0 | 1.0 |
| 50 | Telstad | 1029.0 | 822.2 | 1.0 | 2.0 |
| 51 | Telstad | 1087.0 | 1049.0 | 1.0 | 3.0 |
| 52 | Telstad | 1238.0 | 992.3 | 1.0 | 4.0 |
| 53 | Telstad | 1459.0 | 935.6 | 1.0 | 5.0 |
| 54 | Telstad | 1153.0 | 850.5 | 1.0 | 6.0 |
| 55 | Telstad | 1350.0 | 765.5 | 1.0 | 7.0 |
| 56 | Telstad | 1383.0 | 878.9 | 1.0 | 8.0 |
| 57 | Telstad | 1448.0 | 907.2 | 1.0 | 9.0 |
| 58 | Telstad | 886.0 | 510.3 | 1.0 | 10.0 |
| 59 | Telstad | 1299.0 | 878.9 | 1.0 | 11.0 |
| 60 | Telstad | 1232.0 | 765.5 | 1.0 | 12.0 |
| 61 | Telstad | 867.0 | 595.4 | 2.0 | 1.0 |
| 62 | Telstad | 805.0 | 567.0 | 2.0 | 2.0 |
| 63 | Telstad | 758.0 | 708.8 | 2.0 | 3.0 |
| 64 | Telstad | 894.0 | 822.2 | 2.0 | 4.0 |
| 65 | Telstad | 995.0 | 595.4 | 2.0 | 5.0 |
| 66 | Telstad | 576.0 | 737.1 | 2.0 | 6.0 |
| 67 | Telstad | 918.0 | 595.4 | 2.0 | 7.0 |
| 68 | Telstad | 910.0 | 595.4 | 2.0 | 8.0 |
| 69 | Telstad | 792.0 | 453.6 | 2.0 | 9.0 |
| 70 | Telstad | 559.0 | 396.9 | 2.0 | 10.0 |
| 71 | Telstad | 951.0 | 680.4 | 2.0 | 11.0 |
| 72 | Telstad | 1113.0 | 765.5 | 2.0 | 12.0 |
| 73 | Telstad | 789.0 | 482.0 | 3.0 | 1.0 |
| 74 | Telstad | 1239.0 | 878.9 | 3.0 | 2.0 |
| 75 | Telstad | 984.0 | 1021.0 | 3.0 | 3.0 |
| 76 | Telstad | 989.0 | 793.8 | 3.0 | 4.0 |
| 77 | Telstad | 1134.0 | 708.8 | 3.0 | 5.0 |
| 78 | Telstad | 613.0 | 793.8 | 3.0 | 6.0 |
| 79 | Telstad | 1438.0 | 822.2 | 3.0 | 7.0 |
| 80 | Telstad | 1249.0 | 708.8 | 3.0 | 8.0 |
| 81 | Telstad | 568.0 | 425.3 | 3.0 | 9.0 |
| 82 | Telstad | 452.0 | 198.5 | 3.0 | 10.0 |
| 83 | Telstad | 1010.0 | 708.8 | 3.0 | 11.0 |
| 84 | Telstad | 934.0 | 793.8 | 3.0 | 12.0 |
| 85 | Telstad | 899.0 | 793.8 | 4.0 | 1.0 |
| 86 | Telstad | 1103.0 | 765.5 | 4.0 | 2.0 |

Table 41--Continued.

| Sample Number | Soil Unit | ---- Yield ----- Grain | Straw | Rep | Cultivar |
|---|---|---|---|---|---|
| | | ------ g | ------- | | |
| 87 | Telstad | 826.0 | 822.2 | 4.0 | 3.0 |
| 88 | Telstad | 1097.0 | 1162.0 | 4.0 | 4.0 |
| 89 | Telstad | 1286.0 | 878.9 | 4.0 | 5.0 |
| 90 | Telstad | 945.0 | 1021.0 | 4.0 | 6.0 |
| 91 | Telstad | 1087.0 | 652.1 | 4.0 | 7.0 |
| 92 | Telstad | 935.0 | 510.3 | 4.0 | 8.0 |
| 93 | Telstad | 693.0 | 708.8 | 4.0 | 9.0 |
| 94 | Telstad | 710.0 | 425.3 | 4.0 | 10.0 |
| 95 | Telstad | 1091.0 | 765.5 | 4.0 | 11.0 |
| 96 | Telstad | 1012.0 | 907.2 | 4.0 | 12.0 |
| 97 | Phillips | 1164.0 | 482.0 | 1.0 | 1.0 |
| 98 | Phillips | 985.0 | 482.0 | 1.0 | 2.0 |
| 99 | Phillips | 1106.0 | 623.7 | 1.0 | 3.0 |
| 100 | Phillips | 1218.0 | 708.8 | 1.0 | 4.0 |
| 101 | Phillips | 1478.0 | 680.4 | 1.0 | 5.0 |
| 102 | Phillips | 1013.0 | 482.0 | 1.0 | 6.0 |
| 103 | Phillips | 496.0 | 425.3 | 1.0 | 7.0 |
| 104 | Phillips | 1101.0 | 425.3 | 1.0 | 8.0 |
| 105 | Phillips | 1011.0 | 538.7 | 1.0 | 9.0 |
| 106 | Phillips | 823.0 | 425.3 | 1.0 | 10.0 |
| 107 | Phillips | 1142.0 | 680.4 | 1.0 | 11.0 |
| 108 | Phillips | 1250.0 | 652.1 | 1.0 | 12.0 |
| 109 | Phillips | 1099.0 | 708.8 | 2.0 | 1.0 |
| 110 | Phillips | 1132.0 | 652.1 | 2.0 | 2.0 |
| 111 | Phillips | 1052.0 | 708.8 | 2.0 | 3.0 |
| 112 | Phillips | 1203.0 | 793.8 | 2.0 | 4.0 |
| 113 | Phillips | 1369.0 | 708.9 | 2.0 | 5.0 |
| 114 | Phillips | 1056.0 | 595.4 | 2.0 | 6.0 |
| 115 | Phillips | 1052.0 | 510.3 | 2.0 | 7.0 |
| 116 | Phillips | 1263.0 | 567.0 | 2.0 | 8.0 |
| 117 | Phillips | 1159.0 | 595.4 | 2.0 | 9.0 |
| 118 | Phillips | 660.0 | 283.5 | 2.0 | 10.0 |
| 119 | Phillips | 1234.0 | 652.1 | 2.0 | 11.0 |
| 120 | Phillips | 1396.0 | 737.1 | 2.0 | 12.0 |
| 121 | Phillips | 1175.0 | 680.4 | 3.0 | 1.0 |
| 122 | Phillips | 976.0 | 482.0 | 3.0 | 2.0 |
| 123 | Phillips | 1219.0 | 878.9 | 3.0 | 3.0 |
| 124 | Phillips | 1332.0 | 822.2 | 3.0 | 4.0 |
| 125 | Phillips | 1406.0 | 567.0 | 3.0 | 5.0 |
| 126 | Phillips | 1165.0 | 652.1 | 3.0 | 6.0 |
| 127 | Phillips | 1294.0 | 510.3 | 3.0 | 7.0 |
| 128 | Phillips | 1562.0 | 737.1 | 3.0 | 8.0 |
| 129 | Phillips | 1335.0 | 737.1 | 3.0 | 9.0 |
| 130 | Phillips | 854.0 | 396.9 | 3.0 | 10.0 |

Table 41--Continued.

| Sample Number | Soil Unit | ---- Yield ----- Grain | Straw | Rep | Cultivar |
|---|---|---|---|---|---|
| | | ------ g ------- | | | |
| 131 | Phillips | 1301.0 | 737.1 | 3.0 | 11.0 |
| 132 | Phillips | 1395.0 | 708.8 | 3.0 | 12.0 |
| 133 | Phillips | 1077.0 | 652.1 | 4.0 | 1.0 |
| 134 | Phillips | 1236.0 | 765.5 | 4.0 | 2.0 |
| 135 | Phillips | 972.0 | 595.4 | 4.0 | 3.0 |
| 136 | Phillips | 1094.0 | 708.8 | 4.0 | 4.0 |
| 137 | Phillips | 1565.0 | 708.8 | 4.0 | 5.0 |
| 138 | Phillips | 1056.0 | 567.0 | 4.0 | 6.0 |
| 139 | Phillips | 1374.0 | 680.4 | 4.0 | 7.0 |
| 140 | Phillips | 1251.0 | 623.7 | 4.0 | 8.0 |
| 141 | Phillips | 1216.0 | 510.3 | 4.0 | 9.0 |
| 142 | Phillips | 885.0 | 396.9 | 4.0 | 10.0 |
| 143 | Phillips | 1249.0 | 565.5 | 4.0 | 11.0 |
| 144 | Phillips | 1269.0 | 538.7 | 4.0 | 12.0 |

[1] Cultivars were 1 = Newana, 2 = Pondera, 3 = Fortuna, 4 = Lew, 5 = Glenman, 6 = Success, 7 = Wheaton, 8 = Copper, 9 = Treasure, 10 = NK 751, 11 = Cutless, 12 = MT 7926.

Table 42. Grain yield and straw production of spring wheat samples harvested on contrasting soil units in a field near Havre (1988).

| Sample Number | Soil Unit | ---- Yield ----- | | Rep | Cultivar |
|---|---|---|---|---|---|
| | | Grain | Straw | | |
| | | ------ g ------- | | | |
| 1 | Gerdrum | 205.7 | 269.6 | 1.0 | 1.0 |
| 2 | Gerdrum | 182.7 | 271.1 | 1.0 | 2.0 |
| 3 | Gerdrum | 169.2 | 231.7 | 1.0 | 3.0 |
| 4 | Gerdrum | 208.1 | 355.4 | 2.0 | 1.0 |
| 5 | Gerdrum | 258.7 | 354.1 | 2.0 | 2.0 |
| 6 | Gerdrum | 314.7 | 386.2 | 2.0 | 3.0 |
| 7 | Gerdrum | 244.7 | 381.0 | 3.0 | 1.0 |
| 8 | Gerdrum | 314.1 | 488.2 | 3.0 | 2.0 |
| 9 | Gerdrum | 369.5 | 487.9 | 3.0 | 3.0 |
| 10 | Gerdrum | 176.1 | 286.8 | 4.0 | 1.0 |
| 11 | Gerdrum | 215.2 | 314.5 | 4.0 | 2.0 |
| 12 | Gerdrum | 304.3 | 384.4 | 4.0 | 3.0 |
| 13 | Gerdrum | 303.2 | 364.6 | 5.0 | 1.0 |
| 14 | Gerdrum | 254.0 | 653.8 | 5.0 | 2.0 |
| 15 | Gerdrum | 344.9 | 472.0 | 5.0 | 3.0 |
| 16 | Phillips | 140.3 | 205.7 | 1.0 | 1.0 |
| 17 | Phillips | 149.6 | 224.4 | 1.0 | 2.0 |
| 18 | Phillips | 149.5 | 228.1 | 1.0 | 3.0 |
| 19 | Phillips | 131.1 | 173.6 | 2.0 | 1.0 |
| 20 | Phillips | 114.0 | 185.8 | 2.0 | 2.0 |
| 21 | Phillips | 61.77 | 149.5 | 2.0 | 3.0 |
| 22 | Phillips | 166.6 | 207.6 | 3.0 | 1.0 |
| 23 | Phillips | 155.1 | 242.2 | 3.0 | 2.0 |
| 24 | Phillips | 113.6 | 194.8 | 3.0 | 3.0 |
| 25 | Phillips | 158.3 | 180.6 | 4.0 | 1.0 |
| 26 | Phillips | 140.1 | 222.9 | 4.0 | 2.0 |
| 27 | Phillips | 144.2 | 235.5 | 4.0 | 3.0 |
| 28 | Phillips | 75.00 | 167.5 | 5.0 | 1.0 |
| 29 | Phillips | 89.33 | 216.8 | 5.0 | 2.0 |
| 30 | Phillips | 86.27 | 162.0 | 5.0 | 3.0 |
| 31 | Telstad | 113.7 | 186.9 | 1.0 | 1.0 |
| 32 | Telstad | 107.1 | 180.7 | 1.0 | 2.0 |
| 33 | Telstad | 95.33 | 168.8 | 1.0 | 3.0 |
| 34 | Telstad | 176.5 | 250.4 | 2.0 | 1.0 |
| 35 | Telstad | 185.6 | 292.8 | 2.0 | 2.0 |
| 36 | Telstad | 122.8 | 202.1 | 2.0 | 3.0 |
| 37 | Telstad | 119.6 | 174.3 | 3.0 | 1.0 |
| 38 | Telstad | 117.7 | 185.5 | 3.0 | 2.0 |
| 39 | Telstad | 138.8 | 225.8 | 3.0 | 3.0 |
| 40 | Telstad | 152.8 | 218.4 | 4.0 | 1.0 |
| 41 | Telstad | 146.9 | 236.4 | 4.0 | 2.0 |
| 42 | Telstad | 123.6 | 205.9 | 4.0 | 3.0 |

Table 42--Continued.

| Sample Number | Soil Unit | ---- Yield ----- Grain | Straw | Rep | Cultivar |
|---|---|---|---|---|---|
| | | ------ g ------- | | | |
| 43 | Telstad | 175.4 | 241.8 | 5.0 | 1.0 |
| 44 | Telstad | 152.5 | 231.8 | 5.0 | 2.0 |
| 45 | Telstad | 116.0 | 191.5 | 5.0 | 3.0 |

[1] Cultivars were 1 = Glenman, 2 = Rambo, 3 = Lew, 4 = Cutless.

Table 43. Grain yield and straw production of spring barley samples harvested on contrasting soil units in a field near Townsend.

| Sample Number | Soil Unit | ---- Yield ----- Grain | Straw | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|---|
| | | ------ g | ------- | | |
| 1 | Amesha | 240.2 | 285.4 | 1.0 | 1.0 |
| 2 | Amesha | 168.0 | 246.0 | 2.0 | 1.0 |
| 3 | Amesha | 175.8 | 236.2 | 3.0 | 1.0 |
| 4 | Amesha | 212.6 | 269.4 | 4.0 | 1.0 |
| 5 | Amesha | 208.4 | 261.6 | 1.0 | 2.0 |
| 6 | Amesha | 189.6 | 254.4 | 2.0 | 2.0 |
| 7 | Amesha | 230.5 | 267.1 | 3.0 | 2.0 |
| 8 | Amesha | 186.0 | 237.0 | 4.0 | 2.0 |
| 9 | Amesha | 165.9 | 221.6 | 1.0 | 3.0 |
| 10 | Amesha | 232.2 | 270.9 | 2.0 | 3.0 |
| 11 | Amesha | 228.2 | 277.9 | 3.0 | 3.0 |
| 12 | Amesha | 209.3 | 273.3 | 4.0 | 3.0 |
| 13 | Amesha | 244.8 | 294.8 | 1.0 | 4.0 |
| 14 | Amesha | 195.5 | 252.0 | 2.0 | 4.0 |
| 15 | Amesha | 226.4 | 279.2 | 3.0 | 4.0 |
| 16 | Amesha | 144.2 | 227.8 | 4.0 | 4.0 |
| 17 | Brocko | 230.3 | 277.3 | 1.0 | 1.0 |
| 18 | Brocko | 232.9 | 280.7 | 2.0 | 1.0 |
| 19 | Brocko | 225.9 | 287.7 | 3.0 | 1.0 |
| 20 | Brocko | 163.3 | 259.7 | 4.0 | 1.0 |
| 21 | Brocko | 196.1 | 257.9 | 1.0 | 2.0 |
| 22 | Brocko | 185.1 | 306.9 | 2.0 | 2.0 |
| 23 | Brocko | 253.9 | 235.6 | 3.0 | 2.0 |
| 24 | Brocko | 201.0 | 347.6 | 4.0 | 2.0 |
| 25 | Brocko | 208.6 | 285.4 | 1.0 | 3.0 |
| 26 | Brocko | 240.3 | 264.3 | 2.0 | 3.0 |
| 27 | Brocko | 236.3 | 266.3 | 3.0 | 3.0 |
| 28 | Brocko | 296.7 | 230.9 | 4.0 | 3.0 |
| 29 | Brocko | 159.1 | 233.9 | 1.0 | 4.0 |
| 30 | Brocko | 293.7 | 243.4 | 2.0 | 4.0 |
| 31 | Brocko | 206.6 | 248.9 | 3.0 | 4.0 |
| 32 | Brocko | 231.3 | 277.3 | 4.0 | 4.0 |

[1] Fertilizer treatments, expressed as kg ha$^{-1}$ N, P, and K (N-P-K), were 1 = 0-36-0, 2 = 8-11-34, 3 = 17-5-27, 4 = 0-0-0.

Table 44. Grain yield and straw production of spring wheat samples harvested on contrasting soil units in a field near Whitehall.

| Sample Number | Soil Unit | Yield | | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|---|
| | | Grain | Straw | | |
| | | g | | | |
| 1 | Walbert | 10.90 | 86.60 | 1.0 | 1.0 |
| 2 | Walbert | 52.00 | 131.5 | 2.0 | 1.0 |
| 3 | Walbert | 50.50 | 131.0 | 3.0 | 1.0 |
| 4 | Walbert | 24.90 | 101.6 | 4.0 | 1.0 |
| 5 | Walbert | 23.80 | 89.20 | 1.0 | 2.0 |
| 6 | Walbert | 30.50 | 114.0 | 2.0 | 2.0 |
| 7 | Walbert | 21.70 | 104.8 | 3.0 | 2.0 |
| 8 | Walbert | 51.10 | 145.4 | 4.0 | 2.0 |
| 9 | Walbert | 19.20 | 97.80 | 1.0 | 3.0 |
| 10 | Walbert | 41.60 | 119.9 | 2.0 | 3.0 |
| 11 | Walbert | 17.00 | 91.50 | 3.0 | 3.0 |
| 12 | Walbert | 35.80 | 122.2 | 4.0 | 3.0 |
| 13 | Walbert | 13.00 | 77.00 | 1.0 | 4.0 |
| 14 | Walbert | 50.40 | 128.1 | 2.0 | 4.0 |
| 15 | Walbert | 24.90 | 108.1 | 3.0 | 4.0 |
| 16 | Walbert | 35.80 | 103.2 | 4.0 | 4.0 |
| 17 | Walbert | 34.00 | 99.00 | 1.0 | 5.0 |
| 18 | Walbert | 35.80 | 108.2 | 2.0 | 5.0 |
| 19 | Walbert | 46.40 | 126.6 | 3.0 | 5.0 |
| 20 | Walbert | 15.00 | 86.00 | 4.0 | 5.0 |
| 21 | Varney | 25.20 | 118.3 | 1.0 | 1.0 |
| 22 | Varney | 11.00 | 79.00 | 2.0 | 1.0 |
| 23 | Varney | 16.60 | 95.40 | 3.0 | 1.0 |
| 24 | Varney | 29.00 | 110.5 | 4.0 | 1.0 |
| 25 | Varney | 15.30 | 104.7 | 1.0 | 2.0 |
| 26 | Varney | 19.20 | 93.80 | 2.0 | 2.0 |
| 27 | Varney | 6.200 | 74.80 | 3.0 | 2.0 |
| 28 | Varney | 9.600 | 89.90 | 4.0 | 2.0 |
| 29 | Varney | 28.90 | 119.1 | 1.0 | 3.0 |
| 30 | Varney | 20.10 | 109.4 | 2.0 | 3.0 |
| 31 | Varney | 19.30 | 111.7 | 3.0 | 3.0 |
| 32 | Varney | 13.90 | 129.6 | 4.0 | 3.0 |
| 33 | Varney | 11.90 | 82.60 | 1.0 | 4.0 |
| 34 | Varney | 22.40 | 110.6 | 2.0 | 4.0 |
| 35 | Varney | 20.40 | 104.6 | 3.0 | 4.0 |
| 36 | Varney | 15.10 | 107.9 | 4.0 | 4.0 |
| 37 | Varney | 25.50 | 99.00 | 1.0 | 5.0 |
| 38 | Varney | 11.30 | 89.70 | 2.0 | 5.0 |
| 39 | Varney | 13.50 | 114.0 | 3.0 | 5.0 |
| 40 | Varney | 28.10 | 110.9 | 4.0 | 5.0 |
| 41 | Ethridge | 33.80 | 132.2 | 1.0 | 1.0 |
| 42 | Ethridge | 31.00 | 120.0 | 2.0 | 1.0 |

Table 44--Continued.

| Sample Number | Soil Unit | Yield Grain | Yield Straw | Rep | Fertilizer Treatment[1] |
|---|---|---|---|---|---|
| | | g | g | | |
| 43 | Ethridge | 53.50 | 179.5 | 3.0 | 1.0 |
| 44 | Ethridge | 37.10 | 132.9 | 4.0 | 1.0 |
| 45 | Ethridge | 3.000 | 91.00 | 1.0 | 2.0 |
| 46 | Ethridge | 24.50 | 121.0 | 2.0 | 2.0 |
| 47 | Ethridge | 55.70 | 178.3 | 3.0 | 2.0 |
| 48 | Ethridge | 33.10 | 169.9 | 4.0 | 2.0 |
| 49 | Ethridge | 16.50 | 97.50 | 1.0 | 3.0 |
| 50 | Ethridge | 22.40 | 122.6 | 2.0 | 3.0 |
| 51 | Ethridge | 61.90 | 187.1 | 3.0 | 3.0 |
| 52 | Ethridge | 26.70 | 135.8 | 4.0 | 3.0 |
| 53 | Ethridge | 23.90 | 109.6 | 1.0 | 4.0 |
| 54 | Ethridge | 55.70 | 162.3 | 2.0 | 4.0 |
| 55 | Ethridge | 54.40 | 148.6 | 3.0 | 4.0 |
| 56 | Ethridge | 39.50 | 149.5 | 4.0 | 4.0 |
| 57 | Ethridge | 25.90 | 96.10 | 1.0 | 5.0 |
| 58 | Ethridge | 25.30 | 96.20 | 2.0 | 5.0 |
| 59 | Ethridge | 12.20 | 77.30 | 3.0 | 5.0 |
| 60 | Ethridge | 25.60 | 98.40 | 4.0 | 5.0 |

[1] Fertilizer treatments, expressed as kg $ha^{-1}$ N, P, and K (N-P-K), were 1 = 134-0-0, 2 = 121-0-0, 3 = 74-0-0, 4 = 111-0-0, 5 = 0-0-0.