

Table 1. Long-term experiments at CBARC, Pendleton, Oregon.

Experiment	Treatments	Year initiated
Perennial grassland	None	1931
Continuous cereal	Fertility, tillage	1931`
Residue management	N, manure, burning, pea vine	1931
Tillage-fertility	Tillage, fertility	1940
Wheat-pea	Tillage, fertility	1963
No-till wheat	N, summer fallow	1982

Table 2. Treatment history of the tilled continuous cereal monocultures.

<u>Period</u>	<u>Crop grown</u>	<u>Variables</u>	<u>N Application</u>
1932-1950	Winter wheat	Fertilizer rate and type	0-126
1951-1958	Winter wheat	None	0
1959-1976	Winter wheat	None	70
1977-1992	Winter wheat	None	80
1993-2003	Winter wheat	Fertility	0,80
1932-1953	Spring wheat	Fertilizer rate and type	0-94
1954-1958	Spring wheat	None	0
1959-1976	Spring wheat	None	74
1977-1992	Spring wheat	None	80
1993-2003	Spring wheat	Fertility	0,80
1982-1994	Spring barley	None	80
1994-2003	Spring barley	Fertility	0,80

Table 3. Treatment history of the direct-seeded continuous cereal monocultures.

Period	Crop grown	Variable	N Application
1998-2003	Spring barley	N Rate	0, 90
	Spring wheat	N Rate	0, 90
	Winter wheat	N Rate	0, 100

Table 4. Treatment history of the residue management (CR) experiment.

Trt No.	Organic-N addition	1931-1966		1967-1978		1979 to present	
		RT ^a	N ^b	RT	N	RT	N
1	--- ^c	--	--	--	--	--	--
2	---	FD	0	NB	40	SB	40
3	---	SD	0	NB	80	SB	80
4	---	NB	30	NB	40	NB	40
5	---	NB	30	NB	80	NB	80
6	---	FB	0	FB	0	FB	0
7	---	SB	0	SB	0	SB	0
8	Manure ^d	NB	0	NB	0	NB	0
9	Pea vines ^e	NB	0	NB	0	NB	0
10	---	NB	0	NB	0	NB	0

^a Residue treatment: FD = fall disk, SD = spring disk, NB = no burn, FB = fall burn, SB = spring burn.

^b N rate (lb/acre/crop); applied early October of crop year.

^c 1 ton/acre/crop field weight alfalfa hay applied to plot 11 1939-1949 1-3 days prior to plowing

^d Manure = (10 tons/acre/crop wet wt; 47.5 percent dry matter; 1,404 lb C and 113 lb N/acre/crop; applied in April or May of plow year (1-3 days prior to plowing).

^e Pea vines = (1 ton/acre/crop field weight; 88.4 percent dry matter; 733 lb C and 34 lb N/acre/crop; applied 1-3 days prior to plowing.

Table 5. Treatment history of the tillage-fertility (TF) experiment.

<u>Primary treatment (tillage)</u>		Tillage depth	Average residue cover	
Symbol	Type	(inches)	at Seeding (%)	
MP	Moldboard plow	9	7	
DI	Offset disk	6	34	
SW	Subsurface	6	43	
	Sweep			

<u>Sub-treatment (fertility)</u>		<u>N Rate (lb/acre/crop)</u>			
No.	Sulfur application	1941-1952	1953-1962	1963-1988	1989-present
1	No	0	0	40	0
2	Yes	10	30	40	40
3	No	0	0	80	80
4	Yes	10	30	80	80
5	Yes	10	30	120	120
6	Yes	10	30	160	160

N applied 7-14 days prior to seeding as ammonium sulfate from 1941 to 1962, ammonium nitrate from 1963 to 1988, and urea-ammonium nitrate since 1989. N broadcast from 1941 to 1988, and banded 6 inches deep with 10-inch row spacing since 1989.

Table 6. Current treatments of the wheat/pea (WP) experiment.

<u>Treatment</u>		<u>Primary tillage</u>	
No.	Identification	Wheat stubble	Pea vines
1	Max till	Disk (fall)	Chisel (fall)
2	Fall plow	Plow (fall)	Plow (fall)
3	Spring plow	Plow (spring)	Plow (fall)
4	No-till	No-till	No-till

Table 7. No-till summer fallow experiment treatments.

Component	Year of initiation	System	N rates (lbs N/acre)
Old no-till(A)	1982	No-till	0,40,80,120,160
New no-till(B)	1997	No-till	0,40,80,120,160
Conventional till(C)	1997	ConventionaltTill	0,120

Table 8. Precipitation and growing degree days in the 2002 and 2003 crop-years.

	Time period			
	2002	71-year	2003	72-year
Fallow year precipitation (in)	16.3(2001)	16.5	13.0(2002)	16.5
Crop-year precipitation (in) Sept 1-June 30	12.8	15.7	15.4	15.6
Two-year precipitation (in)	29.1(2001-2002)	32.2	28.4(2002-2003)	32.1
Winter season precipitation (in) Sept 1-Feb 28	7.9	9.8	10.4	9.8
Spring season precipitation (in) March 1-June 30	4.9	5.9	5.0	5.9
Crop-year GDD Sept 1-June 30	2,692	2,643	2,808	2,647
Winter season GDD Sept 1-Feb 28	1,340	1,236	1,284	1,237
Spring season GDD March 1-June 30	1,351	1,407	1,523	1,410

Table 9. Yield and yield components of crops grown in the CBARC-OSU long-term experiments in the 2002 crop year.

Experiment ¹	Target stand (seeds/ft ²)	Stand (plants/ft ²)	Test wt (lb/bu)	Yield (bu/acre)	1,000-kernel wt combine (oz)	1,000-kernel wt bundle (oz)	Heads/ft ²	Bundle size (ft ²)	HI	Bundle yield (bu/acre)
CWW-CT fertilized	22		60.3	42.1	1.31	1.29	33.5	7.437	0.40	37.6
CWW-CT unfertilized	22		60.3	23.0	1.56	1.29	23.2	7.437	0.44	24.2
NTCWW-Conservapak with N	25		53.9	36.7	0.96	0.98	31.8	13.120	0.32	35.2
NTCWW-JD1560 with N	25		56.7	36.5	1.12	1.00	26.9	8.200	0.32	31.3
NTCWW-Conservapak without N	25		57.8	16.1	1.13	1.01	16.7	13.120	0.33	15.8
NTCWW-1560 without N	25		57.8	12.9	1.14	1.10	16.2	8.200	0.32	11.1
CSB-CT fertilized	23	17.9	48.5	63.4	1.05	1.17	64.6	7.437	0.42	62.9
CSB-CT unfertilized	23	19.4	51.6	42.0	1.24	1.47	45.3	7.437	0.50	51.6
NTCSB-Conservapak with N	26	21	46.7	50.4	1.10	1.13	42.8	13.120	0.42	47.3
NTCSB-JD1560 with N	26	14.1	44.8	43.1	1.10	1.06	42.6	8.200	0.37	39.2
NTCSB-Conservapak without N	26	19.6	46.0	20.4	1.16	1.17	26.4	13.120	0.42	27.0
NTCSB-1560 without N	26	21.1	44.5	23.1	1.12	1.07	44.6	8.200	0.37	45.8
CSW-CT fertilized	26	20	56.3	34.2	0.92	0.73	35.3	7.437	0.41	33.1
CSW-CT unfertilized	26	19.2	58.9	21.8	1.17	0.90	19.9	7.437	0.48	19.6
NTCSW-Conservapak with N	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
NTCSW-JD1560 with N	29	20.5	55.8	27.2	0.91	0.85	25.9	8.200	0.43	26.5
NTCSW-Conservapak without N	no data	no data	no data	no data	no data	no data	no data	no data	no data	no data
NTCSW-1560 without N	29	18.9	59.3	15.8	0.94	0.88	23.1	8.200	0.46	16.8
CR-check 1	22		58.4bcd	33.8cd	1.56a		25.0cde	7.437	0.38c	33.0c
CR check 10	22		58.6bcd	35.6cd	1.57a		24.6e	7.437	0.4bc	29.7c
CR 2-spring burn 40#N/A	22		59.6b	49.5b	1.59a		29.8bcd	7.437	0.41abc	47.4b
CR 3-spring burn 80#N/A	22		61a	49.7b	1.60a		29.6bcd	7.437	0.43ab	48.2b
CR 4-40#N/A	22		59.6bc	50.6b	1.54a		29.6bcd	7.437	0.42abc	47.7b
CR 5-80#N/A	22		60.9a	50b	1.60a		31.1bc	7.437	0.45a	51.5b
CR 6-Fall burn	22		58.1d	28.8d	1.58a		23.3e	7.437	0.4bc	28.9c
CR 7-Spring burn	22		58.3cd	32.6cd	1.60a		24.9de	7.437	0.39c	31.6c
CR 8-Manure	22		58.1d	60.5a	1.40b		46.5a	7.437	0.43ab	73.9a
CR 9-Pea vine	22		59.6b	55.3ab	1.65a		34.6b	7.437	0.39c	54.3b
P-2 wheat-fall plow	22		55.8ab	46a	1.08a		37.2a	7.437	0.41a	41.4b
P-2 wheat-spring plow	22		56.3a	47.8a	1.08a		39.1a	7.437	0.41a	46.9a
P-2 wheat-maxi till (chisel)	22		55.6b	40.9b	1.09a		38.1a	7.437	0.41ab	41.2b
P-2 wheat-no-till	25		55.6b	33.4c	1.07a		23.7a	8.202	0.38b	27.1c
P-2 pea-F plow	8	6.6ab	62.3a	451.7d	6.38b			7.437	0.21a	653.1b
P-2 pea-S plow	8	7.4a	61.3b	753.8b	7.11a			7.437	0.26a	984.2a
P-2 pea-maxi till (disk)	8	6.4b	62a	688.1c	7.10a			7.437	0.24a	837.7ab
P-2 pea-no-till	8	6.7ab	62.1a	1091.7a	7.22a			8.202	0.26a	1064.6a

¹CWW-continuous winter wheat; CSW-continuous spring wheat; CSB-continuous spring barley; CT-conventional tillage; NT-no-till; CR-crop residue; P-2-wheat/pea; TF-tillage, fertility; N-nitrogen; HI-harvest index; ct-count; bu-bush

Table 10. T-test comparisons of mean bundle yield under different continuous cereal cropping systems in 2002 (Pr > t).

	ctcwwf ¹	ntcwwfcon	ntcwwfjd	ctcswf	ntcswfjd	ctcsbf	ntcsbfcon	ntcsbfjd	ctcwwnf	ntcwwnfcon	ntcwwnfjd	ctcswnf	ntcswnfjd	ctcsbnf	ntcsbnfcon
ctcwwf	-														
ntcwwfcon	ns ²	-													
ntcwwfjd	ns	ns	-												
ctcswf	ns	ns	ns	-											
ntcswfjd	*	ns	ns	*	-										
ctcsbf	**	**	****	****	****	-									
ntcsbfcon	ns	*	*	*	**	*	-								
ntcsbfjd	ns	ns	***	**	**	****	ns	-							
ctcwwnf	*	ns	ns	*	ns	***	**	**	-						
ntcwwnfcon	**	**	***	****	**	****	**	****	*	-					
ntcwwnfjd	**	**	**	****	**	****	**	****	*	ns	-				
ctcswnf	**	55	**	***	*	****	**	***	ns	*	**	-			
ntcswnfjd	**	**	**	****	**	****	**	****	*	ns	*	*	-		
ctcsbnf	ns	*	**	*	**	*	ns	*	**	**	***	**	**	-	
ntcsbnfcon	ns	ns	ns	ns	ns	**	*	*	ns	ns	**	ns	*	****	-
ntcsbnfjd	ns	*	*	*	*	*	ns	ns	*	**	**	**	**	ns	*

ctcwwf – conventional tillage, continuous winter wheat, fertilized
ctcswf– conventional tillage, continuous spring wheat, fertilized
ctcsbf– conventional tillage, continuous spring barley, fertilized
ctcwwnf – conventional tillage, continuous winter wheat, no fertilizer
ctcswnf– conventional tillage, continuous spring wheat, no fertilizer
ctcsbnf– conventional tillage, continuous spring barley, no fertilizer
ntcwwfcon – no-tillage, continuous winter wheat, fertilized, conservapak drill
ntcwwfjd– no-tillage, continuous winter wheat, fertilized, John Deere drill
ntcswfjd– no-tillage, continuous spring wheat, fertilized, John Deere drill
ntcsbfcon– no-tillage, continuous spring barley, fertilized, conservapak drill
ntcsbfjd– no-tillage, continuous spring barley, fertilized, John Deere drill
ntcwwnfcon – no-tillage, continuous winter wheat, no fertilizer, conservapak drill
ntcwwnfjd– no-tillage, continuous winter wheat, no fertilizer, John Deere drill
ntcswnfjd– no-tillage, continuous spring wheat, no fertilizer, John Deere drill
ntcsbnfcon– no-tillage, continuous spring barley, no fertilizer, conservapak drill
ntcsbnfjd– no-tillage, continuous spring barley, no fertilizer, John Deere drill

²ns–means not significantly different; *, **, ***, and ****- means significantly different at the 0.05, 0.01, 0.001, and 0.0001 levels of probability.

Table 11. Yield and yield components of crops grown in the CBARC-OSU long-term experiments in the 2003 crop year.

Experiment ¹	Target stand (seeds/sq ft)	Stand (plants/sq ft)	Downy brome ct (1ft ²)	Test wt (lb/bu)	Yield (bu/acre)	1,000-kernel wt combine(oz)	1,000-kernel wt bundle(oz)	Heads/ft ²	Bundle size (ft ²)	HI	Bundle yield (bu/acre)
CWW-CT fertilized	22	10.8	1.2	50.9	35.6	0.93	0.93	25.4	7.437	0.34	37.4
CWW-CT unfertilized	22	12.8	0.1	57.7	28.3	1.50	1.48	17.1	7.437	0.46	32.6
NTCWW-Conservapak with N	25	18.8	clearfield	58.9	40.7	0.95	1.00	34.7	13.120	0.40	40.8
NTCWW-Conservapak without	25	21.4	clearfield	60.5	21.9	1.13	1.11	34.5	8.200	0.42	20.9
CSB-CT fertilized	23	20.6		47.6	61.6	1.07	1.09	54.4	7.440	0.43	58.2
CSB-CT unfertilized	23	18.9		50.7	37.4	1.24	1.31	37.1	7.440	0.52	49.6
NTCSB-Conservapak with N	26	37		47.1	58.3	1.06	1.01	52.5	13.120	0.46	58.7
NTCSB-Conservapak without N	26	21.4		48.5	24.6	1.21	1.21	22.6	13.120	0.61	24.1
CSW-CT fertilized	26	22.6		54.6	29.3	0.78	0.81	41.8	7.440	0.32	34.0
CSW-CT unfertilized	26	20.6		60.8	31.7	1.24	0.94	27.7	7.440	0.39	31.3
NTCSW-Conservapak with N	29	30		55.4	25.0	0.77	0.80	32.0	13.120	0.27	22.9
NTCSW-Conservapak without N	29	22.2		60.3	24.1	1.15	1.15	29.1	13.120	0.42	25.2
CR-check 1	22	16c		57.2d	36.8e	1.498d		26.5bcd	7.437	0.4c	47.2cd
CR-check 10	22	17.6bc		57.0d	39.6e	1.565abc		21.1d	7.437	0.41bc	37.5d
CR 2-Spring burn 40#N/A	22	18.4abc		58.8bc	64.7bcd	1.515cd		28.8abcd	7.437	0.4bc	59b
CR 3-Spring burn 80#N/A	22	21.8abc		59.5a	60.7cd	1.512cd		29.9abc	7.437	0.4bc	55.5bc
CR 4-40#N/A	22	18.6abc		59.4ab	66.6abc	1.544abcd		32.0ab	7.437	0.42ab	65b
CR 5-80#N/A	22	18bc		59.6a	69.1ab	1.544abcd		30.5ab	7.437	0.41bc	61.2b
CR 6-Fall burn	22	19.4abc		56.7d	34.4e	1.533bcd		22.3cd	7.437	0.4c	38.3d
CR 7-Spring burn	22	17.8bc		57.1d	35.8e	1.586ab		24.9bcd	7.437	0.41bc	42.4d
CR 8-Manure	22	19.9abc		59.2ab	73.1a	1.586ab		35.6ab	7.437	0.44a	90.6a
CR 9-Pea vine	22	18.8abc		58.3c	58.2d	1.593a		31.9ab	7.437	0.42bc	61.2b
P-2 wheat-fall plow	22	17.7ab	0.2c	56.6b	47b	0.92a		37.2a	7.437	0.31a	52.5ab
P-2 wheat-spring plow	22	19.5a	0.3c	57.8a	49.7a	0.94a		39.8a	7.437	0.31a	55.0a
P-2 wheat-maxi till (chisel)	22	18.3ab	5.8b	57.0ab	44.6c	0.95a		39.9a	7.437	0.3a	46.0ab
P-2 wheat-no-till	25	18.8b	11.1a	56.9ab	43.4c	0.92a		33.1a	11.200	0.28a	42.2b
P-2 pea-fall plow	7	6.2a		62.9b	777.4a	5.22a			7.440	0.52a	1118a
P-2 pea-spring plow	7	5.9a		62.2c	830.3a	5.32a			7.440	0.54a	1145a
P-2 pea-maxi till (disk)	7	5.6a		63.3a	832.1a	5.18a			7.440	0.51a	1268a
P-2 pea-no-till	7	4.6a		62.9b	830.6a	5.22a			10.940	0.52a	777b
TF 0#N	22	18.5a	11.2a	57.8b	40.8c	1.46a		21.7d	7.437	0.39bc	40.8b
TF 40#N	22	18.1a	22.4a	58.9a	63.9a	1.43ab		30.9c	7.437	0.40a	65.5a
TF 80#N (3)	22	17.9a	21.4a	59.3a	64.5a	1.38bc		31.7bc	7.437	0.40a	66.1a
TF 80#N (4)	22	18.1a	15.9a	59a	62.6a	1.37c		31.1c	7.437	0.40ab?	65.2a
TF 120#N	22	18.4a	19.1a	58b	61.8a	1.27d		33.8b	7.437	0.39c	63.6a
TF 160#N	22	18.1a	12.0a	56.7c	58.5b	1.22e		37.4a	7.437	0.38c	64.3a
TF Plow	22	17.6a	0.1b	57.9b	63.3a	1.33b		33.5a	7.437	0.39a	65.8a
TF Disk	22	18.3a	7.6b	57.9b	59.4b	1.33b		32.0a	7.437	0.39a	62.6a
TF Sweep	22	18.6a	43.3a	59a	53.2c	1.41a		27.7b	7.437	0.40a	54.3b

¹CWW-continuous winter wheat; CSW-continuous spring wheat; CSB-continuous spring barley; CT-conventional tillage; NT-no-till; CR-crop residue; P-2-wheat/pea; TF-tillage, fertility; N-nitrogen; HI-harvest index; ct-count; bu-bushel.

Table 12. T-test comparisons of mean bundle yield under different continuous cereal cropping systems in 2003 (Pr > t).

	ctcwwf ¹	ntcwwf	ctcswf	ntcswf	ctcsbf	ntscbf	ctcwwnf	ntcwwnf	ctcswnf	ntcswnf	ctcsbnf
ctcwwf	-										
ntcwwf	ns ²	-									
ctcswf	ns	**	-								
ntcswf	**	**	**	-							
ctcsbf	**	*	**	**	-						
ntscbf	***	**	***	***	ns	-					
ctcwwnf	ns	ns	ns	*	**	**	-				
ntcwwnf	**	**	**	ns	**	***	*	-			
ctcswnf	ns	*	ns	*	**	**	ns	**	-		
ntcswnf	**	**	**	ns	**	****	ns	ns	ns	-	
ctcsbnf	ns	ns	*	*	ns	ns	ns	**	*	*	-
ntcsbnf	*	**	**	ns	**	****	ns	ns	ns	ns	*

¹ctcwwf – conventional tillage, continuous winter wheat, fertilized

ctcswf– conventional tillage, continuous spring wheat, fertilized

ctcsbf– conventional tillage, continuous spring barley, fertilized

ctcwwnf – conventional tillage, continuous winter wheat, no fertilizer

ctcswnf– conventional tillage, continuous spring wheat, no fertilizer

ctcsbnf– conventional tillage, continuous spring barley, no fertilizer

ntcwwf – conventional tillage, continuous winter wheat, fertilized, conservapak drill

ntcswf– conventional tillage, continuous spring wheat, fertilized, conservapak drill

ntscbf– conventional tillage, continuous spring barley, fertilized, conservapak drill

ntcwwnf – conventional tillage, continuous winter wheat, no fertilizer, conservapak drill

ntcswnf– conventional tillage, continuous spring wheat, no fertilizer, conservapak drill

ntcsbnf– conventional tillage, continuous spring barley, no fertilizer, conservapak drill

² ns-means not significantly different; *, **, ***, and ****- means significantly different at the 0.05, 0.01, 0.001, and 0.0001 levels of probability.

Table 13. Effect of nitrogen fertilization on grain yield, test weight, straw yield, and 1,000-kernel weight of no-till winter wheat grown at the Columbia Plateau Conservation Research Center-ARS at Pendleton, Oregon, 2001-2002 and 2002-2003.

2001-2002 N	Yield A	Yield B	Yield C	Test wt A	Test wt B	Test wt C	Straw yield A	Straw yield B	Straw yield C	1000-kernel wt A	1000-kernel wt B	1000-kernel wt C
lbs/acre	bu/acre			lbs/bu			---t/acre---			---oz---		
0	38.2	44.7	60.8	58.1	58.3	58.7	2.03	2.25	3.16	1.57	1.60	1.75
40	58.1	61.0	--	58.9	59.1	--	3.26	3.09	--	1.54	1.51	--
80	71.5	72.6	--	59.0	59.8	--	3.85	4.26	--	1.38	1.40	--
120	61.9	67.3	73.0	56.6	57.7	55.4	3.81	4.08	4.20	1.23	1.31	1.12
160	56.2	58.9	--	54.1	56.2	--	4.28	4.32	--	1.20	1.25	--

2002-2003 N	Yield A	Yield B	Yield C	Test wt A	Test wt B	Test wt C	Straw yield A	Straw yield B	Straw yield C	1000-kernel wt A	1000-kernel wt B	1000-kernel wt C
lbs/acre		bu/acre			lbs/bu			---t/acre---			---oz---	
0	37.7	42.1		58.5	58.9	59.2	2.11	1.80	2.43	1.51	1.54	1.37
40	62.4	64.6	--	58.9	59.3	--	3.41	2.66	--	1.50	1.52	--
80	81.8	72.9	--	59.2	59.7	--	4.35	3.14	--	1.36	1.46	--
120	74.5	81.7		57.0	58.5	58.9	5.06	5.09	5.65	1.23	1.23	1.48
160	82.1	86.2	--	55.4	57.8	--	6.13	4.34	--	1.02	1.18	--

Means of four replications