

Crop Losses Due to Weeds in Canada¹

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Abstract. Concerns about the effect of pesticides on our environment has stimulated questions about the direction of future research in weed science. Knowledge of crop losses due to weeds would be helpful in guiding research objectives by identifying areas of greatest need. A survey was conducted in 1991 to estimate losses due to weeds in 58 commodities in Canada. Data generated included: percent loss in production, quantity loss in production, and loss of production value (monetary value) for each commodity in each province. The estimated average annual losses caused by weeds in the 58 commodities were \$984 million, with losses of \$372 million in Eastern Canada and \$612 million in Western Canada. In Eastern Canada, approximately 50% of the total loss occurred in hay crops and 33% in field crops, whereas in Western Canada, 84% of the total loss occurred in field crops. Loss of potential production due to weeds for each commodity is shown by province.

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INTRODUCTION

Public concerns about pesticide effects on our environment and food quality have stimulated questions about the need for pesticides in our agricultural systems. This concern has led to serious review of various aspects of current production systems in agriculture, and has led to the development of the concept of sustainable agriculture. Sustainability includes concerns about long-term environmental consequences with the use of herbicides as well as exploring other weed control practices.

Government policies directed through Agriculture Canada, have clearly stated that environmental sustainability will be a major goal of Canada's agriculture and food industries. At a provincial government level, the Ontario Ministry of Agriculture and Food announced in January 1988 a major research initiative entitled Food Systems 2002. The goal of this initiative was to achieve a 50% reduction in the total amount of pesticides applied into the environment by the year 2002 through research, education, and infrastructure (i.e. personnel).

In spite of a multitude of control options, weeds still cause major losses in crop production. Documenting monetary losses and reduction in crop yield due to weeds would supply a useful knowledge base. This knowledge could be used to direct research goals in the

area of integrated weed management strategies and various weed-control methods by identifying areas of greatest need and greatest potential monetary return.

For example, administrators at all levels of government could use weed-loss estimates to seek and direct funds when appropriate toward research on weeds that cause greatest losses. Reliable weed-loss data would provide a basis for provincial staffs to direct research and extension activities toward those crops for which the greatest gains would be expected. Finally, weed-loss information would aid in developing a cost/benefit rationale for enhancing food production through weed research.

The Weed Science Society of America requested the Monetary Weed Losses Committee to estimate the crop losses due to weeds, updating a previous survey published by the Weed Science Society of America in 1984. This current report summarizes the data from a survey designed to estimate the yield and monetary losses due to weeds in agronomic and horticultural crops grown in Canada.

PROCEDURES FOR COLLECTION OF DATA AND COMPUTATION OF LOSSES

A survey was conducted during 1991 of 58 commodities grown in Canada to obtain the crop loss data. The crops evaluated are listed in Table 1. Some commodities comprised mixtures of species, such as berries and grapes (*Vitis* sp.), forage grass, fruit trees, hay, miscellaneous vegetables, and mixed grains.

In each province, extension and research weed scientists estimated the percentage yield reductions that oc-

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Table 1. Crops evaluated for losses due to weeds in Canada.

Crop	Scientific name
Field crops	
Alfalfa (seed)	<i>Medicago sativa</i> L.
Barley	<i>Hordeum vulgare</i> L.
Bean (dry)	<i>Phaseolus vulgaris</i> L.
Buckwheat	<i>Fagopyrum esculentum</i> Moench.
Canaryseed	<i>Phalaris canariensis</i> L.
Canola	<i>Brassica napus</i> L. & <i>B. campestris</i> L.
Corn	<i>Zea mays</i> L.
Faba bean	<i>Vicia faba</i> L.
Flax	<i>Linum usitatissimum</i> L.
Lentil	<i>Lens culinaris</i> Medic.
Mustard	<i>Brassica alba</i> Rabenh.
Oat	<i>Avena sativa</i> L.
Pea (dry)	<i>Pisum arvense</i> L.
Rye	<i>Secale cereale</i> L.
Soybean	<i>Glycine max</i> (L.) Merr.
Sunflower	<i>Helianthus annuus</i> L.
Triticale	<i>Triticum X Secale</i>
Wheat	<i>Triticum aestivum</i> L.
Fruits and vegetables	
Asparagus	<i>Asparagus officinalis</i> L.
Bean (lima)	<i>Phaseolus lunatus</i> L.
Beet	<i>Beta vulgaris</i> L.
Blueberry	<i>Vaccinium angustifolium</i> L.
Broccoli	<i>Brassica oleracea</i> L. var. <i>botrytis</i>
Brussel sprout	<i>Brassica oleracea</i> L. var. <i>gemmifera</i> DC.
Cabbage	<i>Brassica oleracea</i> L. var. <i>capitata</i> L.
Carrot	<i>Daucus carota</i> L.
Cauliflower	<i>Brassica oleracea</i> L. var. <i>botrytis</i> L. subvar. <i>cauliflora</i> DC.
Celery	<i>Apium graveolens</i> L. var. <i>dulce</i> Pers.
Cranberry	<i>Vaccinium macrocarpon</i> Ait.
Cucumber	<i>Cucumis sativus</i> L.
Lettuce	<i>Lactuca sativa</i> L.
Onion	<i>Allium cepa</i> L.
Parsnip	<i>Pastinaca sativa</i> L.
Pepper	<i>Capsicum frutescens</i> L.
Potato	<i>Solanum tuberosum</i> L.
Pumpkin	<i>Cucurbita pepo</i> L.
Radish	<i>Raphanus sativus</i> L.
Raspberry	<i>Rubus idaeus</i> L. var. <i>strigosus</i> Mischx. × <i>occidentalis</i> L.
Rutabaga	<i>Brassica napobrassica</i> Mill.
Squash	<i>Cucurbita maxima</i> Duch.
Spinach	<i>Spinacia oleracea</i> L.
Strawberry	<i>Fragaria × ananassa</i> Duch.
Sugarbeet	<i>Beta vulgaris</i> L.
Tobacco	<i>Nicotiana tabacum</i> L.
Tomato	<i>Lycopersicon esculentum</i> Mill.

Table 2. Estimated average annual losses due to weeds by commodity group in Eastern and Western Canada.

Region	Average annual monetary losses
	\$ × 1000
Eastern Canada	
Hay (tame)	186 040
Field crops	123 919
Fruits and vegetables	62 277
Eastern Canada total	372 236
Western Canada	
Hay (tame)	70 967
Field crops	515 908
Fruits and vegetables	20 717
Fruit trees	4 567
Western Canada total	612 159
Canada total	984 395

ducer fields in which mixed populations of economically important weeds existed.

The survey generated three data categories: percent loss in production, quantity loss in production, and loss of production value for each commodity. Estimated percent loss in production obtained from respondents was averaged from each province and multiplied by the total production for each commodity to obtain quantity loss. The loss in commodity value (monetary loss) was computed as the product of estimated quantity loss times average commodity price. The commodity data (based on English unit of produce⁴) and average farm price used in these calculations were obtained from provincial or federal statistics reports.

Calculation of potential production loss for each commodity within a province was based on average production data for five years in Eastern Canada and for

Table 3. Estimated average annual losses due to weeds by province in Canada.

Province	Average annual monetary losses
	\$ × 1000
Eastern Canada	
Newfoundland	446
Prince Edward Island	21 413
Nova Scotia	7 795
New Brunswick	18 040
Quebec	165 012
Ontario	159 530
Western Canada	
Manitoba	130 318
Saskatchewan	286 957
Alberta	155 103
British Columbia	39 781

curred from weeds competing with commodities based on best management practices. Estimates were extrapolated from weed-crop competition studies, comparative observations between weed-check plots and herbicide-control plots, and numerous observations made in pro-

⁴The data are expressed in English units of produce to coincide with a survey estimating crop losses due to weeds in the United States, published by Weed Science Society of America in 1992.

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Table 4. Estimated average annual losses due to weeds in Newfoundland (Eastern Canada), 1985-1989.

Commodity	Production unit	Loss from production		
		Reduction %	Quantity unit × 1000	Value \$ × 1000
Fruits and vegetables				
Cabbage	lb	15	724	136
Carrot	lb	10	121	31
Potato	cwt	5	4	55
Rutabaga	lb	15	1 239	224

two to five years in Western Canada between 1985 and 1989. A range of several years was considered because weed competition varies from year to year as a result of prevailing environment.

The survey results from provinces were grouped into two regions: Eastern (Newfoundland, Prince Edward Island, Nova Scotia, New Brunswick, Quebec, and Ontario) and Western Canada (Manitoba, Saskatchewan, Alberta, and British Columbia).

RESULTS AND DISCUSSION

In Canada, the estimated average annual losses caused by weeds in the 58 commodities considered were \$984 million (Table 2), with losses of \$372 mil-

Table 5. Estimated average annual losses due to weeds in Prince Edward Island (Eastern Canada), 1985-1989.

Commodity	Production unit	Loss from production		
		Reduction %	Quantity unit × 1000	Value \$ × 1000
Hay (tame)	ton	25	108	5 643
Field crops				
Barley	bu	15	705	1 876
Mixed grain	bu	15	718	1 489
Oat	bu	15	294	537
Wheat	bu	15	114	442
Fruits and vegetables				
Beet	lb	25	177	13
Blueberry	lb	15	160	81
Cabbage	lb	15	616	60
Carrot	lb	10	675	77
Cauliflower	lb	15	48	17
Corn (sweet)	lb	15	49	13
Cucumber	lb	15	52	10
Lettuce	lb	10	32	14
Parsnip	lb	10	35	12
Potato	cwt	10	1 582	10 351
Rutabaga	lb	20	2 435	188
Strawberry	qt	15	239	242
Tobacco	lb	3	185	348

Table 6. Estimated average annual losses due to weeds in Nova Scotia (Eastern Canada), 1985-1989.

Commodity	Production unit	Loss from production		
		Reduction %	Quantity unit × 1000	Value \$ × 1000
Hay (tame)	ton	15	65	3 692
Field crops				
Barley	bu	5	36	107
Oat	bu	20	237	478
Wheat	bu	5	20	97
Fruits and vegetables				
Beet	lb	10	249	24
Blueberry	lb	10	1 978	959
Cabbage	lb	10	1 429	155
Carrot	lb	10	5 921	237
Cauliflower	lb	10	167	56
Corn (sweet)	lb	15	532	104
Cranberry	lb	25	157	111
Cucumber	lb	15	181	36
Lettuce	lb	8	69	23
Parsnip	lb	10	48	16
Potato	cwt	5	43	297
Rutabaga	lb	20	2 503	331
Strawberry	qt	20	1 602	959
Raspberry	qt	5	6	8
Tobacco	lb	5	56	105

lion in Eastern Canada and \$612 million in Western Canada. In Eastern Canada, approximately 50% of the total loss occurred in hay crops, 33% in field crops, and 17% in fruit and vegetable crops, while in Western Canada, 84% of the total loss occurred in field crops,

Table 7. Estimated average annual losses due to weeds in New Brunswick (Eastern Canada), 1985-1989.

Commodity	Production unit	Loss from production		
		Reduction %	Quantity unit × 1000	Value \$ × 1000
Hay (tame)	ton	25	138	7 217
Field crops				
Barley	bu	15	281	749
Oat	bu	15	323	615
Wheat	bu	15	85	299
Fruits and vegetables				
Beet	lb	25	90	23
Blueberry	lb	15	1 189	596
Cabbage	lb	15	911	103
Carrot	lb	10	738	33
Cauliflower	lb	15	601	151
Corn (sweet)	lb	15	393	109
Cucumber	lb	20	214	51
Lettuce	lb	15	50	20
Potato	cwt	10	1 218	7 225
Rutabaga	lb	25	1 973	212
Strawberry	qt	20	556	601
Tobacco	lb	3	18	34

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Table 8. Estimated average annual losses due to weeds in Quebec (Eastern Canada), 1985-1989.

Commodity	Production unit	Loss from production		
		Reduction	Quantity	Value
		%	unit × 1000	\$ × 1000
Hay (tame)	ton	20	1 666	116 697
Field crops				
Barley	bu	8	1 947	5 157
Corn (grain)	bu	9	6 505	16 188
Oat	bu	10	1 424	4 208
Wheat	bu	8	686	2 205
Fruits and vegetables				
Asparagus	lb	8	92	97
Bean (fresh)	lb	9	551	209
Bean (process)	lb	8	3 562	345
Beet	lb	5	974	69
Blueberry	lb	15	2 140	1 172
Cabbage	lb	9	13 270	1 194
Carrot (process)	lb	15	33 815	2 811
Cauliflower	lb	9	2 172	495
Celery	lb	5	1 444	235
Corn (sweet fresh)	lb	5	3 063	491
Corn (sweet process)	lb	5	5 489	218
Cucumber (fresh)	lb	11	2 047	332
Cucumber (process)	lb	9	2 221	205
Lettuce	lb	15	11 015	2 229
Onion (dry)	lb	15	11 075	984
Pea (process)	lb	4	1 181	203
Pepper	lb	5	574	150
Potato	cwt	8	617	4 192
Radish	lb	1	38	11
Raspberry	qt	13	310	602
Rutabaga	lb	13	6 363	575
Strawberry	qt	18	3 753	3 035
Spinach	lb	1	22	6
Tobacco	lb	0.5	60	113
Tomato (fresh)	lb	8	2 452	557
Tomato (process)	lb	5	553	30

12% in hay crops, 3% in fruits and vegetables, and 1% in fruit trees (Table 2).

Eastern Canada. The estimated annual monetary losses by province in Eastern Canada are shown in Table 3. Approximately 44% of the total loss in Eastern Canada occurred in Quebec, 43% in Ontario, 11% in New Brunswick and Prince Edward Island, and 2% in Nova Scotia and Newfoundland.

The estimated loss from potential production for each commodity by percent reduction, commodity quantity, and commodity value is listed by province in Tables 4 to 9. The commodities are listed alphabetically within one of three commodity groups: hay, field crops, or fruits and vegetables. Using barley (*Hordeum vulgare* L.) in Ontario as an example (Table 9), weeds reduced barley yields by 7%, quantity by 2.4 million bushels, and value by \$5.6 million. Within a province, the commodity with the highest percent reduction in

Table 9. Estimated average annual losses due to weeds in Ontario (Eastern Canada), 1985-1989.

Commodity	Production unit	Loss from production		
		Reduction	Quantity	Value
		%	unit × 1000	\$ × 1000
Hay (tame)	ton	10	887	52 791
Field crops				
Barley	bu	7	2 367	5 571
Bean (dry)	cwt	6	116	2 281
Buckwheat	bu	5	15	56
Canola	bu	5	99	562
Corn (grain)	bu	5	9 936	27 846
Corn (silage)	ton	5	297	6 394
Flax (seed)	bu	5	6	31
Mixed grain	bu	7	2 477	4 764
Oat	bu	7	1 303	2 424
Rye	bu	5	99	250
Soybean	bu	10	4 502	31 844
Wheat (spring)	bu	7	232	797
Wheat (winter)	bu	5	1 737	6 653
Fruits and vegetables				
Asparagus	lb	7	415	400
Bean (fresh)	lb	4	476	178
Bean (process)	lb	4	918	103
Bean (lima)	lb	4	77	19
Beet (bunching)	lb	10	213	95
Beet (topped)	lb	10	1 350	92
Broccoli	lb	4	740	267
Brussel sprout	lb	4	44	20
Cabbage	lb	4	4 256	448
Carrot (bunching)	lb	7	186	58
Carrot (topped)	lb	7	20 473	1 086
Cauliflower	lb	4	2 489	544
Celery	lb	3	1 349	135
Corn (sweet fresh)	lb	5	3 924	977
Corn (sweet process)	lb	5	19 401	697
Cucumber (fresh)	lb	10	1 627	326
Cucumber (process)	lb	10	7 593	780
Lettuce	lb	3	765	158
Onion (bunching)	lb	5	362	179
Onion (dry)	lb	5	9 980	972
Parsnip	lb	6	235	41
Pea (process)	lb	3	1 697	284
Pepper	lb	5	2 064	425
Potato	lb	6	346	2 795
Pumpkin and squash				
(process)	lb	5	1 578	30
Radish	lb	2	107	34
Raspberry	qt	3	50	103
Rutabaga	lb	4	3 802	250
Spinach	lb	2	78	22
Strawberry	qt	8	1 724	1 381
Tobacco (flue)	lb	0.1	13 754	246
Tobacco (dark)	lb	0.1	207	3
Tomato (fresh)	lb	4	4 367	935
Tomato (process)	lb	5	57 211	3 181

production did not always have the greatest loss in value. For example, in Nova Scotia, weeds reduced cranberry (*Vaccinium macrocarpon* Ait.) yields by 25% and value by \$0.1 million, whereas weeds reduced hay production by 15%, which resulted in a value loss of

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Table 10. Estimated percent yield reduction averaged over provinces and value loss totaled over provinces by commodity for Eastern Canada.

Commodity	Loss of production	
	Reduction	Value
	%	\$ × 1000
Hay (tame)	19	186 040
Field crops		
Barley	10	13 460
Bean (dry)	6	2 281
Buckwheat	5	56
Canola	5	562
Corn (grain)	7	44 034
Corn (silage)	5	6 394
Flax (seed)	5	31
Mixed Grain	11	6 253
Oat	13	8 262
Rye	5	250
Soybean	10	31 844
Wheat	10	10 493
Fruits and vegetables		
Asparagus	8	497
Bean	7	835
Bean (lima)	4	19
Beet	15	316
Blueberry	14	2 808
Broccoli	4	267
Brussel sprout	4	20
Cabbage	11	2 096
Carrot	10	4 333
Cauliflower	11	1 263
Celery	4	370
Corn (sweet)	11	2 437
Cranberry	25	111
Cucumber	14	1 740
Lettuce	10	2 444
Onion (dry)	10	2 135
Parsnip	9	69
Pea (process)	4	487
Pepper	5	575
Potato	7	24 915
Pumpkin and squash	5	30
Radish	2	45
Raspberry	7	713
Rutabaga	16	1 780
Spinach	2	28
Strawberry	16	6 218
Tobacco	2	849
Tomato	6	4 703

\$3.7 million (Table 6). This difference in value loss reflects the quantity of production as well as price for commodity.

The average estimated percent yield loss and the total value loss for each commodity in Eastern Canada are shown in Table 10. For Eastern Canada, cranberry showed 25% loss in yield and hay lost 19% of its productivity due to weeds. Monetarily, hay, corn (*Zea mays* L.) (grain), soybean [*Glycine max* (L.) Merr.], and potato (*Solanum tuberosum* L.) had the greatest loss, \$186, \$44, \$32, and \$25 million, respectively.

Table 11. Estimated average annual losses due to weeds in Manitoba (Western Canada), 1986-1990.

Commodity	Production unit	Loss from production		
		Reduction	Quantity	Value
		%	unit × 1000	\$ × 1000
Hay (tame)	ton	11	152	16 000
Field crops				
Barley	bu	8	6 200	12 487
Bean (dry)	lb	14	3 531	855
Buckwheat	bu	15	129	675
Canaryseed	lb	15	6 195	647
Canola	bu	13	3 065	17 533
Corn (grain)	bu	12	4 280	1 436
Corn (silage)	ton	12	30	670
Faba bean	lb	16	3 322	259
Flax (seed)	bu	16	14 320	13 399
Lentil	lb	25	13 465	11 583
Mixed grain	bu	10	338	579
Mustard	lb	13	3 432	428
Oat	bu	11	2 640	3 764
Pea (dry)	bu	12	429	2 250
Rye	bu	6	262	489
Sunflower	lb	14	17 752	1 805
Wheat	bu	8	12 200	40 836
Fruits and vegetables				
Potato	cwt	8	24 571	3 185
Sugarbeet	ton	10	33 631	1 438

Western Canada. For Western Canada, approximately 47% of the total loss occurred in Saskatchewan, 25% in Alberta, 21% in Manitoba, and 7% in British Columbia (Table 3).

The estimated loss from potential production by percent reduction, commodity quantity, and commodity

Table 12. Estimated average annual losses due to weeds in Saskatchewan (Western Canada), 1985-1989.

Commodity	Production unit	Loss from production		
		Reduction	Quantity	Value
		%	unit × 1000	\$ × 1000
Hay (tame)	ton	11	283	18 507
Field crops				
Barley	bu	8	12 192	26 071
Canaryseed	lb	13	20 719	2 386
Canola	bu	10	6 793	38 756
Faba bean	lb	13	2 022	152
Flax (seed)	bu	11	1 207	7 516
Lentil	lb	14	33 264	578
Mustard	lb	11	28 221	3 467
Oat	bu	11	5 002	7 127
Pea (dry)	bu	13	776	4 014
Rye	bu	7	699	1 374
Sunflower	lb	11	1 199	120
Wheat	bu	10	47 349	170 335
Fruits and vegetables				
Potato	cwt	10	68	554

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Table 13. Estimated average annual losses due to weeds in Alberta (Western Canada), 1988-1989.

Commodity	Production unit	Loss from production		
		Reduction %	Quantity × 1000	Value \$ × 1000
Hay (tame)	ton	3	330	18 000
Field crops				
Alfalfa (seed)	lb	2	108	98
Barley	bu	7	18 612	22 050
Bean (dry)	lb	8	3 064	884
Canaryseed	lb	10	763	110
Canola	bu	10	7 055	22 600
Corn (grain)	bu	4	31	115
Corn (silage)	ton	4	11	290
Flax (seed)	bu	7	85	4 550
Forage grass (seed)	lb	15	4 828	3 862
Lentil	lb	12	571	126
Mixed grain	bu	5	356	500
Mustard	lb	8	4 761	760
Oat	bu	10	10 602	7 800
Pea (dry)	bu	5	190	990
Rye	bu	4	198	280
Sunflower	lb	12	547	130
Triticale	bu	7	12	36
Wheat	bu	10	21 550	69 000
Fruits and vegetables				
Potato	cwt	5	315	2 248
Sugarbeet	ton	4	23	674

Table 15. Estimated percent yield reduction averaged over provinces and value loss totaled over provinces by commodity for Western Canada.

Commodity	Loss of production	
	Reduction %	Value \$ × 1000
Hay (tame)	10	70 967
Field crops		
Alfalfa (seed)	2	98
Barley	8	61 032
Bean (dry)	11	1 739
Buckwheat	15	675
Canaryseed	13	3 143
Canola	11	79 809
Corn (grain)	8	1 551
Corn (silage)	9	2 460
Faba bean	15	411
Flax (seed)	11	25 465
Forage grass (seed)	13	4 102
Lentil	17	18 287
Mixed grain	8	1 116
Mustard	11	4 655
Oat	10	18 999
Pea (dry)	10	7 254
Rye	6	2 178
Sunflower	12	2 055
Triticale	7	36
Wheat	9	280 843
Fruits and vegetables		
Berries and grapes	10	6 172
Misc. vegetables	10	4 824
Potato	8	7 609
Sugarbeet	7	2 112
Fruit trees	10	4 567

value is listed for each province in Western Canada in Tables 11 to 14. The commodities are listed alphabetically within one of four possible commodity groups: hay, field crops, fruits and vegetables, or fruit trees. Table 11 shows that in Manitoba, the commodities with the highest percent loss reduction were lentil (*Lens*

culinaris Medic.) with 25% and faba bean (*Vicia faba* L.) and flax (*Linum usitatissimum* L.) (seed), both with 16% yield loss. Based on loss of value, however, wheat (*Triticum aestivum* L.), canola (*Brassica napus* L.), and flax (seed) had the highest loss, \$40, \$18, and \$13 million, respectively. Similar results occurred in Saskatchewan and Alberta, where the commodities with the highest value loss due to weeds did not have the highest percent loss.

The average estimated yield loss and the total value loss for each commodity in Western Canada are shown in Table 15. Lentil, faba bean, and buckwheat (*Fagopyrum esculentum* Moench.) had the greatest percent yield loss due to weeds, whereas wheat, canola, and barley had the greatest monetary value loss in Western Canada.

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Table 14. Estimated average annual losses due to weeds in British Columbia (Western Canada), 1988-1989.

Commodity	Production unit	Loss from production		
		Reduction %	Quantity × 1000	Value \$ × 1000
Hay (tame)	ton	13	217	18 460
Field crops				
Barley	bu	9	324	424
Canola	bu	10	180	920
Corn (silage)	ton	10	60	1 500
Forage grass (seed)	lb	10	800	240
Mixed grain	bu	8	32	37
Oat	bu	9	308	308
Rye	bu	6	21	35
Wheat	bu	8	310	672
Fruits and vegetables				
Berries and grapes	lb	10	1 002	6 172
Misc. vegetables	lb	10	19 297	4 824
Potato	cwt	9	136	1 622
Fruit trees	lb	10	457	4 567