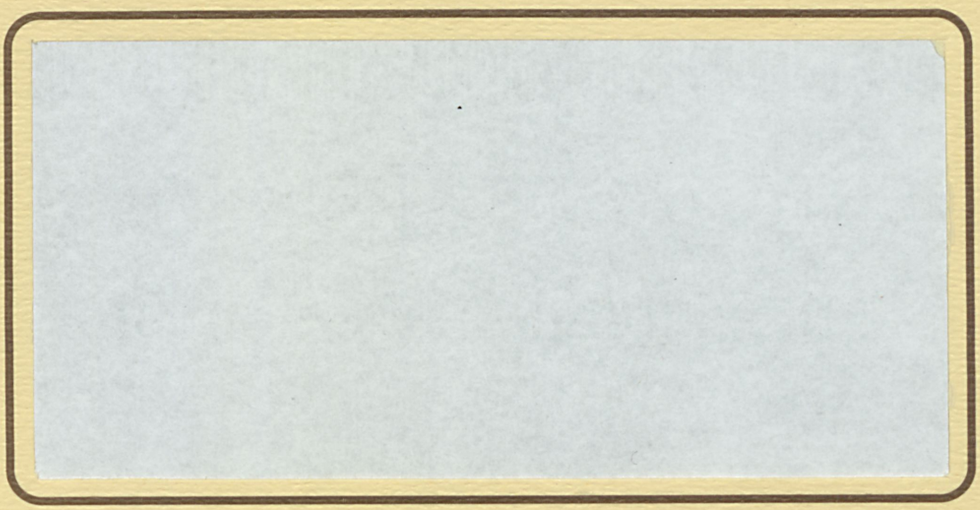
RURAL ECONOMY



PROJECT REPORT

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An Exploration of Potential Benefits from Improved Grades for Wheat on the Northern Prairies

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Executive Summary

The purpose of this research was to establish the extent to which the value of wheat production on the northern prairies could be increased by solving the problem of low grades. The northern prairies are defined in this study by the southern limits of an ecospheric zone known as the Parklands, and by the soil and climatic limits to agriculture on the north. The south boundary of this area runs northwest from just north of Brandon, Manitoba, through Saskatchewan to west of Wetaskiwin, Alberta and includes the British Columbia Peace region.

This study is the first step in establishing the level of investment in northern wheat grades research which could be justified by the likely financial payoff. The study was financed by the Cargill Grain Company in response to a shared initiative begun in 1987 when the Northern Wheat Development Group (NWDG) was founded. This informal group includes representatives of the Western Wheat Growers' Association, Cargill Grain, the Alberta Wheat Pool, Agriculture Canada, Alberta Agriculture, the Universities of Alberta and Saskatchewan, farmers and others interested in the future of wheat as a northern crop. The grades issue was perceived as the main constraint for which a solution would be a precondition to efforts to improve yields, expand area under wheat and invest in improvements to the grain handling and transportation system on the northern prairies.

The objectives of this study were: 1) to estimate the economic value of wheat produced on the northern prairies, 2) to estimate the potential increase in economic value through the improvement of grades, and 3) to estimate the investment in research, development and education expenditure justified by the potential economic gains from resolving the grades problem. The method of this study was to estimate the parameters of the probability density functions for wheat grades and subsequently to simulate the effects of changing these parameters. Sixteen years of data were used for each of the fifteen CWB delivery blocks which make up the northern prairies. Average prices were estimated for each grade for the sixteen year period and applied to the masses of grain to estimate the value of production by grade and year.

The northern prairies are well suited to wheat. The average annual output in this area over the past sixteen years in 1988 dollars was $1.205 billion. However ecospheric limitations to maturing and harvesting in the production and post production systems using current technology lead to "grade loss." Grade loss is interpreted to mean an economic value foregone when otherwise high quality wheat deteriorates during harvest and fails to satisfy grading standards.

The average proportion of CWRS1 wheat on the northern prairies since 1973 was 0.18, ranging from 0.337 in block 23 in the Humboldt/North Battleford axis to 0.019 in block 00 of the British Columbia Peace. The percentage shares of average total value were 16.5 for CWRS1, 28.9 for CWRS2, 39.0 for CWRS3 and 15.6 for Feed. There was considerable variability in these proportions among the blocks. In contrast, year to year variation in value attributable soley to grade as measured by the coefficient of variation was consistently small at only 4 to 5 percent for most blocks.

Four simulations of the potential economic gains from improved grades were carried out. The first simulation estimated the gains from improving the proportions of grain accepted as CWRS1 in each block. The second simulation estimated the effects of developing technologies to prevent the worst years of the past sixteen from recurring. The third simulation estimated the economic gains for each block of a twenty percent improvement in overall performance of the wheat system over twenty years. This simulation was an attempt to recognize that improved grades would likely engender acreage expansion and other improvements. The fourth simulation estimated the changes to the parameters of the grade distributions in each block which would be required to ensure a 60 percent probability of achieving at least the second best annual economic result experienced over the past sixteen years.

The results of the first simulation were gains of $67,858,000, $64,319,000, $44,752,000 and $35,659,000 per year corresponding to the first, second, third and fourth best proportions of CWRS1 wheat. The same simulation based on the four best economic years, instead of the years of best grades, resulted in generally greater potentials of $74,247,000, $63,918,000, $55,567,000 and $45,928,000 respectively. Elimination of the worst year produced little advantage relative to the original average. The annual gain increased to $11,883,000 when the second worst year was also removed and $16,676,000 when the three worst years were removed. The third simulation, using an arbitrary 20 percent target increase in the value of wheat, resulted in an increase of $241,094,000 per year in wheat revenue.

The fourth simulation involved the most interesting target, increasing the probability of good grades. The simulation calculated that the average value of wheat linked solely to grade improvements should increase by $103 million per year to assure a 60 percent probability of obtaining grain revenues corresponding to the second best year since 1973. However, coefficients of variation associated with grades alone would

increase also to 16 to 46 percent from historic values of 3 to 5 percent. The present value of this improvement in average value if realized every year over twenty years discounted at five percent was estimated at $1.279 billion.

These simulation results are presented as if the full value of the annual potentials could be realized immediately. The actual time path of grades improvement would depend on the amount and success of the research, the rate of adoption of results by farmers, and on corresponding adjustments by the grain handling and transportation system. The results could be viewed as guidelines for investment.

No hard and fast rule exists for the correct value of research investment in relation to the anticipated gains. A modest industry rule of thumb of 2.5 percent of gross output was applied to the potential gains from improved grades. The average annual upper limit for investment over twenty years for research, development and education relating only to grades is estimated to range from $158,000 up to $6,027,000 depending on the goals selected.

The results indicated four distinct features of the wheat grades issue. First and foremost, the grades problem has arisen from consistently low grades as opposed to year to year variation. Second, achieving higher proportions of CWRS1 may afford psychological pleasure, but over the sixteen year period studied was not a source of substantial economic value on the northern prairies. Third, greater improvements in economic value lie in attaining the upper end of the distribution of value as opposed to preventing the worst years from reoccurring. Fourth, the principal economic loss takes place when wheat is downgraded from CWRS3 to Feed.

Several matters require further attention before this work could be considered to be complete. The simulations are based on arbitrary norms. A joint exercise is required by producers, scientists and industry to determine appropriate and feasible targets for grades research. Secondly, the data are estimates which have not yet been tested against other data series. Third, a statistical method has to be perfected to address the risk issue associated with the variability that appears to accompany higher grades. And fourth, the consequences of a possible long run narrowing of the price spreads between grades should be examined in light of technological advances in milling and baking and the needs of importing countries. These issues notwithstanding, the analysis has pointed out the importance of the grades issues and raised several broad policy and technical questions.

The complexity of the range of scientific and efficiency issues underlying wheat grades cannot be denied. The range includes production questions of genetic stock, field and water management, and weed and pest control. Post-production questions of harvest mechanization, drying, storage, grading, transportation and processing are also part of the problem of grades. Thus the problem belongs within the domain of systems research involving scientific investigations into the relationships among the individual parts of the problem as well as of the parts themselves. The economic potential arising from the right answers appears to justify a serious effort to learn how to deal with the ecospheric and economic problems. This learning approach underlies the interests and concerns of northern wheat growers and their associates in the grains industry.

In conclusion, the wheat crop is important to the northern prairies, averaging over a billion dollars per year in 1988 dollars. The best economic years constitute a better indicator of the potential revenue gains from better grades than do the years with the highest proportion of CWRS1. The economic potential in grades resides in improving the average grade as opposed to reducing year to year variability. Greater potential lies in aiming for achievements corresponding to the best years than in trying to prevent the worst years from recurring. The pattern of grades received for wheat varies substantially from block to block. Economic potential in grade improvements justifies a significant research commitment.

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1 Introduction

Wheat producers and the grains industry on the northern prairies have been frustrated, since that country was opened up, by grades received using wheat technologies developed for more southern climates. The purpose of this research is to establish the extent to which the value of wheat production could be increased by solving this problem of low grades. Wheat production in the 15 shipping blocks which serve this area averaged an estimated 1.205 billion 1988 dollars per year over the 16 years from 1973-74 through 1988-89 f.o.b. Thunder Bay.

The northern prairies are defined in this study by the southern limits of an ecospheric zone known as the Parklands on the south, and the soil and climatic limits to agriculture in the north. The southern boundary line of this area runs northwest from just north of Brandon, Manitoba, through Saskatchewan, to west of Wetaskiwin, Alberta and includes the British Columbia Peace region (Figure 1).

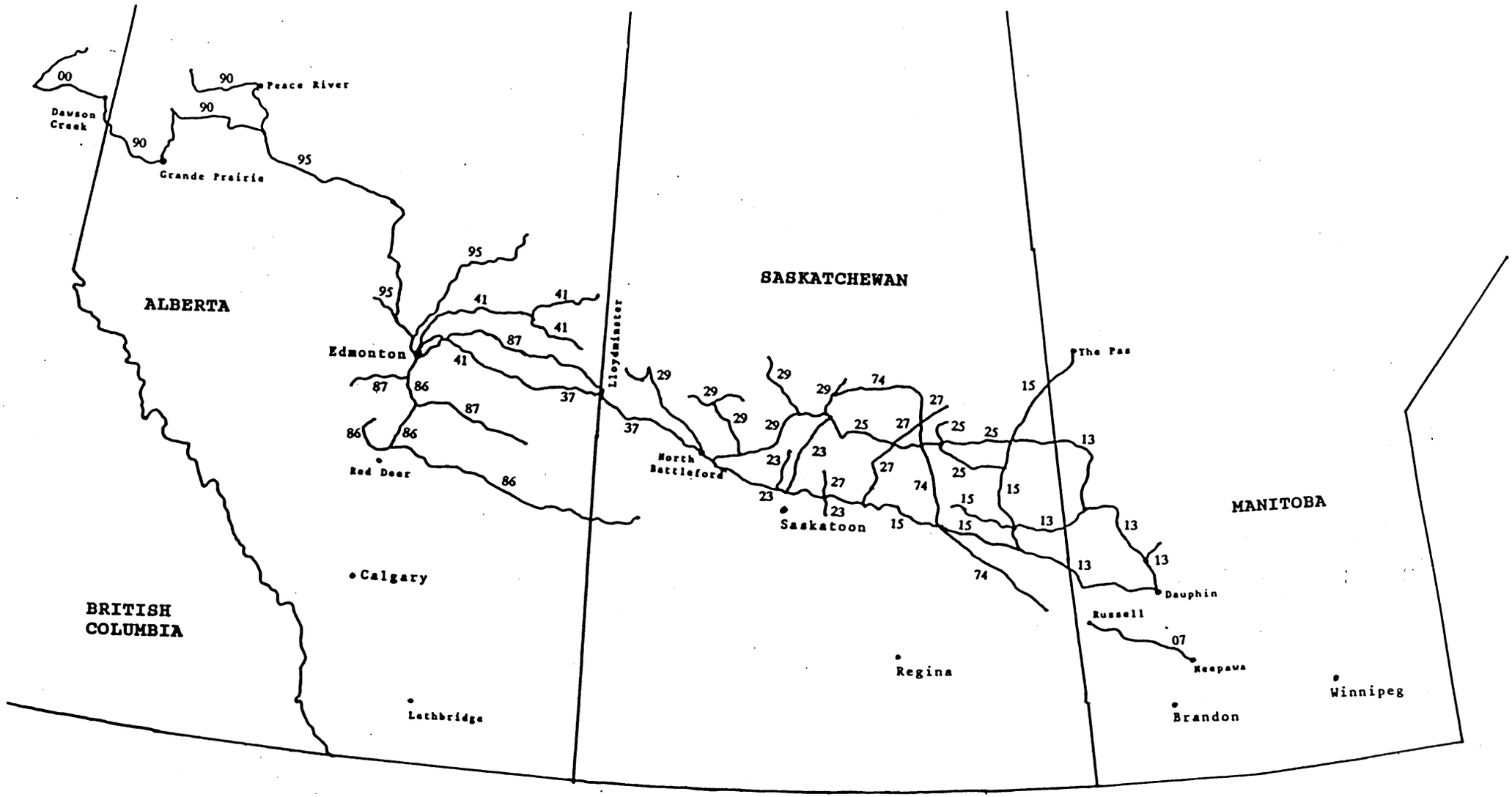
The average proportion of CWRS1 wheat in the fifteen northern CWB shipping blocks during the period studied was 0.18, ranging from 0.337 in block 23 in the Humbolt/North Battleford axis in Saskatchewan to 0.019 in block 00 in the British Columbia Peace. These proportions include adjustments for variations in seeded area and yields. By contrast the proportion of CWRS1 wheat on the prairies as a whole averaged 0.390 over the same time period.

The objectives of this study are:

1. To estimate the economic value of wheat produced on the northern prairies.
2. To estimate the potential increase in economic value through the improvement of grades.
3. To estimate the investment in research, development and education expenditure justified by potential economic gains.

This study is the first step in establishing the level of investment in northern wheat grades research which could be justified by the likely payoff. The study is financed by Cargill Grain Company in response to a shared initiative begun in 1987 when the Northern Wheat Development Group (NWDG) was founded. This informal group includes representatives of the Western Wheat Growers' Association, Cargill Grain, the Alberta Wheat Pool, Agriculture Canada, Alberta Agriculture, the Universities of Alberta and Saskatchewan, farmers and others interested in the future of wheat as a northern crop. The grades issue was perceived as the main constraint for which a solution would be a precondition to efforts to improve yields, expand area under wheat and invest in improvements to the grain handling and transportation system on the northern prairies.

Figure 1: Location of CWB train runs, labelled by shipping block number only, considered in analysis of wheat grade profiles on the northern Prairies.



Source: Canadian Wheat Board. Grain Matters. July 1984.
Energy, Mines and Resources Canada. National Atlas of Canada. Macmillan Company of Canada Ltd.: Toronto. 1974. pp.205-6.

2 The Concept

The northern prairies are well suited to wheat. However ecospheric limitations to maturing and harvesting in the production and post production systems using current technology lead to "grade loss." Grade loss is interpreted to mean an economic value foregone when otherwise high quality wheat deteriorates during harvest and fails to satisfy grading standards. Dry warm weather and longer frost free harvest seasons preempt this deterioration. Historically the principal approach by researchers to this problem has been to seek early maturing varieties, while more recently other avenues such as sprouting resistance have been explored. Over the years farmers have used many other techniques to promote early maturation and to reduce weathering loss.

Grade loss could be defined as the difference between the best and the worst year measured in economic terms using average prices corrected for inflation. The average grade loss per year defined this way over all blocks was $169 million 1988 dollars over the sixteen year period of the study. The question at hand is one of finding human-made technology to substitute for nature-made maturing conditions.

3 Method

The method involves estimating the parameters of the probability density functions for wheat grades and subsequently simulating the effects of changing these parameters. The area of northern wheat production was defined on agroclimatic grounds and the corresponding CWB shipping blocks were identified from a map as those with the majority of shipping points within the study area. Sixteen years of data for each block were used to estimate the means and standard deviations of the mass of grain of each grade in each block. Average prices were estimated for each grade for the sixteen year period and applied to the masses of grain to estimate the value of production by grade and year. These values were summed and averaged to provide the estimate of the average value of grain production on the northern prairies to satisfy the first objective of this study. All values were measured in terms of 1988 dollars.

Four simulations of the potential economic gains from improved grades were carried out. The first simulation estimated the gains from improving the proportions of grain accepted as CWRS1 in each block. The second simulation estimated the effects of developing technologies to prevent the worst years of the past sixteen from recurring. The third simulation estimated the economic gains for each block of a twenty percent improvement in overall performance of the wheat system over twenty years. This simulation was an attempt to recognize that improved grades would likely engender acreage expansion and other improvements. The fourth

simulation was the most complex, estimating the changes to the parameters of the grade distributions in each block to ensure a 60 percent probability of achieving at least the second best annual economic result experienced over the past sixteen years. Each of these simulations is described in more detail later in this report.

The third objective of this work was to estimate the justifiable investments corresponding to the simulated potentials. The method employed to meet this objective was based on the assumption that the simulated gains would be realized over a period of twenty years. The gains were distributed arbitrarily over this period in the absence of any basis for predicting whether the necessary research would be fruitful, how long it would take for new technology to be adopted by farmers and whether the full potential would be attained or even exceeded. The annual benefits estimated according to these various assumptions were discounted and summed to give the present 1988 value of the twenty years of improvements. Costs of implementing improvements by farmers could not be estimated, nor could the effects of such improvements on farm structure be estimated and so are not taken into account. The estimates of gross benefits are interpreted to be a measure of the investment in research, education and communications which could be entailed if grade problems would indeed be resolved to the extent of the simulations. Additional economic and social benefits in the wider economy were not taken into account.

4 Statistical Analysis of the Grades

Let w_{ij} be the tonnes of wheat estimated to be deliverable in a CWB delivery block, where $i \rightarrow (1 - t)$ years and $j \rightarrow (1 - g)$ grades. Thus w_{ij} are cells of a $t \times g$ matrix (Appendix, Table 1). Each w_{ij} contains two principal sources of variability, one due to factors influencing grade and the second due to year to year changes in yield and seeded area. Only grade related variability is the subject of this study. Therefore the data is adjusted to remove the second source of variability. The tonnages w_{ij} are multiplied by the adjustment factor h to standardize yield and area seeded. Let u_{ij} be the adjusted w_{ij} tonnage corresponding to an average yield and area in wheat over the time period t for any block (Appendix, Table 2).

$$u_{ij} = h w_{ij}$$

where

$$h = \left[\sum_{i=1}^{t} \sum_{j=1}^{g} w_{ij} \cdot t^{-1} \right] \left[\sum_{j=1}^{g} w_{ij} \right]^{-1}$$

For a given year t', $r_{t'j}$ is the proportion of the estimated total deliverable quantity of wheat for the jth grade (Appendix, Table 3).

$$r_{t'j} = u_{t'j}\left(\sum_{j=1}^{g} u_{t'j}\right)^{-1}$$

where

$$\left(\sum_{j=1}^{g} u_{t'j}\right)^{-1}$$

is a constant for all years for a given block. This constant is different for each block.

$$\sum_{j=1}^{g} r_{t'j} = 1.$$

For any delivery block the average or expected proportion of the estimated total deliverable quantity of wheat is $\bar{r}_j$.

$$\bar{r}_j = \sum_{i=1}^{t} u_{ij}\left(\sum_{j=1}^{g} u_{ij}\right)^{-1} \cdot t^{-1}$$

This average proportion may be interpreted as the usual experience of farmers within a delivery block in achieving the jth grade. It is assumed that the estimates of deliverable wheat by grade accord well over time with actual experience.

The realization of each grade varies over time. Thus with each average proportion of wheat of a particular grade expected to be delivered, there is an associated variance represented by $\sigma^2 r_{j'}$. The variance may be estimated based on the proportions r_{ij}. The variance for each grade proportion is calculated around the expected proportion of wheat for that grade over time.

$$\sigma^2 r_{j'} = \sum_{i=1}^{t} (r_{ij'} - \bar{r}_{j'})^2 \cdot (t-1)^{-1}$$

where

$$\bar{r}_{j'} = \sum_{i=1}^{t} r_{ij'} \cdot t^{-1}$$

The adjusted tonnages u_{ig} for each grade within a delivery block could be represented by a continuous normal distribution. The average proportions of deliverable wheat adjusted for yield and area changes are converted into comparable economic terms using the constant dollar price series for each grade. Let v_{ij} be the value of adjusted deliverable wheat in any CWB block where $v_{ij} = p_{ij} \cdot u_{ij}$ for each ith year and jth grade. Thus $\sum_{j=1}^{g} v_{ij}$ is the estimated value of deliverable wheat adjusted for yield and area in any year i. Similarly $\sum_{j=1}^{g} \bar{v}_j$ is the average annual estimated value of deliverable wheat for any block. This value may be changed by altering $\bar{r}_j$. The variances of v_{ij} for each $j = 1 - g$ are calculated in the same manner as $\sigma^2_{u_{ij}}$ and are reported as standard deviations.

5 Wheat Grades Data

Data for wheat grades were obtained from the Canadian Wheat Board Planning and Co-ordination Division. Unpublished estimates of deliverable supply by grade were used in the absence of data for all wheat produced. Elevator managers prepared these estimates in September of each year based on conditions observed within their grainshed, which consists of a relatively stable area around their delivery point. Within each shipping block are one or more train runs along which there are several delivery points (Figure 1).

These estimates were collated and reviewed by CWB staff. It was assumed that there was no bias in the estimates, so that errors may be considered randomly distributed about a zero mean for each block. The estimates for sixteen years from 1973 through 1988 covered all wheat including that which does not move through the elevator system. Consequently the proportions for each grade included wheat which may have been fed or used for seed, and therefore will differ from the values recorded by the handling system.

6 Wheat Prices

Questions always arise over the selection of price series, the f.o.b. point, the base and the weights to be used for averaging over the crop year. The northern character of the problem suggests that account be taken of freight rates in the price series. However, for each block the price differentials across grades are independent of the price basis, and only in cases of comparisons among blocks would the freight rate issue arise. As the simulations would not involve direct comparisons among blocks a single price series excluding transportation considerations is suitable for the value estimations. The price series consists of the total CWB price, basis instore Thunder Bay or Vancouver, for CWRS 1, 2 and 3, and the average cash price for Feed wheat, basis instore Thunder Bay (Table 1).

Table 1: Nominal prices per tonne for CWRS 1, 2 and 3, and Feed grades for the period 1973-74 - 1988-89.

year	CWRS 1[a]	CWRS 2[b]	CWRS 3	Feed[c]
1973-74	168.21	165.38	160.68	[d]155.79
1974-75	164.39	158.22	156.60	[e]130.35
1975-76	146.28	141.43	132.79	131.31
1976-77	117.15	109.90	104.35	103.80
1977-78	120.30	113.81	107.17	93.18
1978-79	160.53	151.80	150.11	110.18
1979-80	196.43	187.64	179.18	134.70
1980-81	222.12	217.96	209.42	167.86
1981-82	199.62	197.03	187.76	146.17
1982-83	192.34	187.39	180.39	132.30
1983-84	193.98	190.23	178.56	164.46
1984-85	186.37	184.11	171.51	158.68
1985-86	160.00	154.21	146.21	119.18
1986-87	130.00	124.21	110.21	90.26
1987-88	134.02	127.87	115.78	102.06
1988-89	[f]160.00	[f]154.21	[f]140.21	[f]103.73

a - does not include CWRS 1, 13.5.
b - does not include CWRS 2, 13.5.
c - cash price, basis instore Thunder Bay.
d - estimated using the initial price for 3CU ($3.46/bus) and the final payment on CWRS3 ($0.78/bus).
e - wheat quotes began on the WCE August 1974.
f - estimated using the 1988-89 initial price and the average final payment from 1987-88 ($10.00/bus).
Source: Canada Grains Council.

Cash quotes for Feed wheat on the Winnipeg Commodity Exchange did not begin until August 1974. For the 1973-74 crop year the price was estimated using the initial price for 3CU and the final price for CWRS3. The final price for all four grades for the 1988-89 crop year was estimated using the 1988-89 initial price plus the average final payment from 1987-88.

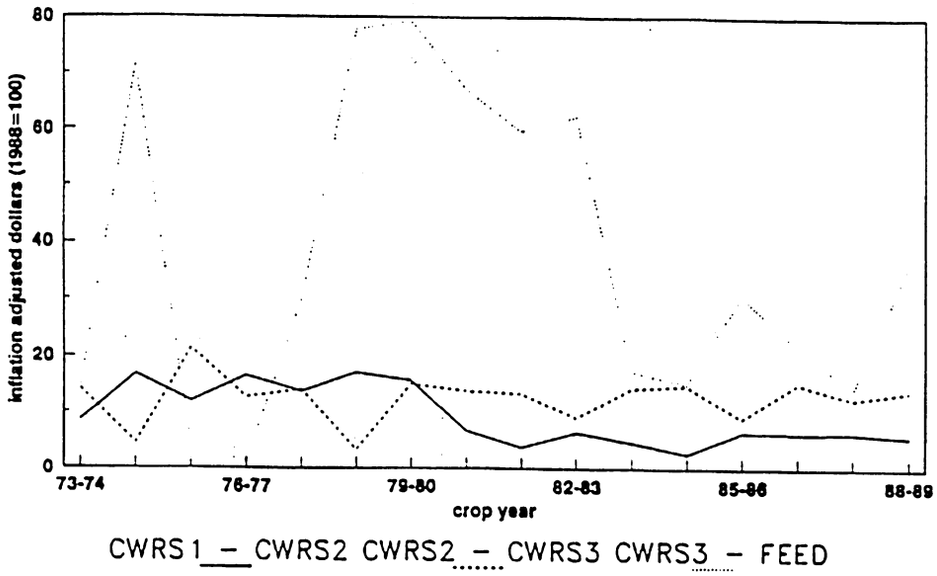
Table 2: Prices per tonne adjusted for inflation used in simulations, for CWRS 1, 2 and 3, and Feed grades for the period 1973-74 - 1988-89, with 1988=100.

year	CPI (1988=100)	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	33.1	508.16	499.61	485.42	470.64
1974-75	36.7	447.71	430.91	426.50	355.01
1975-76	40.7	359.57	347.65	326.41	322.78
1976-77	43.7	267.82	251.25	238.56	237.30
1977-78	47.2	254.77	241.03	226.97	197.34
1978-79	51.4	312.37	295.38	292.09	214.40
1979-80	56.1	350.02	334.36	319.28	240.02
1980-81	61.8	359.29	352.56	338.75	271.52
1981-82	69.5	287.05	283.33	270.00	210.19
1982-83	77.1	249.63	243.20	234.12	171.70
1983-84	81.5	238.01	233.41	219.09	201.79
1984-85	85.0	219.13	216.48	201.66	186.58
1985-86	88.5	180.88	174.33	165.29	134.73
1986-87	92.1	141.19	134.90	119.70	98.03
1987-88	96.1	139.45	133.05	120.47	106.20
1988-89	100.0	160.00	154.21	140.21	103.73
unweighted average		279.69	270.35	257.78	220.12
weighted average		259.89	264.74	262.21	226.08

The original nominal price series was adjusted for inflation using the Consumer Price Index (all items) with 1988=100, to make the prices comparable over the sixteen years (Table 2). The effect of using an alternative base year on the ranking procedure in the simulations was not explored. From this series two average prices were computed. The first was a simple, unweighted average or mean real price over the sixteen years. The second was a weighted average real price which was calculated using the annual adjusted mass of grain multiplied by the annual real price divided by the sum of the masses, for each grade. This second average price more adequately reflects the price received by northern wheat producers as a result of historic grade patterns. The situations where high proportions of CWRS1 were realized in the most recent years when the real annual price for this grade has been low resulted in the anomally in Table 2 where the weighted average real price for CWRS1 is lower than that of grades CWRS2 and 3. The results suggest using the average weighted price would bias results against CWRS1, thus the unweighted average real prices were used throughout the simulation process.

The real price spread between the grades is also of interest when considering the impact of improving the proportion of CWRS1 in northern wheat (Figure 2). Linear regression of spreads against time produced

Figure 2: Real price spreads per tonne between CWRS 1 and 2, 2 and 3, and 3 and Feed grades for the period 1973-74 - 1988-89, in 1988 dollars.



evidence that over the sixteen year period the spread between CWRS1 and CWRS2 has had a negative slope in real terms, while the slope of the spread between CWRS2 and CWRS3 is not significantly different from zero. The high variability of the spread between CWRS3 and Feed wheat prevented a real test for the trend.

7 Results: Description of Northern Wheat Output

The average proportions of wheat expected to grade CWRS1, (CWRS1 and CWRS1 13.5 are referred to as CWRS1 for convenience), ranges from 0.019 to 0.337 over the fifteen blocks under study (Table 3). The range for CWRS2 is 0.122 to 0.317 and for CWRS3 0.267 to 0.508. The proportion of Feed wheat ranges from 0.091 to 0.370 over the fifteen blocks. The standard deviations are also reported in Table 3. These means and standard deviations are used to calculate the coefficients of variation reported in Table 4. These values indicate that generally the proportion of CWRS1 is the most variable over time and across the blocks, while the proportion of CWRS3 is the least.

Table 3: Mean and standard deviations of proportions of adjusted estimated deliverable wheat for each of CWRS 1, 2 and 3, and Feed grades in selected CWB blocks for the period 1973-74 - 1988-89.

block	CWRS 1		CWRS 2		CWRS 3		Feed	
	mean	std dev	mean	std dev	mean	std dev	mean	std dev
07	0.180	0.213	0.317	0.157	0.369	0.209	0.133	0.141
13	0.119	0.167	0.293	0.174	0.406	0.195	0.182	0.188
15	0.180	0.206	0.314	0.195	0.322	0.172	0.183	0.201
23	0.337	0.269	0.305	0.174	0.267	0.169	0.091	0.127
25	0.109	0.133	0.274	0.174	0.447	0.191	0.170	0.191
27	0.232	0.248	0.309	0.170	0.330	0.178	0.129	0.178
29	0.157	0.145	0.280	0.162	0.393	0.170	0.170	0.177
37	0.175	0.170	0.315	0.156	0.377	0.182	0.132	0.162
41	0.033	0.048	0.230	0.197	0.475	0.143	0.262	0.217
74	0.180	0.198	0.294	0.194	0.361	0.194	0.165	0.183
86	0.217	0.203	0.275	0.154	0.338	0.152	0.170	0.165
87	0.066	0.093	0.265	0.197	0.435	0.137	0.234	0.203
90	0.041	0.099	0.179	0.187	0.508	0.175	0.273	0.219
95	0.020	0.065	0.122	0.143	0.488	0.215	0.370	0.303
00	0.019	0.024	0.177	0.186	0.499	0.162	0.304	0.219

When considering the values in Tables 3 and 4 one must keep in mind that each block has its own characteristic grade profile. The Peace River blocks 90 and 00, for example, realize relatively low proportions of CWRS1 and CWRS2 compared to the other blocks, yet exhibit relatively high levels of variation. These blocks also have some of the highest proportions of CWRS3 and Feed wheat on the northern prairies with relatively low levels of variation in these proportions compared to the remaining blocks.

Table 4: Coefficients of variation of proportions of adjusted estimated deliverable wheat for each of CWRS 1, 2 and 3, and Feed grades in selected CWB blocks for the period 1973-74 - 1988-89.

block	CWRS 1	CWRS 2	CWRS 3	Feed
07	1.182	0.495	0.567	1.056
13	1.403	0.595	0.480	1.034
15	1.140	0.621	0.534	1.098
23	0.798	0.570	0.631	1.397
25	1.223	0.634	0.428	1.123
27	1.067	0.551	0.540	1.381
29	0.922	0.577	0.434	1.038
37	0.972	0.494	0.483	1.222
41	1.475	0.855	0.301	0.828
74	1.097	0.661	0.539	1.109
86	0.933	0.560	0.450	0.970
87	1.420	0.742	0.315	0.868
90	2.436	1.044	0.344	0.803
95	3.203	1.174	0.441	0.817
00	1.230	1.051	0.324	0.720

When the grades are examined in terms of the economic value of wheat a slightly different picture emerges. For the purpose of illustration two methods of determining this value are presented. Differences in block size means the blocks may no longer be compared, as well the values should be looked at together with the prices and price spreads for the grades (Table 2 and Figure 2). Table 5 shows the mean and standard deviation of the values when *annual* real prices and annual adjusted masses were used. These values form the basis for the weighted average prices calculated in Table 2. Table 6 illustrates the mean and standard deviation of the value of wheat using annual adjusted masses and *average* unweighted real prices. The difference in total values is not great between the two methods, $8 million or less than 1 percentof the total value, however when one compares the coefficients of variation (Table 7) there are definite differences. The coefficients of variation for individual grades using average unweighted prices are the same as for the proportions (Table 4), while those using annual prices are different but of similar magnitude. However, when one looks at the overall coefficients large differences are evident. When annual prices are used the coefficients are about 40 percent, while the use of average prices results in coefficients of about 4 percent. The use of annual prices results in price variability being reflected in grade values which suggests it is inappropriate for use in the simulations, therefore the values in Table 6 will be used as the base values for the remainder of the study.

The total value of wheat produced annually averages $1.205 billion per year, made up of $199 million of CWRS1, $348 million of CWRS2, $470 million of CWRS3 and $189 million of Feed quality wheat. The percentage shares of average total value over the sixteen years for each grade are 16.5, 28.9, 39.0 and 15.6 respectively. For the two Peace River blocks the percentage shares are 4.2, 19.3, 52.1 and 24.4 for each grade respectively. It becomes evident that the grades issue across the north has different specific characteristics in different parts of the region.

Table 5: Mean and standard deviations of values of adjusted estimated deliverable wheat using *annual* real prices for CWRS 1, 2 and 3, and Feed grades in selected CWB blocks for the period 1973-74 - 1988-89, in 1000's 1988 dollars.

block	CWRS 1[a]		CWRS 2[b]		CWRS 3		Feed		Total	
	mean	std dev	mean	std dev	mean	std dev	mean	std dev	mean	std dev
07	6076	6437	12814	8272	14963	11903	4051	4957	37904	14802
13	14455	17624	41571	26651	64389	51366	21243	22958	141658	55935
15	15723	16325	30281	22722	30917	22441	14393	17604	91314	35997
23	37968	31331	34237	25783	28455	21226	8153	13838	108813	42523
25	8717	10292	22185	15267	36847	23489	11564	13076	79312	31666
27	19333	19700	26226	18327	27277	19419	8813	13110	81649	32207
29	17909	15502	31848	22687	42048	24257	15791	18592	107596	42888
37	13234	12113	23162	13282	26606	16716	8982	14519	71984	27963
41	1916	2683	14494	13403	28971	14895	15123	16400	60504	23946
74	21935	22192	38408	31428	46649	33583	17659	21225	124650	49197
86	17825	17369	20886	13826	24127	14500	10692	12407	73530	29231
87	5271	7058	21567	18078	33767	17222	16431	18518	77036	30640
90	3923	11053	16540	15022	50954	23082	26589	29622	98007	38735
95	594	2013	3322	4138	12760	6409	9461	9751	26137	10612
00	412	716	3137	3509	8836	4323	4630	4280	17015	6923
Totals	185,291		340,678		477,566		193,575		1,197,111	

a - CWRS 1 includes CWRS 1, 13.5 and CWRS 1 in crop years 1986-87 - 1988-89.
b - CWRS 2 includes CWRS 2, 13.5 and CWRS 2 in crop years 1986-87 - 1988-89.

Table 6: Mean and standard deviations of values of adjusted estimated deliverable wheat using *average unweighted* real prices for CWRS 1, 2 and 3, and Feed grades in selected CWB blocks for the period 1973-74 - 1988-89, in 1000's 1988 dollars.

block	CWRS 1[a]		CWRS 2[b]		CWRS 3		Feed		Total	
	mean	std dev	mean	std dev	mean	std dev	mean	std dev	mean	std dev
07	7372	8714	12556	6218	13914	7885	4297	4538	38138	1405
13	18490	25938	43987	26159	58079	27875	22192	22944	142748	5994
15	17998	20518	30295	18823	29640	15823	14395	15802	92328	4383
23	38753	30915	33872	19294	28288	17850	8192	11444	109106	3940
25	9475	11585	23093	14651	35829	15345	11646	13082	80043	3321
27	20376	21736	26225	14454	26675	14412	8888	12273	82164	3418
29	18339	16913	31700	18297	42334	18380	15680	16272	108052	4454
37	13539	13166	23622	11657	26953	13017	8080	9873	72193	2662
41	2232	3292	15132	12940	29753	8967	14044	11625	61161	2548
74	24515	26902	38547	25476	45136	24315	17677	19600	125875	5611
86	17244	16087	21102	11808	24692	11101	10593	10274	73631	3091
87	5638	8006	21959	16283	34340	10805	15771	13694	77707	3266
90	4484	10924	19046	19886	51592	17755	23676	19020	98798	4433
95	613	1964	3541	4158	13544	5973	8788	7179	26487	1452
00	369	454	3275	3444	8807	2853	4583	3299	17035	691
Totals	199,437		347,952		469,576		188,503		1,205,468	

a - CWRS 1 includes CWRS 1, 13.5 and CWRS 1 in crop years 1986-87 - 1988-89.
b - CWRS 2 includes CWRS 2, 13.5 and CWRS 2 in crop years 1986-87 - 1988-89.

Table 7: Comparison of coefficients of variation of the values of adjusted estimated deliverable wheat using *annual* and *average unweighted* real prices for CWRS 1, 2 and 3, and Feed grades in selected CWB blocks for the period 1973-74 - 1988-89, in 1000's 1988 dollars.

block	CWRS 1		CWRS 2		CWRS 3		Feed		Overall	
	annual	average	annual	average	annual	average	annual	average	annual	average
07	1.059	1.182	0.645	0.495	0.796	0.567	1.224	1.056	0.391	0.037
13	1.219	1.403	0.641	0.595	0.798	0.480	1.081	1.034	0.395	0.042
15	1.038	1.140	0.750	0.621	0.726	0.534	1.223	1.098	0.394	0.047
23	0.825	0.798	0.753	0.570	0.746	0.631	1.697	1.397	0.391	0.036
25	1.181	1.223	0.688	0.634	0.637	0.428	1.131	1.0123	0.399	0.041
27	1.019	1.067	0.699	0.551	0.712	0.540	1.488	1.381	0.394	0.042
29	0.866	0.922	0.712	0.577	0.577	0.434	1.177	1.038	0.399	0.041
37	0.915	0.972	0.573	0.494	0.628	0.483	1.616	1.222	0.388	0.037
41	1.401	1.475	0.925	0.855	0.514	0.301	1.084	0.828	0.396	0.042
74	1.012	1.097	0.818	0.661	0.720	0.539	1.202	1.109	0.395	0.045
86	0.974	0.933	0.662	0.560	0.601	0.450	1.160	0.970	0.398	0.042
87	1.339	1.420	0.838	0.742	0.510	0.315	1.127	0.868	0.398	0.042
90	2.817	2.436	0.908	1.044	0.453	0.344	1.114	0.803	0.395	0.045
95	3.388	3.203	1.246	1.174	0.502	0.441	1.031	0.817	0.406	0.055
00	1.739	1.230	1.118	1.051	0.489	0.324	0.924	0.720	0.407	0.041

8 Results for the Four Simulations

8.1 The Simulation Procedure

Simulations are used to estimate alternative future situations when one or more key elements require discretionary choice. Consequently the results are normative. The future economic potential from improved wheat grades is based on the recent history of grades. However an arbitrary decision must be made about what is possible to achieve in the future. Conceptually any grade less than the best represents an economic loss to northern farmers. Thus one approach could be to estimate the difference between average historic grades and the best situation in which all hard red spring wheats grade CWRS1. The four simulations reported here each represent alternative norms for the grades which might be achieved if a technological substitute for weather would emerge from research. Thus the norms contain an element of expectation about the likely success of research to correct the grades problem on the northern prairies.

The results are reported as annual potential increases in value expressed in 1988 dollars and based on historic experience over the most recent sixteen year period, 1973-74 to 1988-89. As well, twenty year present values are calculated using a 5 percent discount rate representing long run rates of interest after inflation. Any future additions to the value of wheat would not be as valuable as present amounts and are discounted using standard procedures.

In the reporting of the simulation results calculations are made as if the full value of the annual potentials could be realized immediately. The actual time path of grades improvement would depend on the amount and success of the research, the rate of adoption of results by farmers, and by corresponding adjustments by the grain handling and transportation system.

8.2 Simulation Number One

Table 8: Simulation One: The economic gain associated with achievement over twenty years of the second best historic wheat grade profile in selected CWB blocks on the northern Prairies over the period 1973-74 - 1988-89, in 1000's 1988 dollars.

blk	average grade profile (%)				second best grade profile (%)				average value	simulation average value	average gain
	1	2	3	Fd	1	2	3	Fd			
07	0.180	0.317	0.369	0.133	0.559	0.390	0.051	0.000	38138	40215	2076
13	0.119	0.293	0.406	0.182	0.513	0.286	0.183	0.018	142748	150877	8128
15	0.180	0.314	0.322	0.183	0.384	0.501	0.115	0.001	92328	97192	4864
23	0.337	0.305	0.267	0.091	0.798	0.182	0.021	0.000	109106	113997	4891
25	0.109	0.274	0.447	0.170	0.308	0.590	0.096	0.006	80043	84541	4498
27	0.232	0.309	0.330	0.129	0.580	0.313	0.105	0.001	82164	86071	3906
29	0.157	0.280	0.393	0.170	0.348	0.522	0.120	0.011	108052	113568	5516
37	0.175	0.315	0.377	0.132	0.374	0.536	0.086	0.004	72193	75506	3312
41	0.033	0.230	0.475	0.262	0.089	0.577	0.304	0.030	61161	64637	3476
74	0.180	0.294	0.361	0.165	0.356	0.453	0.185	0.006	125875	131616	5741
86	0.217	0.275	0.338	0.170	0.561	0.335	0.097	0.006	73631	77714	4083
87	0.066	0.265	0.435	0.234	0.248	0.537	0.185	0.030	77707	82309	4601
90	0.041	0.179	0.508	0.273	0.113	0.603	0.267	0.017	98798	105309	6511
95	0.020	0.122	0.488	0.370	0.035	0.393	0.522	0.050	26487	28186	1699
00	0.019	0.177	0.499	0.304	0.053	0.600	0.278	0.070	17035	18050	1016
Totals									1,205,468	1,269,788	64,319

The first simulation estimates the annual potential gains in wheat revenue of realizing higher proportions of CWRS1. The proportion of wheat grading CWRS1 is the measure of quality of the wheat crop used conventionally by farmers and the grain trade. This simulation is based on the first, second, third and fourth best proportions of CWRS1 wheat since 1973. The potential gains are the differences between the value of wheat in these better years using unweighted average prices and the average value of wheat over the sixteen year period expressed in 1988 dollars. The gain is estimated to be $67,858,000, $64,319,000, $44,752,000 and $35,659,000 per year corresponding to the first, second, third and fourth best proportions of CWRS1 wheat. The block estimates corresponding to the second best achievement of CWRS1 are

reported in Table 8. Block 90 in the Alberta Peace would realize the greatest relative gain of 6.6% in grain revenue of all blocks studied. Otherwise the relative gains by obtaining the second best CWRS1 grades in the sixteen year period studied are relatively small at 5.3%.

Simulation One was repeated using the four best years in terms of the economic value of the wheat produced. The results generally are greater economic potential than when the best years are judged according to the proportion of CWRS1. The potentials are $74,247,000, $63,918,000, $55,567,000 and $45,928,000 for the first through fourth best years respectively (Table 12).

The total estimated present values of the gains based on the best proportion of CWRS1, if realized every year over twenty years discounted at 5 percent are $845,663,000, $801,554,000, $557,713,000 and $444,386,000 for the best through fourth best CWRS1 years respectively. The potential gains simulated on the basis of the best economic years are generally higher at $925,287,000, $796,556,000, $692,491,000 and $572,368,000 respectively.

8.3 Simulation Number Two

Table 9: Simulation Two: The economic gains and changes in variation for fifteen shipping blocks on the northern Prairies after eliminating the three worst years of sixteen, in terms of estimated value of wheat output for 1973-74 - 1988-89, in 1000's 1988 dollars.

block	average value of output			coefficients of variation		
	16 yr series	sim 13 best yrs	gain	16 yr series	sim 13 best yrs	difference
07	38138	38571	433	0.037	0.029	0.008
13	142748	144592	1843	0.042	0.034	0.008
15	92328	93750	1422	0.047	0.037	0.010
23	109106	110526	1420	0.036	0.023	0.013
25	80043	81128	1085	0.041	0.031	0.010
27	82164	83367	1203	0.042	0.026	0.016
29	108052	109548	1496	0.041	0.031	0.010
37	72193	73137	944	0.037	0.024	0.013
41	61161	62038	877	0.042	0.029	0.013
74	125875	127694	1818	0.045	0.035	0.010
86	73631	74669	1038	0.042	0.031	0.011
87	77707	78836	1128	0.042	0.030	0.012
90	98798	100121	1323	0.045	0.038	0.007
95	26487	26906	419	0.055	0.047	0.008
00	17035	17260	226	0.041	0.032	0.009
Totals	1,205,468	1,222,143	16,676			

The second simulation addresses the benefits of preventing disastrous years in terms of value of production. The procedure is to reduce the standard deviation around the revised mean and to skew the distribution to simulate reduced risk. One of the grade problems perceived to be facing northern farmers is the year to year variability in grades received. This simulation estimates the economic gain if research could eliminate the possibility of experiencing the worst, second, and third worst years, which were calculated using unweighted average prices and annual adjusted deliverables. The results of removal of the three worst years are contained in Table 9 and are compared to the sixteen year average.

Elimination of the worst year produces little advantage relative to the original average. The gain increases to $11,883,000 when the second worst year is also removed and $16,676,000 when the three worst years are removed. The coefficients of variation declined by a small amount as the worst years were removed. The corresponding total present values of these gains if realized every year over twenty years discounted at 5 percent are $148,091,000 and $207,825,000 respectively.

8.4 Simulation Number Three

Table 10: Simulation Three: The increased values required of selected CWB blocks to achieve an annual twenty percent gain in northern Prairie wheat production, in 1000's 1988 dollars.

block	proportional share of target by block	share of target increase of average value	16 year average value
07	0.032	7634	38138
13	0.118	28529	142748
15	0.076	18390	92328
23	0.091	21915	109106
25	0.066	15973	80043
27	0.068	16444	82164
29	0.090	21670	108052
37	0.060	14497	72193
41	0.051	12185	61161
74	0.104	25104	125875
86	0.061	14809	73631
87	0.064	15515	77707
90	0.082	19738	98798
95	0.022	5264	26486
00	0.014	3427	17035
Totals	1.000	241,094	1,205,468

The third simulation establishes an arbitrary target of a 20 percent increase in the value of wheat, to be achieved over twenty years. Such a target could be attained by higher prices, greater yield, larger areas seeded and/or better grades based on better economic incentives for wheat arising from grade

improvements, other things remaining equal. This 20 percent target relative to the average value of wheat output over the 1973-89 period is an increase of $241,094,000 per year in wheat revenue. This improvement is distributed over the blocks in proportion to their demonstrated potential estimated in terms of their average production over the past sixteen years. The targets for each block are outlined in Table 10. The present value of this target based on the same discount process as used in Simulations One and Two is $3,004,564,000 over 20 years.

8.5 Simulation Number Four

Table 11: Simulation Four: The changes in mean and standard deviation of the real value of wheat in the northern Prairies required to obtain the second best value of the sixteen year 1973-1988 period, 60 percent of the time, in 1000's 1988 dollars.

block	historic mean	required mean	difference	historic std dev	required std dev	difference	historic C.V.	required C.V.
07	38138	41138	3000	1405	19000	17595	0.037	0.462
13	142748	152748	10000	5994	25000	19006	0.042	0.164
15	92328	101328	9000	4383	32000	27617	0.048	0.316
23	109106	119106	10000	3940	37000	23060	0.036	0.311
25	80043	88043	8000	3321	17700	14379	0.042	0.201
27	82164	90164	8000	3418	19700	16282	0.042	0.218
29	108052	118052	10000	4454	35000	30546	0.041	0.296
37	72193	73193	1000	2662	20500	17838	0.037	0.280
41	61161	67161	6000	2548	20700	18152	0.042	0.308
74	125875	137875	12000	5611	43000	37389	0.045	0.312
86	73631	79631	6000	3091	17800	14709	0.042	0.224
87	77707	83707	6000	3266	20000	16734	0.042	0.239
90	98798	108798	10000	4433	31000	26567	0.045	0.285
95	26487	28487	2000	1452	4700	3248	0.056	0.165
00	17035	18635	1600	691	5700	5009	0.041	0.306
Totals	1,205,468	1,308,066	102,600					

The fourth simulation explores the changes required of the distribution of the value of wheat to be able to assure farmers and grain companies of grade performance at least equivalent to that of the second best year since 1973, six times out of ten. Recall that the analysis addresses variation due to grades only. This simulation was obtained by using a standard normal distribution,

$$z = \frac{(c - \mu)}{\sigma}$$

Both μ and σ were varied within arbitrary upper and lower bounds to obtain values of z ranging around 0.60. The effect of the simulation was to describe a normal distribution to the right of the original distribution with a new mean close to the value of the second best year. For the majority of the blocks this simulation involves increasing the variance of the distribution significantly (Table 11).

The result of this simulation is that the average value of wheat produced should increase by $103 million per year through grade improvements to assure a 60 percent probability of obtaining grain revenues corresponding to the second best year since 1973. However, a corresponding increase in standard deviation would also be incurred, increasing the coefficients of variation (column 9) to a range of 16.4 to 46.2 percent from historic sixteen year values of 3.6 to 5.5 percent (column 8). The present value of such an increase if realized every year over twenty years discounted at five percent is $1,278,623,000.

9 Estimates of Research Investment Justified by Grade Improvements

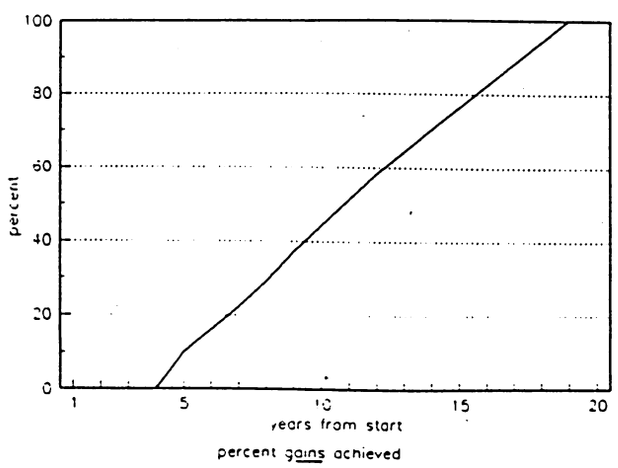
Table 12: Research Investment: Estimated annual value of wheat and present values of twenty years of improvement and budget guidelines for research, development and education pertaining to wheat improvements for the northern Prairies, 1988-89 - 2009-10, in 1000's 1988 dollars.

basis for justification	annual potential	annual budget guidelines based on 2.5% rule	present value of twenty years improvement with development path
SIM ONE			
grade profiles			
first best	67,858	1,696	316,319
second best	64,319	1,608	299,822
third best	44,752	1,119	208,611
fourth best	35,659	891	166,224
average value			
first best	74,247	1,856	346,102
second best	63,918	1,598	297,953
third best	55,567	1,389	259,025
fourth best	45,928	1,148	214,093
SIM TWO			
15 best years	6,338	158	29,544
14 best years	11,883	297	55,393
13 best years	16,676	417	77,735
SIM THREE			
20% target	241,094	6,027	1,123,858
SIM FOUR			
second best			
60% of time	102,598	2,565	478,259

Estimation of research investment justified by economic potential of grain revenues is tempered by the divergence of the paths of investment and its consequent results, and by the probability of success in achieving the results. Present value accounting methods with a positive discount rate reduce the importance of future results thereby also reducing the economic justification for investments. The expected results should also incorporate a subjective probability of success less than 1.0. Such considerations underlie the industrial sector's rule of thumb for research investment of 2.5 percent of the gross value of output.

The estimation of the amounts which could be invested in attacking the problem of low grades are based on the simulated potential gains from reducing the problem. An arbitrary development path was selected anticipating that gains would start to show up in the fifth year following the commencement of a concerted research effort. Maximum potential would be realized by year nineteen (Figure 3). It could be anticipated that the research investment would be concentrated in the first ten years of the twenty year period, with education and communication programs extending over a longer period. A schedule of research is not estimated.

Figure 3: Arbitrary development path used in determining the twenty year present value of potential gains in discussion of research investment justified.



The gains in wheat revenue corresponding to the four simulations are compared in Table 12. The 'annual potential' recorded in column two is the potential increase per year in the value of northern prairie wheat production, over and above the average value of $1,205 million per year. Column three contains the investment levels calculated as 2.5 percent of the annual potential gain in the gross value of wheat output.

This value could be viewed as a guideline for investment specifically directed to wheat grades research. If the same rule of thumb were applied to the average $1.205 billion value of northern prairie wheat production, approximately $30 million should already have been allocated annually to northern wheat research in one form or another. Column four contains the estimated present value of the gains in wheat revenue taking into account the development path described in Figure 3.

10 Discussion of Results and Conclusions

The results indicate four distinct features of the wheat grades issue. First and foremost, the grades problem arises from consistently low grades as opposed to year to year variation. Second, achieving higher proportions of CWRS1 may afford psychological pleasure, but over the sixteen year period studied was not a source of substantial economic value on the northern prairies. Third, greater improvements in economic value lie in attaining the upper end of the distribution of value as opposed to preventing the worst years from recurring. Fourth, the principal economic loss takes place when wheat is downgraded from CWRS3 to Feed.

The main feature of the grades problem is evident from the results of simulation four. To increase the probability of achieving the second best value of wheat to 60 percent, the mean has to increase by $102,600,000, or 9 percent of average annual value. This value is the best indication of the potential associated with resolving the grades problem. Without second guessing the likely costs to farmers of the solution to the problem, it should be noted that this potential probably represents a significant gain to net farm income. This simulation did reveal a cost in the form of higher year to year variability in grades in the form of increased coefficients of variation. Recall, however, that the historical coefficients of variation due strictly to grades variability for each block are extremely low, by agricultural standards, ranging from 3.6 to 5.5 percent.

The second feature is that potential gains from improved grades are generally higher when judged by the best economic years than when based on reliving years with the greatest proportions of CWRS1, when production values are adjusted for variations in prices, yields and acreages. The annual potential gains corresponding to years with the highest proportions of CWRS1 grades are $67,858,000, $64,319,000 and $44,752,000 for the first, second and third best years respectively. The corresponding values based on the best economic years are $74,247,000, $63,918,000 and $55,567,000 respectively. Differences of increased magnitude exist when the potential of $44,548,000 gained from eliminating the worst year based on the

proportion of CWRS1, is compared to the potential gain of $95,066,000 based on economic value. This evidence indicates that the proportion of CWRS1 wheat is not a useful indicator of the economic value of a wheat crop.

The third feature is that the potential gain from aiming for better grades is larger than from aiming to avoid the worst years. Potential estimated in simulation two by subtracting the value of wheat with average grades from the value for the second best year in value terms is $63,918,000, compared to $11,883,00 by using the second worst year. The second best year was considered to be a reasonably attainable target as opposed to the best year which no doubt reflected especially favorable weather conditions. Note however, that the selection of any year as a norm was arbitrary.

The fourth feature of the economic value of better grades is the price spread between grades, both over time and on average (Figure 2 and Table 2). Feed wheat accounts for an average 16 percent of the annual economic value of wheat on the northern prairies while accounting for 18 percent of adjusted tonnes of deliverable wheat (Appendix, Table 2). The price discount from CWRS3 to Feed is higher than between the other grades. Those blocks with the highest average proportions of Feed wheat stand to gain the most from progress in resolving the grades problem.

The potentials indicate the basis on which research, development and education expenditures may be justified. No hard and fast rule exists for the value of research investment in relation to the anticipated gains. When a modest industry rule of thumb of 2.5 percent of gross output is applied to the potential gains from improved grades, the annual investment over twenty years in research, development and education relating only to grades ranges from $158,000 up to $6,027,000 depending on the goals built into the simulations.

Several matters require further attention before this work could be considered to be complete. The simulations are based on arbitrary norms. A joint exercise involving producers, industry representatives and scientists is required to determine appropriate and feasible goals to aim for. The data are estimates which have not yet been tested against other data series. A statistical method has to be perfected to address the risk issue associated with the variability that appears to accompany higher grades. Comparisons of potential associated with improved grades for the northern prairies should be made with the rest of the prairies. More study of final disposition of wheat within each block is required as well as of the effect within each block of handling

and transportation rates on the regional incidence of potential gain from better grades. And finally, the consequences of a possible long run narrowing of the price spreads between grades should be examined in light of technological advances in milling and baking and the needs of importing countries.

The analysis has pointed out the importance of the grades issues and raised several broad policy and technical questions. The answers depend on the paradigm used to understand the economic development of the northern prairies. For those who view agriculture as a struggle with the ecosphere, the question of finding an efficient solution to the grades problem may be seen to lie in promoting other crops more compatible with the natural environment. Barley, canola, oats, rye and forages are all alternatives to hard red spring wheat in the north. An alternative paradigm is that civilizations, in dialogue with the ecosphere, learn and develop technology to transform ecospheric conditions to human benefit. Following this paradigm, efficiency questions are answered by investments in learning how to deal with ecospheric problems through research, development and education. This latter paradigm underlies the interests and concerns of northern wheat growers and their associates in the grains industry.

The science problems underlying the grades problem are not a subject of this paper. Nevertheless, the investments which seem to be justified by the scope of the potential payoff would have to address a range of researchable issues. The range would include production questions of genetic stock, field and water management, and weed and pest control. Post-production questions of harvest mechanization, drying, storage, grading, transportation and processing also are part of the problem of grades. In short the investment in grades-related research belongs within the domain of systems research involving scientific investigations into the relationships among the individual parts of the problem as well as of the parts themselves.

In conclusion, the wheat crop is important to the northern prairies, averaging over a billion dollars per year in 1988 dollars. The best economic years constitute a better indicator of the potential revenue gains from better grades than do the years with the highest proportion of CWRS1. Greater potential lies in attempting to attain the achievements of the best years than in trying to prevent the worst years from recurring. The economic potential in grades resides in improving the average grade as opposed to reducing year to year variability. The pattern of grades received for wheat varies substantially from block to block. Economic potential exists in grade improvements to justify a significant research commitment.

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12 Appendix

Table 1: Estimated deliverable supplies of wheat in selected CWB blocks for CWRS 1, 2 and 3, and Feed wheat grades, 1973-74 - 1988-89 crop years.

Block[a] 07

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	6396	58025	72503	191
1974-75	3320	19840	36170	34728
1975-76	408	29910	61916	7729
1976-77	34129	104754	12029	327
1977-78	21256	28386	94848	33666
1978-79	28083	73079	56134	23974
1979-80	17272	49886	30899	19540
1980-81	0	10787	94401	17552
1981-82	7097	72893	77541	598
1982-83	15487	55400	42243	41504
1983-84	64996	48846	27787	1486
1984-85	111999	35203	7613	0
1985-86	5785	17737	85855	87327
1986-87	25047	27738	70129	41781
1987-88	15048	59290	86111	12837
1988-89	63073	44019	5773	0

Block[a] 13

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	13417	72395	187763	8355
1974-75	245	20902	88751	59086
1975-76	0	27461	183354	31543
1976-77	68693	338159	108973	1198
1977-78	31298	56827	118580	315597
1978-79	18681	68953	225904	220580
1979-80	13523	141193	175212	75583
1980-81	2084	78368	331960	54621
1981-82	81845	457370	187261	1884
1982-83	37919	175500	261013	267061
1983-84	133280	301424	263040	12192
1984-85	352303	196544	126109	12421
1985-86	40534	134767	380198	263371
1986-87	64888	169183	276078	233211
1987-88	33810	313913	336680	18329
1988-89	329020	227576	40491	9141

Block[a] 15

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	40770	131943	121846	17037
1974-75	3429	21011	55820	78328
1975-76	1388	92289	135182	18725
1976-77	109136	242277	31543	1633
1977-78	64094	42811	108510	115886
1978-79	33023	46454	133086	145665
1979-80	13017	39384	131362	78333
1980-81	6792	150109	149617	10656
1981-82	162135	322419	32606	1111
1982-83	30731	30876	158546	309412
1983-84	137563	170817	80945	19600
1984-85	337708	70904	18620	4354
1985-86	3200	47826	232888	165547
1986-87	74945	98636	161357	76056
1987-88	8734	169343	172926	6000
1988-89	88482	115578	26483	172

Block[a] 23

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	112021	136815	43001	680
1974-75	19106	51221	92289	91310
1975-76	65917	128813	61726	19024
1976-77	321339	81185	24141	816
1977-78	95719	26808	180360	68911
1978-79	64068	79103	216680	6183
1979-80	153494	114191	84969	14426
1980-81	22727	188545	118645	12197
1981-82	316711	72076	8236	0
1982-83	20243	99281	278611	245263
1983-84	263433	143523	173736	3800
1984-85	365406	33862	9316	0
1985-86	76144	215270	205847	84366
1986-87	132571	111514	186602	95665
1987-88	67226	302583	131476	12754
1988-89	75319	124805	19740	30

Block[a] 25

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	21446	62270	80804	10560
1974-75	599	12900	62325	44689
1975-76	4654	47955	106034	13254
1976-77	117274	224967	36469	2368
1977-78	31924	40688	119642	128487
1978-79	6228	40156	205027	92759
1979-80	6033	52088	122681	84012
1980-81	1075	64786	269516	23261
1981-82	110279	240051	117116	1190
1982-83	10668	25442	151013	339221
1983-84	89257	115630	308072	25120
1984-85	122486	82265	52400	2366
1985-86	2250	51100	131845	78998
1986-87	48708	99077	130457	41928
1987-88	4125	60667	227346	4988
1988-89	11398	106993	48277	667

Block[a] 27

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	62597	97923	76695	9689
1974-75	3593	31652	72667	74817
1975-76	14996	122418	70299	6260
1976-77	187056	163976	31434	408
1977-78	62052	32224	61209	62216
1978-79	24701	59042	256749	41733
1979-80	58288	157103	99812	42830
1980-81	13036	114891	190649	12355
1981-82	203573	109944	36943	311
1982-83	25981	26847	123070	299334
1983-84	147911	93475	190848	13740
1984-85	267958	18126	5066	212
1985-86	14404	91886	194491	66619
1986-87	55196	91410	100786	50533
1987-88	19000	160190	149775	5081
1988-89	23090	85822	31675	0

Block[a] 29

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	43654	106687	103067	20684
1974-75	10097	28305	76314	99393
1975-76	30101	97705	79988	35218
1976-77	124105	192853	71986	2477
1977-78	33557	24576	132896	147647
1978-79	29996	47969	197013	34050
1979-80	70718	132822	112783	20027
1980-81	8335	58882	247103	90915
1981-82	162498	244122	55970	5003
1982-83	9908	72341	197051	277560
1983-84	89410	102648	383902	16151
1984-85	235810	112733	93874	448
1985-86	13590	90416	282986	171673
1986-87	44185	99058	296514	183578
1987-88	19782	188279	328371	35065
1988-89	93569	209275	62562	1175

Block[a] 37

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	35000	67605	100073	1551
1974-75	6423	15894	40144	84152
1975-76	6886	43573	58977	37449
1976-77	92643	125384	37531	2341
1977-78	21664	38293	96780	107993
1978-79	44854	34439	96933	23428
1979-80	66483	134191	64407	10431
1980-81	11008	79617	147541	31427
1981-82	96211	138010	22123	933
1982-83	4060	103497	145145	49197
1983-84	63388	73026	188859	5100
1984-85	200240	54744	38846	14529
1985-86	18310	133907	167842	34668
1986-87	48427	96088	202697	89714
1987-88	11100	80111	277704	23277
1988-89	47427	183872	53001	884

Block[a] 41

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	3157	25556	98005	26536
1974-75	27	2504	21392	79580
1975-76	980	60338	62025	22589
1976-77	12547	106333	111286	14343
1977-78	1361	25365	99202	77021
1978-79	1586	4820	79131	104521
1979-80	1278	96859	89269	29001
1980-81	0	15240	160134	130614
1981-82	26117	169706	89402	8837
1982-83	11000	31139	127534	167328
1983-84	4037	51286	242667	47993
1984-85	51630	32601	131774	61767
1985-86	730	15150	188874	69991
1986-87	19698	41656	130640	109263
1987-88	864	67436	164266	6323
1988-89	8924	150814	92820	5318

Block[a] 74

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	59930	155240	100400	10015
1974-75	3375	22698	108401	97950
1975-76	4899	92453	182810	23896
1976-77	172005	329885	30754	626
1977-78	76368	45151	181014	202433
1978-79	61619	91080	237854	147646
1979-80	32518	52942	201728	118645
1980-81	5571	121910	262656	33935
1981-82	161919	413296	60263	96
1982-83	47545	49108	205605	413621
1983-84	182455	235488	154230	28213
1984-85	409386	87368	25798	500
1985-86	11427	44711	407143	172781
1986-87	88773	154568	244025	77186
1987-88	30017	254805	268362	15052
1988-89	91367	116377	47610	1439

Block[a] 86

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	59957	82002	48499	15214
1974-75	10206	22508	48581	68231
1975-76	2939	43056	81702	59685
1976-77	160057	95610	27706	1823
1977-78	38130	27216	118879	52255
1978-79	15156	18553	97005	45340
1979-80	133996	116598	47216	4763
1980-81	26807	39109	173305	74439
1981-82	196319	110661	32141	2489
1982-83	53221	210899	128780	46750
1983-84	90920	197386	110205	9503
1984-85	175493	47307	73313	20308
1985-86	25711	66052	155060	53654
1986-87	12427	23114	150860	231807
1987-88	9425	138244	93801	10683
1988-89	28589	60898	83670	30949

Block[a] 87

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	10505	73456	123152	19242
1974-75	0	7702	33802	81594
1975-76	898	56773	97134	50295
1976-77	16357	170644	109436	3974
1977-78	16275	25964	137414	93541
1978-79	3054	7788	96805	159591
1979-80	19971	147801	89769	12577
1980-81	7565	34956	217211	144317
1981-82	84028	181978	62881	10267
1982-83	16116	63181	161428	113472
1983-84	19381	104466	235496	39996
1984-85	121849	66804	113524	56695
1985-86	1536	9057	258474	78573
1986-87	13367	54917	177105	185828
1987-88	2185	132675	149274	13279
1988-89	18148	148341	110091	25135

Block[a] 90

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	0	5797	44634	53616
1974-75	0	1442	17854	34809
1975-76	381	27869	63549	9008
1976-77	109	40715	151375	12274
1977-78	0	12220	78409	74626
1978-79	0	6601	63695	109064
1979-80	2179	61530	108863	21649
1980-81	0	25533	175090	116065
1981-82	171571	156163	98048	8182
1982-83	3553	29565	287946	173525
1983-84	350	67368	762546	121716
1984-85	29193	15096	534536	99363
1985-86	2575	22176	288384	239574
1986-87	19900	52014	236276	194463
1987-88	19387	324041	239302	23664
1988-89	86648	462038	204914	12886

Block[a] 95

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	0	4137	37231	45260
1974-75	0	0	5416	25093
1975-76	354	7348	40552	6287
1976-77	0	20575	94576	6804
1977-78	0	1225	23515	71388
1978-79	0	288	27275	60985
1979-80	145	35099	45828	14082
1980-81	0	5507	59675	113307
1981-82	50648	75939	64344	2351
1982-83	0	1192	22515	67960
1983-84	0	11950	99341	25467
1984-85	2871	12480	111521	13423
1985-86	0	300	74694	47242
1986-87	0	2585	34678	63863
1987-88	0	13684	57092	7371
1988-89	3803	42560	56613	5392

Block[a] 00

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	3593	2803	18997	18044
1974-75	381	1579	7838	15812
1975-76	0	16765	25610	1034
1976-77	218	26209	24141	7648
1977-78	1796	3375	21446	33095
1978-79	96	3324	41018	8018
1979-80	0	17407	44627	15234
1980-81	2513	1005	93981	48532
1981-82	1878	21428	9937	2483
1982-83	1013	5123	55244	41022
1983-84	0	12118	72476	27161
1984-85	0	950	54295	20587
1985-86	312	1770	18184	30814
1986-87	838	2464	13736	37615
1987-88	2500	35129	47130	9041
1988-89	3000	18528	37120	4540

a - Block estimates are aggregates of estimates voluntarily prepared and submitted to the CWB by elevator managers in September of each year.
Source: CWB.

b - CWRS 1 includes CWRS 1, 13.5 and CWRS 1 in crop years 1986-87 - 1988-89.

c - CWRS 2 includes CWRS 2, 13.5 and CWRS 2 in crop years 1986-87 - 1988-89.

Table 2: Adjusted deliverable wheat in selected CWB blocks for CWRS 1, 2 and 3, and Feed wheat grades, 1973-74 - 1988-89 crop years.

Block[a] 07

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	6823	61901	77346	204
1974-75	5163	30854	56250	54007
1975-76	597	43767	90600	11310
1976-77	33009	101315	11634	316
1977-78	17452	23306	77874	27641
1978-79	22661	58970	45297	19346
1979-80	21484	62051	38434	24305
1980-81	0	12855	112501	20917
1981-82	6565	67428	71728	553
1982-83	14650	52405	39959	39260
1983-84	66431	49924	28400	1519
1984-85	105820	33261	7193	0
1985-86	4302	13190	63844	64938
1986-87	22245	24635	62285	37108
1987-88	12702	50048	72688	10836
1988-89	81743	57049	7482	0

Block[a] 13

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	26405	142477	369526	16443
1974-75	804	68631	291410	194006
1975-76	0	62869	419768	72214
1976-77	73719	362900	116946	1286
1977-78	33248	60368	125970	335264
1978-79	19406	71630	234673	229142
1979-80	18503	193191	239738	103418
1980-81	2476	93104	394380	64892
1981-82	62348	348416	142652	1435
1982-83	28374	131325	195313	199839
1983-84	104165	235578	205579	9529
1984-85	284379	158650	101795	10026
1985-86	27465	91316	257615	178455
1986-87	48433	126280	206067	174071
1987-88	26695	247854	265830	14472
1988-89	301136	208289	37059	8366

Block[a] 15

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	46675	151055	139495	19505
1974-75	7713	47262	125562	176192
1975-76	2000	132974	194776	26980
1976-77	101230	224727	29258	1515
1977-78	69013	46097	116839	124781
1978-79	32885	46260	132529	145056
1979-80	17717	53604	178792	106616
1980-81	7639	168830	168276	11985
1981-82	111599	221923	22443	765
1982-83	20701	20799	106801	208429
1983-84	120004	149014	70613	17098
1984-85	279134	58606	15390	3599
1985-86	2540	37959	184839	131392
1986-87	65050	85613	140053	66014
1987-88	8727	169213	172794	5995
1988-89	136810	178706	40948	266

Block[a] 23

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	157295	192110	60380	955
1974-75	30905	82853	149283	147699
1975-76	98282	192060	92033	28365
1976-77	308755	78006	23196	784
1977-78	105745	29616	199251	76129
1978-79	71893	88764	243144	6938
1979-80	171750	127773	95075	16142
1980-81	27286	226366	142444	14644
1981-82	327653	74566	8521	0
1982-83	12923	63380	177863	156574
1983-84	185122	100858	122089	2670
1984-85	367334	34041	9365	0
1985-86	53772	152022	145367	59579
1986-87	103452	87020	145615	74652
1987-88	53717	241777	105055	10191
1988-89	140688	233123	36872	56

Block[a] 25

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	38113	110664	143602	18767
1974-75	1547	33306	160913	115380
1975-76	8424	86802	191929	23991
1976-77	95753	183683	29777	1933
1977-78	30969	39471	116063	124643
1978-79	5630	36303	185354	83858
1979-80	7089	61201	144145	98711
1980-81	933	56207	233826	20181
1981-82	73219	159379	77758	790
1982-83	6306	15040	89271	200529
1983-84	51613	66863	178143	14526
1984-85	146854	98631	62825	2837
1985-86	2650	60162	155277	93038
1986-87	47335	96284	126780	40746
1987-88	4320	63530	238073	5223
1988-89	21194	198945	89767	1240

Block[a] 27

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	79523	124401	97433	12309
1974-75	6168	54333	124738	128428
1975-76	21983	179455	103053	9177
1976-77	153244	134336	25752	334
1977-78	89405	46429	88191	89642
1978-79	20270	48452	210697	34248
1979-80	51065	137635	87444	37523
1980-81	12356	108897	180703	11710
1981-82	182039	98314	33035	278
1982-83	17148	17720	81230	197569
1983-84	104030	65744	134229	9664
1984-85	288471	19514	5454	228
1985-86	12297	78447	166046	56876
1986-87	58112	96240	106111	53203
1987-88	17841	150417	140638	4771
1988-89	51517	191479	70671	0

Block[a] 29

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	66608	162785	157261	31560
1974-75	19722	55288	149062	194142
1975-76	51803	168147	137656	60609
1976-77	132600	206054	76914	2647
1977-78	41438	30348	164107	182322
1978-79	40594	64918	266622	46081
1979-80	87930	165150	140233	24901
1980-81	8602	60768	255018	93827
1981-82	145338	218342	50059	4475
1982-83	7441	54330	147990	208454
1983-84	63151	72501	271154	11408
1984-85	222684	106458	88649	423
1985-86	10173	67685	211842	128514
1986-87	29645	66461	198940	123168
1987-88	14476	137780	240298	25660
1988-89	106748	238752	71374	1341

Block[a] 37

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	47472	91695	135733	2104
1974-75	12135	30029	75846	158993
1975-76	12986	82172	111222	70623
1976-77	99506	134672	40311	2514
1977-78	22668	40068	101267	113000
1978-79	62231	47781	134486	32504
1979-80	66843	134917	64756	10487
1980-81	11311	81805	151596	32291
1981-82	103588	148592	23819	1005
1982-83	3725	94962	133176	45140
1983-84	53148	61229	158350	4276
1984-85	179878	49177	34896	13052
1985-86	14298	104567	131066	27072
1986-87	30702	60918	128506	56877
1987-88	7840	56582	196141	16440
1988-89	46067	178597	51481	859

Block[a] 41

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	5009	40544	155484	42099
1974-75	63	5882	50251	186940
1975-76	1633	100529	103340	37635
1976-77	12477	105736	110661	14262
1977-78	1631	30388	118846	92273
1978-79	2029	6166	101230	133711
1979-80	1436	108823	100295	32583
1980-81	0	12110	127242	103785
1981-82	21594	140316	73919	7307
1982-83	7936	22466	92012	120722
1983-84	2837	36041	170532	33727
1984-85	45192	28536	115343	54065
1985-86	646	13407	167145	61939
1986-87	15898	33619	105436	88183
1987-88	879	68635	167187	6435
1988-89	8414	142194	87515	5014

Block[a] 74

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	89376	231516	149731	14936
1974-75	7051	47419	226461	204628
1975-76	7823	147641	291934	38160
1976-77	156616	300370	28002	570
1977-78	73433	43416	174057	194653
1978-79	55592	82172	214590	133205
1979-80	38906	63342	241357	141953
1980-81	6379	139586	300739	38855
1981-82	123701	315745	46039	73
1982-83	32248	33308	139456	280546
1983-84	147559	190450	124733	22817
1984-85	380041	81105	23949	464
1985-86	8723	34132	310806	131898
1986-87	76352	132941	209881	66386
1987-88	25650	217731	229316	12862
1988-89	172762	220052	90024	2721

Block[a] 86

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	82667	113062	66869	20977
1974-75	19356	42686	92133	129399
1975-76	4448	65159	123643	90324
1976-77	159147	95066	27548	1813
1977-78	45723	32636	142553	62661
1978-79	24412	29884	156248	73030
1979-80	125582	109277	44251	4464
1980-81	24236	35358	156682	67299
1981-82	162966	91861	26681	2066
1982-83	34327	136030	83063	30154
1983-84	63190	137185	76594	6605
1984-85	157275	42396	65703	18200
1985-86	24265	62336	146337	50636
1986-87	8426	15673	102293	157181
1987-88	10599	155471	105490	12014
1988-89	39720	84608	116247	42999

Block[a] 87

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	14210	99365	166590	26029
1974-75	0	19158	84079	202957
1975-76	1341	84757	145012	75086
1976-77	16672	173929	111543	4051
1977-78	18241	29100	154013	104840
1978-79	3499	8923	110917	182855
1979-80	22638	167541	101758	14257
1980-81	5733	26490	164606	109366
1981-82	75862	164293	56770	9269
1982-83	13932	54618	139550	98094
1983-84	14860	80100	180567	30667
1984-85	103963	56998	96860	48373
1985-86	1353	7977	227659	69206
1986-87	9492	38995	125757	131951
1987-88	2250	136592	153681	13671
1988-89	18417	150543	111725	25508

Block[a] 90

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	0	21958	169069	203092
1974-75	0	10504	130055	253561
1975-76	1490	108958	248454	35218
1976-77	210	78478	291774	23658
1977-78	0	29144	186999	177977
1978-79	0	14505	139961	239654
1979-80	4422	124859	220909	43931
1980-81	0	31776	217900	144444
1981-82	155818	141825	89046	7431
1982-83	2831	23559	229454	138276
1983-84	145	27890	315694	50390
1984-85	16965	8773	310638	57743
1985-86	1836	15813	205638	170833
1986-87	15603	40783	185259	152474
1987-88	12600	210607	155532	15380
1988-89	44554	237576	105365	6626

Block[a] 95

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	0	5145	46304	56290
1974-75	0	0	19126	88613
1975-76	699	14515	80106	12419
1976-77	0	18177	83552	6011
1977-78	0	1373	26355	80011
1978-79	0	350	33186	74203
1979-80	164	39741	51889	15945
1980-81	0	3324	36021	68394
1981-82	28232	42330	35867	1310
1982-83	0	1401	26463	79876
1983-84	0	9414	78262	20063
1984-85	2205	9584	85642	10308
1985-86	0	264	65836	41639
1986-87	0	2754	36946	68040
1987-88	0	18866	78711	10162
1988-89	3781	42313	56285	5361

Block[a] 00

year	CWRS 1[b]	CWRS 2[c]	CWRS 3	Feed
1973-74	5659	4415	29919	28418
1974-75	1018	4218	20937	42238
1975-76	0	26421	40360	1630
1976-77	256	30799	28369	8987
1977-78	2058	3867	24570	37916
1978-79	125	4335	53494	10457
1979-80	0	15412	39512	13488
1980-81	1177	471	44027	22736
1981-82	3596	41032	19028	4755
1982-83	677	3422	36906	27405
1983-84	0	7418	44366	16627
1984-85	0	857	48982	18572
1985-86	418	2371	24354	41269
1986-87	1049	3084	17194	47084
1987-88	1823	25621	34373	6594
1988-89	3248	20059	40188	4915

[a] - Block estimates are aggregate of estimates voluntarily prepared and submitted to the CWB by elevator managers in September of each year.
Source: CWB.

[b] - CWRS 1 includes CWRS 1, 13.5 and CWRS 1 in crop years 1986-87 - 1988-89.
[c] - CWRS 2 includes CWRS 2, 13.5 and CWRS 2 in crop years 1986-87 - 1988-89.

Table 3: Proportions of adjusted estimated deliverable wheat in selected CWB blocks for CWRS 1, 2 and 3, and Feed wheat grades, 1973-74 - 1988-89 crop years.

Block 07

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.046645	0.423185	0.528774	0.001394
1974-75	0.035296	0.210932	0.384552	0.369218
1975-76	0.004081	0.299212	0.619385	0.077320
1976-77	0.225665	0.692638	0.079535	0.002160
1977-78	0.119311	0.159332	0.532388	0.188968
1978-79	0.154921	0.403147	0.309672	0.132258
1979-80	0.146875	0.424210	0.262753	0.166160
1980-81	0	0.087883	0.769116	0.142999
1981-82	0.044881	0.460970	0.490367	0.003780
1982-83	0.100154	0.358265	0.273179	0.268400
1983-84	0.454154	0.341304	0.194156	0.010384
1984-85	0.723436	0.227388	0.049174	0
1985-86	0.029410	0.090173	0.436468	0.443947
1986-87	0.152078	0.168417	0.425813	0.253690
1987-88	0.086837	0.342152	0.496930	0.074080
1988-89	0.558834	0.390014	0.051150	0

Block 13

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.047589	0.256784	0.665991	0.029634
1974-75	0.001449	0.123692	0.525204	0.349654
1975-76	0	0.113307	0.756541	0.130150
1976-77	0.132862	0.654049	0.210770	0.002317
1977-78	0.059922	0.108800	0.227034	0.604242
1978-79	0.034975	0.129097	0.422947	0.412979
1979-80	0.033347	0.348185	0.432077	0.186389
1980-81	0.004462	0.167799	0.710784	0.116953
1981-82	0.112368	0.627945	0.257099	0.002586
1982-83	0.051138	0.236685	0.352009	0.360166
1983-84	0.187735	0.424578	0.370512	0.017173
1984-85	0.512533	0.285933	0.183463	0.018069
1985-86	0.049499	0.164577	0.464295	0.321626
1986-87	0.087290	0.227592	0.371391	0.313725
1987-88	0.048112	0.446703	0.479101	0.026082
1988-89	0.542734	0.375396	0.066791	0.015077

Block 15

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.130841	0.423443	0.391038	0.054677
1974-75	0.021621	0.132487	0.351981	0.493909
1975-76	0.005606	0.372758	0.546003	0.075631
1976-77	0.283772	0.629963	0.082017	0.004246
1977-78	0.193460	0.129220	0.327527	0.349791
1978-79	0.092184	0.129677	0.371510	0.406626
1979-80	0.049665	0.150265	0.501198	0.298871
1980-81	0.021413	0.473271	0.471718	0.033596
1981-82	0.312838	0.622103	0.062913	0.002144
1982-83	0.058029	0.058304	0.299388	0.584276
1983-84	0.336401	0.417723	0.197945	0.047929
1984-85	0.782481	0.164287	0.043141	0.010088
1985-86	0.007120	0.106408	0.518148	0.368323
1986-87	0.182350	0.239993	0.392602	0.185053
1987-88	0.024463	0.474346	0.484384	0.016805
1988-89	0.383511	0.500955	0.114787	0.000745

Block 23

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.382955	0.467716	0.147002	0.002325
1974-75	0.075242	0.201716	0.363448	0.359592
1975-76	0.239280	0.467595	0.224066	0.069058
1976-77	0.751702	0.189915	0.056473	0.001908
1977-78	0.257449	0.072103	0.485101	0.185345
1978-79	0.175033	0.216108	0.591967	0.016891
1979-80	0.418147	0.311080	0.231472	0.039299
1980-81	0.066431	0.551117	0.346798	0.035652
1981-82	0.797713	0.181540	0.020745	0
1982-83	0.031462	0.154306	0.433030	0.381199
1983-84	0.450704	0.245552	0.297242	0.006500
1984-85	0.894322	0.082877	0.022800	0
1985-86	0.130914	0.370117	0.353914	0.145052
1986-87	0.251867	0.211862	0.354519	0.181750
1987-88	0.130781	0.588637	0.255770	0.024811
1988-89	0.342524	0.567569	0.089769	0.000136

Block 25

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.122492	0.355665	0.461526	0.060315
1974-75	0.004971	0.107042	0.517162	0.370822
1975-76	0.027074	0.278975	0.616845	0.077105
1976-77	0.307742	0.590343	0.095701	0.006212
1977-78	0.099532	0.126856	0.373017	0.400593
1978-79	0.018094	0.116675	0.595715	0.269514
1979-80	0.022783	0.196695	0.463271	0.317249
1980-81	0.002998	0.180644	0.751496	0.064860
1981-82	0.235320	0.512232	0.249908	0.002539
1982-83	0.020267	0.048337	0.286910	0.644485
1983-84	0.165880	0.214893	0.572540	0.046685
1984-85	0.471976	0.316991	0.201914	0.009117
1985-86	0.008516	0.193419	0.499047	0.299016
1986-87	0.152131	0.309450	0.407462	0.130955
1987-88	0.013884	0.204180	0.765148	0.016786
1988-89	0.068115	0.639394	0.288504	0.003985

Block 27

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.253527	0.396603	0.310626	0.039242
1974-75	0.019664	0.173218	0.397676	0.409440
1975-76	0.070083	0.572117	0.328541	0.029257
1976-77	0.488557	0.428277	0.082100	0.001064
1977-78	0.285031	0.148020	0.281161	0.285787
1978-79	0.064622	0.154469	0.671721	0.109185
1979-80	0.162800	0.438793	0.278779	0.119626
1980-81	0.039392	0.347175	0.576100	0.037332
1981-82	0.580359	0.313435	0.105319	0.000886
1982-83	0.054669	0.056493	0.258968	0.629868
1983-84	0.331657	0.209598	0.427934	0.030809
1984-85	0.919672	0.062212	0.017387	0.000726
1985-86	0.039204	0.250097	0.529372	0.181326
1986-87	0.185267	0.306823	0.338292	0.169616
1987-88	0.056878	0.479543	0.448367	0.015210
1988-89	0.164241	0.610453	0.225305	0

Block 29

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.159267	0.389238	0.376029	0.075463
1974-75	0.047157	0.132200	0.356425	0.464216
1975-76	0.123866	0.402058	0.329151	0.144923
1976-77	0.317061	0.492698	0.183910	0.006329
1977-78	0.099083	0.072565	0.392398	0.435952
1978-79	0.097064	0.155226	0.637523	0.110184
1979-80	0.210251	0.394893	0.335313	0.059541
1980-81	0.020568	0.145303	0.609777	0.224351
1981-82	0.347520	0.522081	0.119697	0.010700
1982-83	0.017792	0.129909	0.353861	0.498437
1983-84	0.151001	0.173358	0.648361	0.027277
1984-85	0.532464	0.254553	0.211970	0.001011
1985-86	0.024324	0.161842	0.506539	0.307292
1986-87	0.070884	0.158916	0.475689	0.294509
1987-88	0.034613	0.329448	0.574581	0.061356
1988-89	0.255246	0.570883	0.170663	0.003206

Block 37

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.171376	0.331024	0.490003	0.007595
1974-75	0.043808	0.108406	0.273809	0.573975
1975-76	0.046880	0.296646	0.401519	0.254953
1976-77	0.359223	0.486175	0.145525	0.009075
1977-78	0.081833	0.144648	0.365580	0.407937
1978-79	0.224659	0.172493	0.485505	0.117342
1979-80	0.241307	0.487059	0.233773	0.037858
1980-81	0.040833	0.295321	0.547272	0.116572
1981-82	0.373958	0.536425	0.085987	0.003628
1982-83	0.013447	0.342819	0.480774	0.162958
1983-84	0.191867	0.221040	0.571654	0.015436
1984-85	0.649372	0.177532	0.125976	0.047118
1985-86	0.051616	0.377494	0.473157	0.097731
1986-87	0.110836	0.219918	0.463915	0.205329
1987-88	0.028302	0.204264	0.708082	0.059349
1988-89	0.166304	0.644745	0.185849	0.003101

Block 41

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.020601	0.166754	0.639493	0.173150
1974-75	0.000259	0.024192	0.206678	0.768870
1975-76	0.006716	0.413466	0.425027	0.154789
1976-77	0.051316	0.434884	0.455140	0.058658
1977-78	0.006708	0.124982	0.488800	0.379508
1978-79	0.008345	0.025360	0.416351	0.549943
1979-80	0.005906	0.447578	0.412504	0.134010
1980-81	0	0.049807	0.523334	0.426858
1981-82	0.088814	0.577109	0.304023	0.030053
1982-83	0.032640	0.092400	0.378438	0.496520
1983-84	0.011668	0.148233	0.701382	0.138716
1984-85	0.185871	0.117366	0.474397	0.222365
1985-86	0.002656	0.055141	0.687451	0.254749
1986-87	0.065387	0.138272	0.433650	0.362690
1987-88	0.003615	0.282290	0.687627	0.026466
1988-89	0.034606	0.584830	0.359941	0.020622

Block 74

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.184068	0.476803	0.308368	0.030760
1974-75	0.014521	0.097658	0.466392	0.421427
1975-76	0.016111	0.304064	0.601234	0.078589
1976-77	0.322548	0.618607	0.057669	0.001173
1977-78	0.151233	0.089414	0.358467	0.400884
1978-79	0.114490	0.169231	0.441944	0.274333
1979-80	0.080126	0.130451	0.497071	0.292350
1980-81	0.013137	0.287474	0.619366	0.080021
1981-82	0.254760	0.650272	0.094816	0.000150
1982-83	0.066414	0.068597	0.287207	0.577780
1983-84	0.303895	0.392228	0.256885	0.046991
1984-85	0.782687	0.167034	0.049322	0.000955
1985-86	0.017964	0.070294	0.640099	0.271641
1986-87	0.157245	0.273789	0.432245	0.136720
1987-88	0.052825	0.448413	0.472272	0.026489
1988-89	0.355800	0.453193	0.185402	0.005603

Block 86

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.291517	0.398702	0.235807	0.073973
1974-75	0.068257	0.150528	0.324899	0.456314
1975-76	0.015685	0.229777	0.436016	0.318520
1976-77	0.561218	0.335242	0.097145	0.006393
1977-78	0.161238	0.115088	0.502703	0.220969
1978-79	0.086086	0.105383	0.550995	0.257534
1979-80	0.442854	0.385356	0.156047	0.015741
1980-81	0.085465	0.124686	0.552524	0.237323
1981-82	0.574685	0.323940	0.094088	0.007285
1982-83	0.121051	0.479698	0.292914	0.106335
1983-84	0.222834	0.483771	0.270102	0.023291
1984-85	0.554617	0.149505	0.231696	0.064180
1985-86	0.085568	0.219822	0.516045	0.178563
1986-87	0.029713	0.055269	0.360728	0.554287
1987-88	0.037376	0.548255	0.372001	0.042366
1988-89	0.140069	0.298363	0.409935	0.151632

Block 87

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.046408	0.324516	0.544066	0.085008
1974-75	0	0.062568	0.274593	0.662837
1975-76	0.004379	0.276806	0.473592	0.245222
1976-77	0.054448	0.568033	0.364287	0.013230
1977-78	0.059573	0.095037	0.502991	0.342397
1978-79	0.011427	0.029141	0.362244	0.597186
1979-80	0.073933	0.547172	0.332331	0.046561
1980-81	0.018723	0.086513	0.537585	0.357177
1981-82	0.247757	0.536565	0.185405	0.030271
1982-83	0.045500	0.178377	0.455756	0.320365
1983-84	0.048531	0.261598	0.589714	0.100155
1984-85	0.339533	0.186149	0.316335	0.157981
1985-86	0.004418	0.026052	0.743509	0.226019
1986-87	0.030999	0.127353	0.410708	0.430937
1987-88	0.007348	0.446096	0.501907	0.044648
1988-89	0.060148	0.491660	0.364884	0.083306

Block 90

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0	0.055714	0.428979	0.515306
1974-75	0	0.026651	0.329988	0.643359
1975-76	0.003780	0.276458	0.630401	0.089358
1976-77	0.000532	0.199122	0.740317	0.060027
1977-78	0	0.073947	0.474472	0.451580
1978-79	0	0.036803	0.355122	0.608073
1979-80	0.011219	0.316803	0.560510	0.111465
1980-81	0	0.080625	0.552877	0.366497
1981-82	0.395356	0.359852	0.225936	0.018854
1982-83	0.007183	0.059776	0.582193	0.350847
1983-84	0.000367	0.070765	0.801011	0.127854
1984-85	0.043045	0.022259	0.788183	0.146511
1985-86	0.004658	0.040122	0.521764	0.433454
1986-87	0.039589	0.103478	0.470058	0.386873
1987-88	0.031970	0.534374	0.394632	0.039023
1988-89	0.113046	0.602799	0.267341	0.016812

Block 95

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0	0.047754	0.429779	0.522466
1974-75	0	0	0.177521	0.822478
1975-76	0.006487	0.134723	0.743519	0.115269
1976-77	0	0.168711	0.775496	0.055791
1977-78	0	0.012743	0.244618	0.742637
1978-79	0	0.003248	0.308022	0.688729
1979-80	0.001522	0.368863	0.481617	0.147996
1980-81	0	0.030852	0.334335	0.634811
1981-82	0.262040	0.392893	0.332906	0.012159
1982-83	0	0.013003	0.245619	0.741377
1983-84	0	0.087377	0.726403	0.186218
1984-85	0.020466	0.088955	0.794902	0.095675
1985-86	0	0.002450	0.611069	0.386480
1986-87	0	0.025561	0.342918	0.631520
1987-88	0	0.175108	0.730571	0.094320
1988-89	0.035093	0.392732	0.522415	0.049758

Block 00

year	CWRS 1	CWRS 2	CWRS 3	Feed
1973-74	0.082720	0.064536	0.437341	0.415401
1974-75	0.014880	0.061656	0.306047	0.617415
1975-76	0	0.386209	0.589963	0.023826
1976-77	0.003742	0.450205	0.414684	0.131367
1977-78	0.030082	0.056525	0.359152	0.554238
1978-79	0.001827	0.063367	0.781950	0.152855
1979-80	0	0.225282	0.577559	0.197158
1980-81	0.017204	0.006884	0.643566	0.332344
1981-82	0.052564	0.599786	0.278142	0.069506
1982-83	0.009896	0.050021	0.539482	0.400599
1983-84	0	0.108432	0.648521	0.243045
1984-85	0	0.012527	0.715995	0.271476
1985-86	0.006110	0.034657	0.355990	0.603242
1986-87	0.015333	0.045080	0.251333	0.688251
1987-88	0.026647	0.374515	0.502448	0.096388
1988-89	0.047478	0.293217	0.587457	0.071846