AN ANALYSIS OF ALTERNATIVE
WHEAT PRICING SCHEMES

BY

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The objective of this study was to ascertain the performance of alternative domestic wheat pricing arrangements. The historical simulation approach adopted is a useful tool for exploring alternative schemes when results need to be viewed in a multiple attribute framework. The study was particularly timely as it coincided with, and made an input to, discussions between various parties attempting to derive an improved pricing system for wheat.

J.B. Dent
Director
ACKNOWLEDGEMENTS

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SUMMARY

The aim of this study was to measure, from an economic efficiency viewpoint, the impact of making the domestic wheat pricing scheme more responsive to changes in the world wheat price. This was done by distilling information on the effects that alternative pricing schemes could have on those criteria thought to be of interest to policymakers.

The results were based on historical data and therefore show what could have happened in the past if alternative schemes had been in operation. However it is unlikely that future data on variables, such as prices, will coincide with the past pattern.

A problem encountered in this study was data availability. This resulted in the fixed costs and imported inputs involved in wheat and sheep production being disregarded. These are important omissions as machinery fixed costs and the import components of machinery in wheatgrowing are significant. The problem of data availability also caused an intractable validation problem involving assumptions made concerning farmers' wheat area response to different schemes. A weakness was that the study considered only the average, not marginal, value of potential wheatgrowing land.

Despite these deficiencies the study has obtained some useful policy implications. For the traditional wheat pricing scheme these include:

(i) The resultant wheat area grown in New Zealand has saved the nation considerable foreign exchange, when compared to the option of importing all wheat require-
ments and exporting more livestock products.

(ii) The resultant level of self sufficiency and revenue to producers has been more stable than most alternative schemes.

Implications arising from the study of alternative schemes were:

(i) Higher domestic producer wheat prices obtained through schemes being more directly linked to world prices would most likely to be achieved at the cost of less stable prices. Such higher prices would result in a higher cost to consumers but not necessarily a higher self sufficiency level, since the latter was influenced strongly by farm gate prices for fat lambs and wool. Revenue to producers would usually increase when either the domestic producer wheat price rose or self sufficiency rose. An increase in self sufficiency would appear to be associated with a rise in foreign exchange earnings.

(ii) Foreign exchange earned, by a scheme which maintained the domestic wheat price at a level comparable to world wheat prices, would probably be higher than the traditional method of wheat price setting.

Pointers about how the recently announced new scheme would have performed in the past include:

(i) Higher and more unstable domestic producer wheat prices would have been achieved.

(ii) These higher producer prices would have resulted in a higher cost to consumers and probably a higher wheat self sufficiency level.
(iii) The total revenue to producers and foreign exchange earnings would have been greater.
CHAPTER 1

INTRODUCTION

1.1 Purpose of Study

A stated objective of the New Zealand government, under the Wheat Board Act 1965, is that the country should be self sufficient in the production of milling standard grade wheat. A key policy instrument used to achieve this objective is the wheat price paid to producers as it affects the quantity of wheat grown and hence the need to export and import wheat. The wheat price paid to growers has also been an important variable within the arable industry because it has usually affected prices of other crops such as barley and peas. A high wheat price usually has lifted the prices of these other commodities.

Up until 1980 the method of wheat price setting, in addition to being an economic issue, was political as it involved direct negotiation by producer representatives with the Wheat Board and government to determine the basic price, that is the price f.o.r. (free on rail) to be paid to the New Zealand producer. Each year these representatives presented a case to the Wheat Board supporting what they considered to be a fair basic price. In turn the Wheat Board, after a further series of discussions with the producer representatives, presented a case to government supporting what they thought was a fair basic price. The government, after heeding advice from three of its departments,
then announced the basic price for the coming season.
The departments involved were Trade and Industry, Treasury and Agriculture and Fisheries.

The factors considered by the different parties, in deciding a fair basic price included:

i) Estimated f.o.b. (free on board) cost of imported wheat.

ii) Estimated landed cost at Auckland of imported wheat and New Zealand grown wheat.

iii) Estimated effect of wool and lamb prices on wheat area.

iv) Movement in growers' costs.

During 1979 there was growing dissatisfaction with this method of price setting by both producers and government; as a result several alternative wheat pricing schemes were suggested. The two major reasons for this dissatisfaction included:

i) Some government representatives believed that wheat price setting should be removed from the realm of politics.

ii) Since 1973 the basic price has been in most years less than the world wheat price. An indicator of this world price was taken to be the Australian price, that is the New Zealand equivalent of the average Australian standard white wheat export price f.o.b. for the months of September, October and November, as shown in Figure 1.
The aim of this study was to measure the impact of making the domestic pricing scheme more responsive to changes in the world wheat price. This was done by developing a model which could evaluate the impact of alternative pricing schemes on policy criteria, that is criteria which were thought to be of interest to policymakers.

1.2 Previous New Zealand Studies

Earlier research, relevant to wheat pricing policy, concentrated on explaining the economic factors affecting wheat areas in terms of econometric equations. The first published study was by Candler (1957), who attempted to explain the variation in wheat area by the fat lamb price, red clover price and area of wheat harvested, all measured in the previous season.
This study was extended by Guise (1968) who used relative, rather than absolute, farm product prices as independent variables. His model explained the area of wheat in terms of the expected fat lamb prices relative to wheat prices, expected small seeds prices relative to wheat prices and a lagged dependent variable. Rich and Zwart (1979) updated Guise's study in order to explain the wheat area harvested for the period 1953-76. The explanatory variables were the expected wheat price relative to both the expected fat lamb price and the expected wool price.

A study by Chudleigh et al (1978b) evaluated the size and sources of wheat production variability between regions within New Zealand over different time periods as well as making some international comparisons. One conclusion was that the major objective of the current wheat scheme appeared to be, not one of assuring stable production close to self sufficiency but rather, one of allowing a less stable production at stable prices. It was acknowledged that further research was necessary to determine the resource costs of the present scheme relative to alternative pricing schemes which have objectives other than self sufficiency or price stability.

A theoretical model of the New Zealand wheat industry for the evaluation of alternative pricing schemes, was developed by Zwart (1978). He suggested that a scheme which maintains a domestic wheat price at a level comparable with world price levels would maximise the long run value of the wheat industry to the nation as a whole. Many simplistic assumptions about the industry were made and it was concluded
that, in order to better evaluate pricing schemes, a more realistic model was needed. This requirement was set as a major objective of the present study.

The remainder of this report is arranged as follows: Chapter 2 describes the different possible pricing schemes considered, the linkages between the basic wheat price and policy variables and the validation method used. Chapter 3 discusses the simulation experiments used, explains the effects of schemes on policy variables and what implications for policy stem from these results. Chapter 4 mentions some possible areas for further research.
CHAPTER 2

MODEL CONSTRUCTION

2.1 Pricing Schemes Considered

A scheme is a mechanism for determining the basic price; that is the wheat price f.o.r. paid to the New Zealand grower. A general description of schemes considered is given in this section while a more detailed account is found in Appendix 1. The status quo scheme reflects the traditional method of setting the wheat price as outlined in section 1.1.

The alternative schemes were more closely related to the world wheat price, via the Australian price, than the status quo scheme. This meant that any movements, up or down, in world wheat prices would tend to be quickly passed on to the producer. For example, if world prices increased, growers would benefit, however, if world prices fell, growers would tend to bear the brunt of this decline.

A direct linkage of the basic price to world prices occurred in schemes 3, 10 and 13. The basic price in schemes 3 and 10 was equated to the current Australian price whereas in scheme 13 it was defined as last year's Australian price. An allowance for transport costs was made in scheme 10 by equating the basic price plus domestic wheat transport costs to the Australian price plus shipping costs on imported wheat.

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1. Defined as the New Zealand equivalent of the average Australian standard white wheat export price f.o.b. for the months September, October and November.
In an attempt to insulate producers from violent world wheat price fluctuations, a buffer fund was used to link the world price to the basic price in scheme 4. The fund was not necessarily self-balancing and the basic price was taken to be the current Australian price provided the yearly price movement was no greater than 10 percent. If the Australian price movement was greater than this proportion then the buffer fund was activated in order to supplement or reduce the basic price so that the price paid to the farmer remained within the range of plus or minus 10 percent.

A stable price that was related to the world price was the intention of schemes 1, 6 and 2. The disadvantage of any scheme with these aims was that they were slower to react to any change in world prices. In scheme 1 the basic price was taken to be an average of the Australian price over the last three years. In scheme 6 the basic price was deemed to be last year's net basic price plus or minus one half the difference between the current Australian price and last year's net basic price. Scheme 2 was identical to this last scheme except the basic price was never allowed to fall; it was always at least last year's net basic price.

An attempt to relate the basic price to a measure of self-sufficiency was the theme of schemes 5, 11 and 12. In scheme 11 the basic price was set at a level such that all of the country's wheat requirements were produced domestically. In scheme 12 the basic price was zero and this necessitated

2. Net basic price was the basic price net of any export levies that would be imposed to offset the lower price received for export wheat.
all wheat requirements to be imported. Scheme 5 attempted to achieve a high level of self sufficiency. The basic price was taken to be a weighted average of the current Australian price and last year's net basic price where the weights were determined by the degree of self sufficiency obtained in the last year. As self sufficiency decreased the basic price approached the current Australian price but when self sufficiency increased the basic price came closer to the last year's net basic price. A weakness of this scheme was that it assumed the Australian price would always be the higher price; it ignored the fact that the current Australian price could be below last year's net basic price.

A compensation for movements in wheatgrowing costs and world wheat prices were the key features of schemes 7, 8 and 9. In addition a high level of self sufficiency was aimed for in scheme 8. The way in which these factors interacted to yield the basic price was complex as indicated in Appendix 1. The danger of increasing the domestic price to compensate for increases in growing costs is that, during periods when the world wheat price is falling, the nation would be poorer because it grew wheat at a higher cost than for what it could import wheat.

A characteristic of the status quo and schemes 7 and 9 is that the basic price was announced prior to the wheat crop being drilled, whereas in all other schemes the price was announced immediately prior to harvest.

2.2 Policy Criteria

2.2.1 Introduction

The export price was taken as 90 percent of the import
price of wheat\textsuperscript{3}. The 10 percent reduction was imposed in an attempt to capture the price which New Zealand export wheat would fetch, given that in the past it has tended to be of an inferior quality compared to Australian export wheat. The fixed percentage does not allow for the possibility that, in the event of continuing overproduction, the quality of New Zealand export wheat might improve.

In order to equate the real dollars of one time period with those of another period the money values of policy variables were reported in 1979 dollar terms. An analogous mathematical description of these variables is given in Appendix 2.

2.2.2 Net Basic Price

This was defined as the basic price except for those years that wheat was exported. When this latter situation occurred the net basic price was a weighted average of the basic price and the export price; where the respective weights were the proportion of domestically produced wheat consumed and the proportion exported.

The expected net basic price was a forecast price made in the early autumn prior to producers drilling their wheat. This price estimate was an important consideration to farmers because it would influence their decision regarding the area of wheat to drill. Relatively simplistic definitions of expectations were used for the different schemes. In the status quo scheme and schemes 7 and 9 it was the basic price

\textsuperscript{3} Import price of wheat was defined as the f.o.b. cost in New Zealand dollars, of importing Australian wheat.
because in these schemes, the price was announced prior to sowing; for schemes 2, 3, 4, 5, 6, and 13 it was last year's net basic price; for schemes 1 and 10 it was last year's Australian price; for scheme 8 it was last year's net basic price adjusted for the movement in growers' costs and the shortfall in last year's self sufficiency.

The price expectation adopted in scheme 11 was one that caused producers to grow that area of wheat which could result in 100 percent self sufficiency in wheat production being achieved each year. It was impractical for producers to form this expectation because it necessitated knowing the wheat area needed each year to achieve total self sufficiency and this information would never be accurately known until after the wheat was consumed. However the scheme was included in order to gain understanding about policy variable implications that would result, if New Zealand adopted a scheme which encouraged high levels of wheat self sufficiency.

2.2.3 Self Sufficiency

This was taken to be the quantity of milling grade wheat produced in New Zealand divided by domestic milling grade wheat consumption requirements and expressed as a percentage. Milling grade wheat was taken to be total wheat production, that is area harvested multiplied by yield, minus that wheat which is unsuitable for milling. This non milling grade wheat was thought to be grown irrespective of what pricing scheme operated because it is used mainly by growers for their own use as seed or feed or is sold as certified seed.
The area of wheat harvested was defined by the econometric equation reported by Rich and Zwart (1979), but with updated parameter estimates. The factors affecting the area of wheat harvested (A) were the expected net basic price (ENBP) relative to the expected fat lamb price and the expected wool price. This specification of relative, rather than absolute, prices conforms with that which would be derived from neoclassical production theory under assumptions of fixed resource supplies and constant technology. That is, the potential area of wheatgrowing land was assumed fixed and the technologies of wheat and sheep farming were thought to be changing at similar rates.

The expected fat lamb price was taken to be last season's actual price, \((PL_{t-1})\) where subscript \(t\) refer to time period \(t\). It was thought that farmers' expectations towards wool prices were not only affected by the actual wool price in the previous season, \((PWO_{t-1})\), but also by the quantity of wool stocks held in the previous season, \((WO_{t-1})\). This was because, in many years, farm gate wool prices have been influenced by the buying and selling activities of wool marketing authorities especially the New Zealand Wool Commission. These explanatory variables were chosen because land on wheatgrowing farms is devoted mainly to either sheepfarming or wheat production, as implied by Table 1.

<table>
<thead>
<tr>
<th>Sources of Gross Farm Income on Wheatgrowing Farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wool</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>23.1%</td>
</tr>
</tbody>
</table>

Source: Agricultural Economics Research Unit (1979 b).
On estimating this area equation, under the status quo scheme over the period 1953-79, the best statistical fit was obtained when the area harvested was equated with last year's area harvested plus the change (Δ) in area harvested between last year and the current year. In addition it was found that excessively wet conditions at drilling time (D) reduced the area in 1975 and 1979. Estimates of the unknown parameters are shown in equation (1), where standard errors associated with the parameters are shown in brackets. The associated coefficient of multiple correlation adjusted for degrees of freedom, $R^2$, and Durbin Watson statistic, $d$, are also given.

$$\Delta A_t = 3.742 + 0.601 \Delta (ENBP_t/PL_{t-1})$$

$$\quad \quad + 0.212 \Delta (ENBP_t/PO_t) + 0.031 \Delta WO_t + D_t$$

$$R^2 = 0.79$$

$$d = 1.76$$

where $D_t = -29.33$ in 1975, $-14.97$ in 1979 and 0 otherwise

2.2.4 Cost to Consumers

A cost to consumers was defined as the cost of providing a sufficient quantity of wheat to meet New Zealand's milling grade wheat consumption requirements; that is the consumer cost per tonne multiplied by the tonnes of wheat consumed. In any year when wheat was imported the cost per tonne was taken to be a weighted average of the basic price and the import price, the weights being determined by the proportion of consumption requirements that are domestically harvested and the proportion that are imported. When wheat was exported or the country was self-sufficient in wheat production the cost per tonne was simply the basic
price. This definition implied that the cost of any export loss was borne by the producer rather than the consumer.

The majority of milling grade wheat is used for bread production and this tends to be an essential food item in most household budgets. Therefore, it was assumed that the consumption requirements were exogenous, that is the demand for milling grade wheat was independent of the particular producer pricing scheme.

The true cost of supplying a sufficient quantity of wheat to meet New Zealand's consumption requirements includes the cost of the product plus the additional costs incurred in moving the product to the flour mill. These additional costs, which include storage, handling and transport, were not formally modelled in this study.

Additional costs incurred when moving wheat to flour mills within either the South Island or North Island will tend to be incurred irrespective of the particular pricing scheme. Between island movements of wheat tend to be confined to South Island grown wheat being transported from rail sidings to Auckland. If the South Island production cannot meet this additional North Island demand then wheat is imported from an Australian port, usually Sydney. Given that those, between island and trans Tasman additional costs are roughly equivalent on a per tonne basis the omission of additional costs was not considered significant.

### 2.2.5 Revenue to Producers

A weakness of the model was that it considered only the average, and not marginal, value of potential wheatgrowing
land. That is each additional unit of land was taken to be worth as much as each preceding unit. For example the capital and labour requirements per hectare for wheat-growing were taken to be the same whether the producer grew 25 or 50 hectares.

The revenue to producers was deemed to be the gross margin obtained at the farm gate from production taken off a fixed area of potential wheatgrowing land. To obtain the gross margin it was necessary to subtract direct costs from the gross revenue earned by the wheat and sheep production enterprises.

The gross revenue from wheat was defined as milling grade wheat production valued at the real basic price generated by the particular pricing scheme. Wheatgrowing direct costs were calculated to be $198 per hectare in 1979 and this figure was adjusted by a wheatgrowing costs index for the preceding years.

The gross revenue from sheep production was $249 per hectare in 1979 but this varied between years due to fluctuating meat and wool prices. Direct costs associated with sheep production were estimated at $73 per hectare in 1979 and this figure was adjusted by the sheepfarming prices paid index for the preceding years. Further details on the calculations of these 1979 figures are found in Appendix 3.

The two possible production enterprises give rise to three alternative production situations, which relate to the degree of substitution between wheat and sheep. The first is that of complete substitution; that is a hectare of wheat causes a hectare of land to be unavailable for sheep production.

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4. This was taken to be an arbitrary 200,000 hectares since the largest area of wheat harvested in N.Z. was 162,000 in 1892. The arbitrary way in which the fixed area was chosen does not affect the interpretation of results.
The second situation is no substitution; that is a hectare of wheat has no effect on the land available for sheep production.

These two situations are extremes and the more likely possibility is partial substitution; that is a hectare of wheat causes part of a hectare of land being unavailable for sheep production. It was assumed that 1 hectare of wheat caused 0.5 hectares of land being unavailable for sheep production. Clearly this is a simplification of reality and some sort of non linear function, by which wheat and sheep became more competitive for land as more wheat was grown, would give an improved representation of product substitution.

2.2.6 Foreign Exchange

This was taken to be overseas funds earned from the fixed area of potential wheatgrowing land minus any funds paid out to buy that quantity of imported wheat needed to fill the gap between domestic production and consumption. The funds earned from potential wheatgrowing land were defined as the tonnes of wheat exported valued at the export price of wheat plus the f.o.b. value of export sheep product earnings.

Export sheep product earnings were deemed to be those hectares of potential wheatgrowing land used for sheep production multiplied by the sheep gross revenue per hectare f.o.b. This last variable was composed of two parts. First, there was the sheep gross revenue per hectare at farmgate. This was taken to be $249 in 1979 but varied between years due to fluctuating export meat and wool prices. The second
component, value added per hectare from farmgate to f.o.b., was assumed to be $183 in 1979. Further details on the calculation of these 1979 figures are found in Appendix 3.

The inputs required for wheat production involve machinery which has a higher imported content than inputs required for sheep production. However, due to the lack of data regarding the levels of these two import components no attempt was made to include them explicitly in this study.

A schematic summary of the model is given in Figure 2. The historical data used to simulate the different schemes were taken to be exogenous while the policy criteria were assumed to be endogenous. A description and full listing of this historical data are found in Appendix 4.

2.3 Validation

An intractable validation problem was the assumption about farmers' wheat area response to different schemes. An assumption made was that the farmers' expected net basic price to different schemes was correctly specified. In addition it was taken that the coefficients obtained by estimating the wheat area econometric equation, from data obtained under the status quo scheme, would remain unchanged for alternative pricing schemes. These assumptions could be regarded as somewhat tenuous.

It was only possible to attempt to validate the status quo scheme and the only data available for validating this scheme were historical information on wheat areas. A comparison of these data with those generated by the wheat area econometric equation gave an indication of how well the equation explained the historical facts. It was thought
FIGURE 2

Schematic Representation of the Model

Consumption of Milling Grade Wheat

Cost to Consumers

Import Price of Wheat

Schematic Representation of the Model

Australian Price

Basic Price of Wheat

Area of Wheat

Production of Wheat and Sheep

Net Basic Price

Foreign Exchange

Revenue to Producers

Prices for Lamb & Wool

Yield of Wheat

Revenue to Producers

Key

Endogenous

Exogenous
that the equation was suitable for policy analysis work provided it was used within the sample period over which it was estimated.  

For the remainder of the status quo scheme, validation procedures involved graphically comparing policy variable results against subjective judgements of what the output should be. This approach was necessary since policy criterion levels are not published in the form defined by the model. Subjective judgements on the output were made by those conversant with industry and the general consensus was that the output seemed reasonable.

CHAPTER 3

RESULTS

3.1 The Simulation Experiments

Simulation experiments were performed over different time periods to evaluate the impact of alternative pricing schemes on criteria which were thought to be of interest to policymakers. The programming language used was ALGOL, a general purpose language.

These simulations were dynamic in the sense that estimated wheat areas in past periods were carried forward and used to define the current wheat area as last period's wheat area plus the change in wheat area as estimated by the econometric equation.

The simulations were deterministic in the sense that historical data was used and a zero value was assumed in every year for the error term in the econometric equation which was embedded in the model. All other equations in the model were specified as identities.

To facilitate a check as to whether the relative performance of schemes was sensitive to the time period chosen, results were calculated over two time periods. The periods were 23 years (1957-79) and 7 years (1973-79). The starting year for the long time period was constrained to 1957 due to lack of data on some variables prior to this date. The beginning date of 1973 for the more recent time...
period was chosen because, since that year, the Australian price has tended to be above the historical basic price.

The effect of schemes on policy criteria are summarised in Tables 1 and 2. The central tendency summary measure used was the mean or average level of a policy criterion (Ave) over the period of years considered. The stability measure reported was the coefficient of variation (CV); that is the standard deviation, divided by the mean and expressed as a percentage. This section discusses the results of these Tables mainly by comparing alternative schemes with a benchmark; the benchmark used was the status quo scheme.

3.2 Effect of Schemes on Policy Criteria

3.2.1 Net Basic Price

It can be seen that under the status quo scheme, the average price received by growers measured in 1979 dollars, over the recent 7 year period was $27 per tonne lower than that obtained over the 23 year period.

The average price was greater than the status quo in schemes 3, 8, 10 and 11 over the 23 year period, and in all schemes except 7 and 9 over the 7 year period. The only schemes for which the average price was less than the status quo scheme over both time periods, were 7 and 9. These two schemes constrained price movements to grower cost increases at times when world wheat prices were rapidly rising. A more stable price than the status quo occurred in schemes 1, 2, 5, 6 and 7 over the 23 year period, and in schemes 7, 8 and 9 over the 7 year period.
### TABLE 2

Effect of Schemes on Policy Criteria over 23 years (1957-79)

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Net Basic Price</th>
<th>Self Sufficiency</th>
<th>Cost to Consumers</th>
<th>Revenue to Producers</th>
<th>Foreign Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ave</td>
<td>CV</td>
<td>Ave</td>
<td>CV</td>
<td>Ave</td>
</tr>
<tr>
<td>Status Quo</td>
<td>$'79/t</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>$'79 mill</td>
</tr>
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<td>53.2</td>
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<tr>
<td>2</td>
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<td>47</td>
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<td>0</td>
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<tr>
<td>13</td>
<td>155.8</td>
<td>18</td>
<td>73.2</td>
<td>50</td>
<td>53.1</td>
</tr>
</tbody>
</table>
TABLE 3
Effect of Schemes on Policy Criteria over 7 years (1973-79)

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Net Basic Price</th>
<th>Self Sufficiency</th>
<th>Cost to Consumers</th>
<th>Revenue to Producers</th>
<th>Foreign Exchange</th>
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<td>Ave CV</td>
<td>Ave CV</td>
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<td>90.3 25</td>
<td>56.2 19</td>
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<td>61.8 16</td>
</tr>
<tr>
<td>3</td>
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<td>94.7 31</td>
<td>60.1 29</td>
<td>68.2 31</td>
<td>64.1 16</td>
</tr>
<tr>
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<td>90.7 29</td>
<td>56.8 24</td>
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<td>62.1 16</td>
</tr>
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<td>82.2 21</td>
<td>51.0 15</td>
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<td>58.7 17</td>
</tr>
<tr>
<td>6</td>
<td>165.3 21</td>
<td>88.7 27</td>
<td>55.0 21</td>
<td>60.6 25</td>
<td>61.3 16</td>
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<td>76.6 19</td>
<td>44.2 10</td>
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<td>56.3 15</td>
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<td>187.9 4</td>
<td>102.0 22</td>
<td>59.8 8</td>
<td>71.5 22</td>
<td>68.2 19</td>
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<td>40.9 17</td>
<td>53.3 15</td>
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<tr>
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<td>65.5 28</td>
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<tr>
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<td>67.1 17</td>
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<td>67.8 32</td>
<td>34.4 2</td>
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<tr>
<td>13</td>
<td>159.6 31</td>
<td>94.8 31</td>
<td>54.9 24</td>
<td>62.6 33</td>
<td>63.8 17</td>
</tr>
</tbody>
</table>
Associated with these more stable prices was a lower average price. However, this tradeoff did not occur in scheme 8 over the 7 year period, because a major determinant of the basic price was the percent short fall in last year's self sufficiency and this kept prices high and relatively stable. Also, the tendency did not occur in scheme 9 over the 23 year period because the increase in the basic price was constrained by the increase in producers' costs.

3.2.2 Self Sufficiency

The status quo scheme achieved a 10 percent greater level of self sufficiency for the 7 year period compared to the 23 years. The main reason for this increase was that wheat consumption has been significantly less in the 1970's compared to the 1960's.

The self sufficiency level was higher than the status quo in schemes 8 and 11 over the 23 year period and in schemes 1, 2, 3, 4, 6, 8, 10, 11 and 13 over the 7 year period. By ranking these results alongside the net basic price results it was found that a higher producer price for wheat did not necessarily result in a higher self sufficiency level. This was because producers' wheat area was determined by net basic price relative to prices for fat lamb and wool. Only if these two sheep related prices decreased or were held constant would a higher net basic price be expected to cause a higher self sufficiency level.

More stable self sufficiency levels than the status quo were achieved only by scheme 8 over the 23 year period and schemes 7 and 9 over the 7 year period. This suggests that the past scheme has performed well in achieving a
stable self sufficiency, relative to other schemes that would be more closely associated with the world price.

3.2.3 Cost to Consumers

This cost under the status quo scheme has declined in more recent years, that is the 7 year period compared to the 23 years. The main cause of this decline was a $9 reduction in the average consumer cost per tonne.

The average cost was smaller than the status quo over the 23 year period in schemes 1, 5, 6, 7, 9 and 13 while over the 7 year period it was only smaller in schemes 7 and 9. A closer examination of time paths, associated with the policy criteria, revealed a strong positive correlation between cost to consumers and net basic price. This was because the basic price of wheat has been a much greater component of the consumer cost per tonne than the import price for wheat.

3.2.4 Revenue to Producers

Producers' revenue was higher than the status quo scheme in schemes 2, 3, 4, 8, 10 and 11 over the 23 year period and all alternative schemes except 7, 9 and 12 over the 7 year period. Ranking of these results along with previously discussed policy criterion results showed that schemes with a higher producers' revenue also had either a higher net basic price or a higher self sufficiency or both. This result is to be expected because producers' revenue, as defined by the model, is affected by net basic price and the level of self sufficiency.
The traditional pricing scheme has, in the past, given producers a relatively stable income. The only scheme to give a more stable income was scheme 12 over both time periods and scheme 9 over the 23 year period.

3.2.5 Foreign Exchange

A comparison of the status quo scheme with that of importing all wheat requirements (scheme 12) shows that New Zealand has saved considerable foreign exchange by growing a large proportion of its domestic wheat requirements.

Foreign exchange was higher than the status quo in schemes 3, 8 and 11 over the 23 year period and in schemes 1, 2, 3, 4, 6, 8, 10, 11 and 13 for the 7 year period. Ranking these results, alongside the self sufficiency outcomes, shows that foreign exchange increased as self sufficiency increased. The principal reason for this strong positive correlation was that, one hectare of wheat replaced more foreign exchange than a hectare of sheep produced under all alternative schemes.

3.3 The Substitution Rate Assumption

One assumption that was not made with confidence was the 1:0.5 substitution rate. That is 1 hectare of wheat was taken to be grown at the cost of 0.5 hectares of land being unavailable for sheep production. This assumption affects two policy criteria; revenue to producers and foreign exchange. It was found, when the simulation experiments were rerun using substitution rates of 1:0.25, 1:0.75 and 1:1, that these two policy criterion levels relative to the status quo scheme remained virtually the
same as those levels recorded when 1:0.5 was assumed. This implies that the relative performance of schemes was robust to the substitution rate assumption. That is the policy criterion levels of all schemes move by roughly the same amount as the substitution rate assumption is changed.

To indicate the proportional magnitude of movement in these policy criteria when the substitution rate assumption is changed the results obtained under the status quo scheme are shown in Table 4. As would be expected, the revenue to producers and foreign exchange both declined as the substitution rate became more competitive.

**TABLE 4**
Effect of Substitution Rate Assumption on Status Quo Scheme

<table>
<thead>
<tr>
<th>Substitution Rate</th>
<th>Change in Revenue to Producers</th>
<th>Change in Foreign Exchange</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>23 years</td>
<td>7 years</td>
</tr>
<tr>
<td>1:0.50</td>
<td>Ave</td>
<td>Ave</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-5.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-25.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

aRelative to that obtained under 1:0.25 substitution rate assumption.

3.3 Implications for Policy

3.3.1 The Status Quo Scheme

The results show that the scheme used for setting the past wheat price has performed well in achieving a stable self sufficiency, relative to other schemes that would be more closely associated with the world price. This result
is reconcilable with that obtained by Chudleigh et al (1978 b), for their study was comparing the status quo with schemes used in overseas countries where the area of wheat sown was not as greatly influenced by unstable meat and wool prices.

A comparison of the status quo scheme results for the 7 year and 23 year periods showed that in recent years the net basic price has decreased by $27 per tonne and yet self sufficiency has increased 10 percent. The fact that a decrease in real prices to the producer resulted in an increase in self sufficiency can be partly explained by total wheat consumption declining in recent years. However, it also suggests that the productivity of growers has increased in recent years. Over this same time period the cost to consumers has declined by $9 per tonne. This small decline, relative to the large fall in producer wheat prices, was mainly due to the high imported price of wheat in recent years.

It was found that this traditional pricing scheme has in the past given producers a stable total revenue, relative to alternative schemes. The scheme has also saved the nation considerable foreign exchange when compared to the option of importing all wheat requirements.

3.2.2 Alternative Schemes

The performance of alternative schemes, relative to the status quo scheme, was sensitive to the time period over which the model was simulated. This was because alternative schemes were more responsive than the status quo scheme to movements in the world wheat price. Despite this sensitivity, some generalisations can be made concerning the character
of alternative schemes and their ability to meet objectives as discussed in section 2.2.

The direct linkage of schemes 3, 10 and 13 with the world price resulted in these schemes having the most unstable prices over the recent 7 year period. As would be expected the average price level was higher in scheme 3 where the basic price was linked to the current Australian price, than in scheme 13 where the basic price was linked to last year's Australian price.

The buffer fund in scheme 4, when compared with scheme 3, was successful in stabilising prices to producers. However, because it was not self balancing the net basic price was lower by $3 per tonne over the 23 year period and $13 per tonne over the more recent 7 year period. A similar fund, which was self balancing, would have also been successful in stabilising prices. This implies that it is in the producer interests to ensure that any buffer fund scheme is self balancing.

Schemes 1, 6 and 2 achieved their objective of more stable prices than those obtained by schemes closer linked to the world price, such as schemes 3, 10 and 13. Because these schemes were slow to react to any change in world prices, the cost of this stability objective was a price level below that obtained in scheme 3.

The cost of achieving total self sufficiency in wheat production was unstable net basic prices, as shown by scheme 11, especially over the 23 year period when large fluctuations in fat lamb and wool prices occurred. Scheme 5 was unsuccessful in consistently achieving a high level of self sufficiency because it assumed the world wheat price would always
increase. Although average self sufficiency levels were below the status quo, the scheme did consistently give a stable net basic price.

The attempt to compensate for movements in wheatgrowing costs and world wheat prices failed in schemes 7 and 9. Both schemes resulted in the average wheat price being less than the status quo scheme, mainly because they constrained basic price movements to grower cost increases at times when the world wheat price was rapidly rising. Scheme 8 was successful in its objectives of adequate compensation for wheatgrowing costs, keeping up with world wheat prices and attaining a high self sufficiency level.

3.3.3 Desirable Schemes

The Wheat Board Act 1965 stresses self sufficiency as a necessary objective to conserve overseas funds in an attempt to contribute toward a satisfactory balance of payments. A satisfactory balance of payments is only necessary in as much as it enables the country to pay its foreign import bill. The concern for conservation of overseas funds, in addition to ensuring that the import bill can be paid, also results in the best use of resources. This desire to conserve overseas funds may or may not be achieved by increasing the level of wheat self sufficiency. It will depend on whether the resources presently used for wheat production, if engaged in an alternative enterprise, might be able to generate enough foreign exchange to import the equivalent wheat foregone plus additional imports.

The policy criterion used in this study to indicate the conservation of overseas funds was foreign exchange. Over
both time periods schemes 3, 8 and 11 had a higher foreign exchange earnings than the status quo. These last two schemes, which seek a high level of self sufficiency, performed well mainly because the particular model used in this study ignored fixed costs and the imported inputs involved in wheat and sheep production.

These two omissions resulted in the model favouring wheat on a per hectare basis, rather than sheep. For example in 1979, under the status quo scheme, foreign exchange favoured wheat by a gross margin of $184 per hectare. The relatively large amount of machinery needed for wheat growing causes these two omissions to be important as machinery fixed costs and the import components of machinery are significant. These two weaknesses of the current model would need to be overcome before it is possible to say anything definite about schemes which seek a high level of self sufficiency.

Scheme 3 maintains the domestic wheat price at a level comparable to world price levels and is also that suggested by Zwart (1978) as being necessary to maximise the value of the wheat industry to the nation as whole. The fact that this scheme performs well in an empirically based study such as this one, and a theoretical study, implies that it is a more desirable scheme than the traditional method of wheat price setting.

3.3.4 The New Scheme

A new producer pricing structure for wheat production has been recently announced and is similar to some of the
schemes analysed in this study but it is not identical to any of them. The scheme relates the basic domestic wheat price to a 3 year moving average of the world wheat price as specified by the Australian price. The moving average uses the export price of the last two seasons and a price estimated in December of the current season, which is approximately from February through to the next December. In addition the scheme also provides for a minimum producer price set at 90 percent of the price paid to growers in the previous season.

An indication as to how well this new scheme would have performed in the past, relative to the traditional pricing scheme, can be obtained from this current study. Higher and more unstable domestic producer wheat prices would have been achieved. These higher prices would have resulted in higher cost to consumers and probably a higher wheat self sufficiency level. Both the revenue to producers and foreign exchange earnings would have been greater than the traditional scheme.
CHAPTER 4

AREAS FOR FURTHER RESEARCH

4.1 A Forecast of World Wheat Prices

The problem facing policymakers responsible for the new wheat pricing scheme is to estimate world wheat prices up to 12 months in advance. One way of obtaining these forecasts is to use a futures market.

Strong advocates of futures markets claim that virtually all grain traded internationally in the world is priced in direct relationship to daily values competitively determined on the U.S. futures market and that the international grain market is a simple extension of the U.S. futures market. Critics of this view argue that the international grain market is characterised by imperfect competition and that futures markets do not play as significant a role in price discovery and formation as advocates claim.

To decide if price forecasts should be obtained from a futures market a measure is needed as to the informational efficiency of the market. Considerable overseas empirical research has already been directed toward this issue and therefore a literature review would be a useful aid in deciding whether a futures market should be used to estimate world wheat prices up to 12 months in advance.

An alternative way of obtaining the price forecasts would be to build a short term forecasting model of the world
wheat price. The explanatory variable that might be included in an econometric specification are wheat production in the major exporting and importing countries; production of other competing food and feed grains; wheat stocks in the exporting countries; import requirements in the main importing regions; and, the net export availabilities of wheat in the exporting countries.

4.2 An Evaluation of Price Differential Schemes

The Wheat Board, a quasi-government marketing authority, is ultimately responsible, after discussions with grower representatives, for the administration of producer wheat price premiums and discounts which are currently related to wheat varieties. These price differentials are used as instruments to adjust the national wheat variety mix so that the domestic quality needs of the different end users are met. An annual decision faced by policymakers is to decide the optimum wheat price premiums and discounts. An aid to making this decision would be quantitative information on regional wheat quantities likely to be supplied, if a particular price differential scheme was announced.

Wheat variety yield information is available on a regional basis, and tolerable South Island regional wheat supply functions can be estimated. Given these tools it would be possible to evaluate the effect of alternative farmgate price differential schemes on regional South Island wheat supplies and consequent consumer costs. A similar methodological approach could be used to that used in this study.

6. See Agricultural Economics Research Unit (1979 a)
4.3 An Evaluation of the New Scheme

The recently announced producer wheat pricing scheme links the price received by the grower to world wheat prices. This link includes a forecast being made of world prices up to 12 months in advance. This new scheme was different to any of the schemes analysed in this study. Although indications can be obtained from the study about the new scheme's performance, more information is needed about its advantages, pitfalls and likely consequences. This information could be obtained by analysing the new scheme within the model framework used in this study, but with extensions.

A way of securing the necessary price forecasts of world wheat prices is to use values obtained from a U.S. grain futures market. If there is forecasting error then this will particularly affect the foreign exchange earned by the scheme. For example an optimistic price forecast would result in New Zealand growing some wheat at a more expensive cost than what it could import it. Alternatively a pessimistic forecast would cause the country to import some wheat at a higher price than what it could grow it for. Therefore it would be useful to analyse the implications of these forecasting errors.

The measure of foreign exchange used in this study was a gross, rather than a net, amount. That is, the imported inputs involved in wheat and sheep production were disregarded. This is an important omission as the import components of machinery, on a per hectare basis, up to the farmgate are probably more significant in wheatgrowing than sheep production, due to the machinery intensive nature of wheat harvesting.
However from the farmgate to f.o.b. the situation could be reversed, depending on the value of the import component of machinery involved in different operations within New Zealand. These operations include transporting wheat and sheep products, and processing sheep at freezing works. Given these different operations, it would be useful to know the contribution that wheat production makes to foreign exchange net of imported inputs.

A further extension could also be to derive more general and explicit functional relationships between this new pricing scheme and the different wheat industry policy criteria.
REFERENCES


APPENDICES
APPENDIX 1
POSSIBLE PRICING SCHEMES CONSIDERED

Given the historical data on the exogenous variables HBP, AP, MP, FCD, FCI and WP from Appendix 4, the model calculated the basic price (BP), in $/tonne, for the different schemes as given below. Two lagged endogenous variables used in the calculations were:

\[ NBP_{t-1} = \text{Last year's net basic price ($/tonne)} \]
\[ SS_{t-1} = \text{Last year's self sufficiency level (％)} \]

In some schemes the basic price was obtained via temporary prices (TP\_l, TP\_2). The change in growers costs (GC) was estimated as the annual percent change in the wheatgrowing costs index i.e. \( \frac{(WP_t - WP_{t-1})}{WP_{t-1}} \times 100 \).

**Status Quo Scheme**

\[ BP_t = HBP_t \]

**Scheme 1**

\[ BP_t = \frac{(AP_t + AP_{t-1} + AP_{t-2})}{3} \]

**Scheme 2**

If \( AP_t > NBP_{t-1} \)

then \( BP_t = NBP_{t-1} + \frac{(AP_t - NBP_{t-1})}{2} \)

Otherwise \( BP_t = NBP_{t-1} \)

**Scheme 3**

\[ BP_t = AP_t \]
Scheme 4
If \( AP_t > 1.1 \ NBP_{t-1} \)
then \( BP_t = 1.1 \ NBP_{t-1} + \frac{(AP_t - 1.1 \ NBP_{t-1})}{2} \)
If \( AP_t < 0.9 \ NBP_{t-1} \)
then \( BP_t = 0.9 \ NBP_{t-1} \)
Otherwise \( BP_t = AP_t \)

Scheme 5
\( BP_t = \frac{(1 - SS_{t-1}/100) \ AP_t + (SS_{t-1}/100) \ NBP_{t-1}}{2} \)

Scheme 6
\( BP_t = NBP_{t-1} + \frac{(AP_t - NBP_{t-1})}{2} \)

Scheme 7
1. If \( AP_{t-1} > NBP_{t-1} \)
then either (a) \( GC_t > 0 \) then \( TP_t = NBP_{t-1} + \frac{(1 + GC_t/100)}{2} \)
or (b) \( -8 < GC_t < 0 \) then \( TP_t = NBP_{t-1} \)
or (c) \( GC_t < -8 \) then \( TP_t = NBP_{t-1} (1 + GC_t/100 + 0.08) \)
now if \( TP_t > AP_{t-1} \) then \( BP_t = AP_{t-1} \)
Otherwise \( BP_t = TP_t \)

2. If \( AP_{t-1} \leq NBP_{t-1} \) and \( AP_{t-2} \leq NBP_{t-2} \) or \( GC_t \leq 0 \)
either (a) \( GC_t > 8 \) then \( BP_t = NBP_{t-1} (1 - \text{Fall}^3 + (GC_t - 8)/100) \)
or (b) \( GC_t < 8 \) then \( BP_t = NBP_{t-1} (1 - \text{Fall}^3/100) \)

3. If \( AP_{t-1} \leq NBP_{t-1} \) and \( GC_t > 0 \)
then \( BP_t = NBP_{t-1} \)

\(^a\) \text{Fall} = \text{last per cent decrease in Australian price.}
Scheme 8

\[ TP_{1t} = \frac{NBP_{t-1} (1 + \frac{GC_t}{100} + \frac{1-SS_{t-1}}{100}/2)}{2} \]

\[ TP_{2t} = \frac{NBP_{t-1} (1 + \frac{GC_t}{100} + \frac{(AP_{t-1} - NBP_{t-1})/AP_{t-1}}{2})}{2} \]

\[ BP_t = TP_{1t} \text{ or } TP_{2t}, \text{ which ever is greater} \]

Scheme 9

If \[ AP_{t-1} > NBP_{t-1} \]

then \[ BP_t \] was minimum of either

\[ NBP_{t-1} (1 + \frac{GC_t}{100}) \] or \[ AP_{t-1} \]

Otherwise \[ BP_t = AP_{t-1} \]

Scheme 10

\[ BP_t = 0.95 (AP_t + FCI_t - FCD_t) \]

Scheme 11

\[ BP_t = f (\text{Wheat Area}) \text{ such that 100 per cent self sufficiency in wheat production is achieved.} \]

Scheme 12

\[ BP_t = 0 \]

Scheme 13

\[ BP_t = AP_{t-1} \]
APPENDIX 2
POLICY CRITERION LINKAGES

Given historical data on the exogenous variables AP, MP, PL, PWO, WO, C, Y, NMQ, CPI, MWB, SP, and WP, from Appendix 4 and the simulated basic price variable from Appendix 1 the model calculated the following policy criteria:

\[
\begin{align*}
NBP & = \text{Net basic price ($'79/tonne)} \\
SS & = \text{Level of self sufficiency (%) } \\
TCC & = \text{Cost to Consumers ($'79 mill)} \\
RP & = \text{Revenue to Producers from 200,000 ha ($'79 mill)}
\end{align*}
\]

The intermediate steps necessary to obtain these policy criteria involved calculating:

\[
\begin{align*}
PD & = \text{Proportion of domestic wheat consumed} \\
PE & = \text{Proportion of domestic wheat exported} \\
\Delta A & = \text{Change in wheat area} \\
A & = \text{Total wheat area} \\
ENBP & = \text{Expected net basic price} \\
MQ & = \text{Milling grade wheat production} \\
X & = \text{Wheat Exports} \\
M & = \text{Wheat Imports} \\
MA & = \text{Milling grade wheat area} \\
PTD & = \text{Proportion of wheat requirements domestically harvested} \\
PTM & = \text{Proportion of wheat requirements imported} \\
CC & = \text{Consumer cost per tonne}
\end{align*}
\]

The calculations involved were:

\[
NBP_t = \frac{(BP_t \cdot PD_t + 0.9 \cdot MP_t \cdot PE_t)}{CPI_t}
\]
ΔA_t = 3.742 + 0.601 Δ(ENBP_t/PL_{t-1}) + 0.212 Δ(ENBP_t/PO_{t-1})
+ 0.031 ΔW_{t-1} + D_t

where D_t = -29.33 in 1975
= -14.97 in 1979
= 0 otherwise

and where ENBP_t = BP_t for schemes 0, 7, 9
= NBP_{t-1} for schemes 2, 3, 4, 5, 6, 13
= AP_{t-1} for schemes 1, 10
= TP_{1t} for scheme 8
= f (Wheat Area_t) for scheme 11

Now A_t = A_{t-1} + ΔA_t

MQt = A_t Y_t - NMQt

SS_t = (MQ_t/C_t) 100

X_t = MQ - C_t

If X_t ≤ 0 then M_t = X_t

If SS_t ≤ 100
then CC_t = (BP_t PTD_t + MP_t PTM_t)/CPI_t

otherwise CC_t = BP_t/CPI_t

TCC = CC_t C_t

MA_t = A_t - NMO_t/Y_t

RP_t = (MQ_t NBP_t - A_t 198 WP_t)/CPI_t
+ (200 000 - MA_t/(1/0.5)) (250 MWB_t - 73 SP_t))/CPI_t

FE_t = (0.9MP_t X_t - MP_t M_t)/CPI_t
+ (200,000 - (MA_t/(1/0.5))) (250 MWB_t/CPI_t + 182).
APPENDIX 3

PRODUCTION PROFITABILITY IN 1979

Figures on the farmgate profitability of sheep and wheat were taken from the Lincoln College Farm Budget Manual, Financial, 1979. These figures for sheep were based on two different management policies: buying replacements and breeding own replacements (pp 7.28), and reported on a ewe replacement basis. The conversion from ewe replacements to stock units for the buying policy was 1:1 while for the breeding policy it was 1.3:1.

Wheat returns were based on two different rotations: old grass to wheat, and wheat to wheat. It was assumed that contractors, at $53 per hectare, were used for harvesting (pp 7.12). The estimate of 11.56 stock units per hectare was calculated as a weighted average of stock units per hectare of available spring grazing area on wheat and non wheatgrowing farms. The profitability calculations were:

(a) **Sheep gross revenue per hectare at farm gate** equalled the average gross revenue per stock unit, for the two different management policies, times stock units per hectare i.e.

$$\frac{(25.80 + 17.37)}{2} \times 11.56 = $249.52$$

(b) **Sheep direct costs per hectare at farm gate** equalled the average direct costs per stock unit for the two different management policies times stock units per hectare i.e.

$$\frac{(10.16 + 2.54)}{2} \times 11.56 = $73.40$$

(c) **Wheat direct costs per hectare at farm gate** equalled the

---

average direct costs for the two different rotations i.e. 

\[(204 + 193)/2 = \$198.50.\]

(d) Sheep gross revenue per hectare from farm gate to f.o.b.

In the early 1970's the proportion of f.o.b. meat and wool values, made up of post-farm gate marketing and processing charges, were 44 percent for lamb and 61 percent for mutton and about 15 percent for wool. This information enabled the gross revenue per stock unit from farm gate to f.o.b. for the different products to be calculated. This was, for the particular product, the average product farm gate gross revenue per stock unit, obtained under the two different management policies, multiplied by the proportion of value added from farmgate to f.o.b. That is:

\[
\begin{align*}
\text{Lamb} & \quad \frac{(13.23 + 3.82)/2}{(0.44/(1-0.44)} = \$6.70 \\
\text{Mutton} & \quad \frac{(4.72 + 5.15)/2}{(0.61/(1-0.61))} = \$7.71 \\
\text{Wool} & \quad \frac{(7.98 + 8.40)/2}{(0.15/(1 - 0.15)} = \$1.44
\end{align*}
\]

The sum of these three farmgate to f.o.b. product values per stock unit ($15.85) was then multiplied by the stock units per hectare (11.56) and this yielded the sheep gross revenue from farmgate to f.o.b. i.e. $183.2.

---


10. Chudleigh (1977), p 1 calculated that wool marketing charges from farm gate to f.o.b. made up 10-18 percent of f.o.b. wool prices.
APPENDIX 4

SOURCES OF HISTORICAL DATA

The data shown in Table 5 are related to the particular harvest year. For example wheat harvested in December 1978 and January/February 1979 is said to be associated with the 1979 harvest year.

The historical basic price (HBP), that is the wheat price f.o.r. paid to the New Zealand grower, was obtained from the Annual Report and Statement of Accounts of the New Zealand Wheat Board. The import price (MP), defined as the cost in New Zealand dollars of importing Australian wheat f.o.b., was also obtained from this Wheat Board publication. The Australian price (AP) was generated by taking the average of the Australian standard white wheat price f.o.b. for the months of September, October and November all measured in New Zealand dollars. These figures were taken from the Statistical Bulletin - Wheat Industry published by the Australian Bureau of Statistics, and converted to New Zealand dollars using the exchange rates reported by the Reserve Bank of New Zealand.

Averages of the mid monthly lamb schedule prices from November to April inclusive were used to calculate the per head lamb price (PL). The price assumed a lamb weight of 13.6 kilograms, and a wool pull of 1 kilogram. Up to 1966 these data were obtained from the New Zealand Meat Producer Board's Annual Reports. In later years they were obtained from the Annual Review of the Sheep and Beef Industry published by the New Zealand Meat and Wool Board's Economic Service.
The wool price used (PW0), was the average New Zealand auction greasy wool price obtained from the Annual Review of the Sheep and Beef Industry.

The wool stocks (W0) were the New Zealand Wool Authorities' stocks in the United Kingdom and New Zealand at 1 July as reported by first the Wool Commission up till 1972, then the Wool Marketing Corporation until 1977 and more recently the Wool Board.

The majority of domestic wheat purchased by the Wheat Board in the past has been milling standard, hence a simplifying assumption was made that milling grade wheat was wheat purchased by the Wheat Board. Therefore wheat consumption (C) in any year was estimated by taking wheat sold to the Board, adding wheat imports and subtracting any wheat exports. Data on exports were obtained from the New Zealand Department of Statistics while data on the other two variables were obtained from the Wheat Board's Annual Report and Statement of Accounts. This Board publication was also the source of data on yields (Y), average freight costs on domestic and imported wheat (FCD, FCI) and total wheat production. Non milling grade wheat production (NMQ) was obtained by subtracting Wheat Board purchases from total wheat production.

The consumers price index (CPI) and the meat, wool and by-products export price index (MWB) were obtained from the New Zealand Department of Statistics while the sheep farm prices paid index (SP) was obtained from the New Zealand Meat and Wool Board's Economic Service. The wheat growing costs index (WP) was generated by taking those items in the sheep farm prices paid index that relate to wheatgrowing. These four indices were then corrected to a 1979 base.
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<th>MP ($/tonne)</th>
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* Estimates

a All money values are measured in New Zealand dollars.
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