QUALITY IN THE NEW ZEALAND
WHEAT AND FLOUR MARKETS

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PREFACE

The A.E.R.U. has a continuing involvement with the New Zealand wheat industry. Annual national surveys of the wheat enterprise have now been carried out for six years; annual national surveys of the financial performance of wheat growing farms have been continuing for four years. All survey results have been published as A.E.R.U. research reports. Also, analysis of factors affecting wheat areas in New Zealand have been researched (see for example Discussion Paper No. 46).

Consumer attitudes to bread have been reported in Research Report No. 91. The wheat marketing system has been studied with respect to wheat pricing (Research Report No. 112) and distribution of wheat and flour (Research Report No. 124).

The issue of wheat quality affects all sectors of the wheat and flour industry. The present Discussion Paper presents a useful framework for discussion of the wheat quality issue and makes some suggestions regarding pricing and segregation policies.

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Director
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SUMMARY

Interest in the quality of N.Z. (New Zealand) wheat and flour is ever-ongoing. A further catalyst to interest in the topic was the announcement that N.Z. farmgate wheat prices would be directly linked with world prices as from the 1981 harvest. This greater exposure of the wheat industry to international market forces has caused wheat millers and flour bakers to advocate more forcefully for quality improvements.

Quality is the set of attributes which the different sectors of the market look for in wheat based products. The objective of this study is to compare the market quality demands with the existing quality supplies of N.Z. grown wheat and flour, in order to suggest management changes that would bring quality supplies closer to quality demands.

The market for wheat and flour is segmented, and centres around that required for milling (300,000 tonnes), animal foods (60,000 tonnes) and seed (13,000 tonnes). For every 100 tonnes of wheat milled approximately 78 tonnes of flour is extracted for human consumption and industrial use, whilst the remaining 22 tonnes becomes bran and pollard byproducts for animal use. The resultant flour is sold mainly to bakers for the production of bread. Other flour buyers include householders, starch and gluten manufacturers, biscuit makers, cake makers and pasta manufacturers.

Wheat for milling needs to have a low screenings content, low moisture content, low sprout index, freedom from insect and bug damage, and heavy grain weight. Millers also require to know grain hardness, protein content and dough strength. Animal feed wheats need to have desirable nutritional qualities primarily in the form of high total energy yield. The seed wheat market requires varieties that are profitable to growers, and multiply into grain that meets the quality requirements of the market to which it is destined (i.e. milling grade or animal feed).

Milling grade wheat products and associated quality requirements are varied. The breakfast cereal market often requires health promoting products that are high in both fibre and protein. Good bread flour
comes from high protein, relatively hard wheats exhibiting strong dough characteristics. Other products requiring this flour type are cracker biscuits, fruit cakes and puff pastry. "Biscuit" flour needs a lower protein, softer wheat exhibiting weaker dough characteristics. Products requiring this flour type are sweet biscuits, plain cakes and short pastry. Pasta flour is best made from certain hard wheat varieties. Starch flour needs a high protein content and a high past viscosity potential.

Quality is affected by management applied at various points along the distribution chain. An organisation that exercises considerable control over this management is the N.Z. Wheat Board. Important quality management aspects include breeding, farm pricing and segregation. This latter topic includes the segregation of milling grade wheat, the segregation and blending of the resultant flour, plus the associated storage and transport.

Suggestions that would bring existing standards closer to the qualities required in the market include the introduction of:

(i) Milling grade protein payments to growers
(ii) Animal feed contracts
(iii) An industrial flour category
(iv) A lower flour extraction rate
(v) A minimum grain weight for defining milling grade wheat.

The institution that has the power to implement and co-ordinate these suggestions is the N.Z. Wheat Board, because it is the single authority responsible for marketing N.Z. wheat and flour. Further research needed, to establish how best to implement some of these suggestions, is also discussed.
CHAPTER 1

INTRODUCTION

The quality of N.Z. (New Zealand) milling grade wheat and flour has always been a concern to the various groups within the industry. For example, in 1977 the N.Z. Wheat Board arranged a seminar to discuss the qualities of Karamu wheat. A further catalyst to interest in the topic was the announcement by the Minister of Trade and Industry that the N.Z. farmgate wheat price would be directly linked with world prices as from the 1981 harvest. Under this new scheme the basic milling grade price paid to growers f.o.r. (free on rail) would be a three year moving average of the N.Z. equivalent of the f.o.b. (free on board) price for Australian Standard White wheat.

This greater exposure of the wheat industry to international market forces has caused certain users of wheat and flour to advocate more forcefully for quality improvements. For example, bakers argue that it is now fair to expect N.Z. grown wheat to have bread making qualities that are comparable to imported Australian Standard White wheat, now that the cost to the Board of wheat from both locations is much the same. The Board, a monopoly marketing authority, is the sole importer of wheat into N.Z.

Quality, whether it be that of wheat or flour, may be thought of as the set of attributes (characteristics) which the different sectors of the market look for in wheat based products. This implies that quality is only a meaningful concept when applied to a particular product in the market. There is also the implication that quality cannot be expressed in terms of a single property (e.g. bake score), because different products will have different requirements. Some quality parameters will be common to all products, whilst others will be specific to a particular product.

Improving these quality parameters involves changing the standards of management which affect the supply and demand of different wheat and flour qualities. The objective of this study is to compare the market quality demands with the existing quality supplies of N.Z. grown wheat and flour, in order to suggest management changes that would bring quality supplies closer to quality demands. The suggestions
need to consider whether the costs of any proposed changes would be economically acceptable to those parties affected by the change.

Chapter 2 of this discussion paper outlines the market for N.Z. wheat and flour. The associated quality requirements are discussed in Chapter 3. Chapter 4 discusses the standards of existing management as they apply to the distribution of wheat and flour. The final chapter suggests changes to existing management that would bring about needed improvements in quality.

The background information for generating this report was obtained (either through personal interviews or reading the literature) from senior executives with extensive experience in the industry.

The discussion considers quality improvements that are consistent with the existing functions of the Wheat Board, one of which is "to encourage wheatgrowing in N.Z. and the use of N.Z. wheat". Therefore two possibilities not considered are: importing Australian wheat, apart from that needed to meet quantity deficiencies in the domestic crop; and importing Australian flour. This means that the discussion is confined to quality in N.Z. grown wheat and flour. The pressure to consider these two wider options may become greater as Closer Economic Relations is progressively implemented between N.Z. and Australia.
A wheat grain (kernel) has a brownish bran coating that is richer in protein and minerals and much higher in fibre than the entire grain. Under the bran is the aleurone layer, a brownish layer consisting of tiny protein granules. The germ (embryo) at the base of the kernel is rich in oil as well as protein and minerals. The rest of the kernel consists of thin walled cells packed with starch. Among these starch cells are the gluten particles that give wheat dough its elasticity, and hence the ability to be used as the raw material for breadmaking. Collectively this starch and gluten make up the endosperm.

This physical description illustrates that a wheat grain consists of several component parts, which in turn suggests that it may have a number of uses. In fact, a wide range of food products, made under very different processing conditions, are produced from wheat. The purpose of this chapter is to show how the wheat and flour markets are segmented.

Wheat used in products for human consumption and industrial use make up what is known as milling grade wheat, whilst wheat used for animal feed is classified as non-milling grade wheat. For N.Z. to meet the domestic milling grade wheat demand about 300,000 tonnes needs to be purchased by the Wheat Board each year from either N.Z. growers or overseas. Most of this wheat is sold to millers, with any residual being sold for animal feed. The demand for non-milling grade wheat is about 60,000 tonnes per year (Elliot, 1980).

Non-milling grade wheat is used to feed a variety of animals, but particularly poultry and pigs. This grain is either purchased from farmers by firms and used as an input into their commercial mixes, or is used directly by farmers themselves. Other inputs to the compound mixes (commercial or home) include maize, barley, oats, bran, pollard and meatmeal. In the commercial mixes these inputs are often combined together using computer techniques in a least cost manner subject to obtaining the appropriate balance of ingredients such as energy, protein, minerals and vitamins. This means that a relative economic value is placed on ingredients according to their nutrient content.
The stockfeed market demand originates principally from poultry and pig farms, the majority of which are located in the North Island. The supply of this stockfeed comes mainly from cereal grains (86 per cent) with wheat (whole wheat, bran and pollard) contributing about 25 per cent (Ireland, 1978). Therefore wheat prices are a significant determinant of stockfeed prices and consequently have an important influence on production costs in the poultry and pork industries.

In addition to the milling and non-milling grades, wheat is also required for seed. About 13,000 tonnes per year are needed, based on sowings calculated from surveys of wheatgrowers (Lough et al, 1981). Growers obtain this seed either by retaining some of their own wheat from last harvest or by purchasing requirements from commercial firms.

Wheat purchased by mills is milled principally into flour, while a small amount is milled into breakfast cereals. A small amount is rejected from the milling process and used as animal feed. For every 100 tonnes of wheat milled, approximately 78 tonnes is extracted as flour whilst the remaining 22 tonnes are byproducts taking the form of bran and pollard. These byproducts also are sold to animal feed manufacturers.

The resultant flour is sold to bakers for the production of bread (i.e. standard, wheatmeal, speciality), buns and rolls; to households for a variety of uses, in forms such as plain, self-raising and wheatmeal; to manufacturers of starch and gluten; to biscuit producers; to makers of cakes such as high ratio, sponge, madeira and pastry; and to manufacturers of pasta products such as macaroni, vermicelli, spaghetti and noodles.

Figures 1 and 2 summarise the wheat and flour markets and illustrate the diversity of end uses.
FIGURE 1
Market for Wheat in N.Z.

Seed (13,000t) → Wheat (60,000t) → Animal Feed

(300,000t) → Mills

FIGURE 2
Market for Purchased Milling Grade Wheat in N.Z.

Open Market Growing
3% Breakfast Cereals
95% Flour Production
2% Feed Wheat

Contract Growing

Bread (45%)
Household Flour (14%)
Starch Gluten (10%)
Biscuits Cakes (9%)
Bran Pollard (22%)
Pasta

Source: Adapted from Ireland (1978)
CHAPTER 3
QUALITIES REQUIRED IN THE MARKET

The previous chapter shows that the N.Z. wheat and flour markets can be divided into numerous segments. The purpose of this chapter is to discuss the quality attributes desired in each of these market segments. Many of the terms used in the discussion are further defined in Appendix 1.

3.1 Wheat

3.1.1 Milling Grade  Wheat must be crushed or ground prior to subsequent processing for all uses, except in animal feeding and certain forms of human food such as some breakfast cereals.

The milling operation attempts to extract as much starch and gluten from the grain as possible whilst avoiding the germ and the bran. The miller first cleans and moistens the grain to toughen the bran. Then he passes the grain between several pairs of steel rollers that gradually break the kernel into pieces and flatten out the bran. This action, coupled with a pneumatic sieving process, separates the endosperm from the bran. Another sophisticated process is used to remove the germ and so leave just flour. Recent years have seen major changes in flour milling technology with the adaption of high capacity milling in which a much greater production of flour is obtained per centimetre of roller surface.

Millers, in selecting wheat for whatever use, require to know whether the grain is hard or soft, and whether it is commercially acceptable. Grain hardness is essentially a varietal characteristic (Appendix 2). A commercially acceptable grain is one that is sound, well filled, with protein content and dough strength suitable to flour users (Ireland, 1981). A sound grain has a low screenings content, low moisture content, low sprout index, and freedom from bug and pest damage. A well filled grain is indicated by a heavy weight. Grains that are sound and well filled allow a large proportion of flour to be extracted with a minimum of milling power.
3.1.2 Animal Feed  Wheat products for consumption by poultry and pigs can take the form of whole wheat, bran and pollard, and compounded stock feeds either commercially mixed or home mixed. The type of wheat that makes a good animal feed is one that has desirable nutritional qualities primarily in the form of high total energy yield. The total energy obtained is primarily determined by the tonnes harvested per hectare, although the energy content within each grain can also vary. The total energy obtained from grain is commonly expressed in terms of metabolisable energy for poultry and digestible energy for pigs. Whilst wheat is traditionally viewed as an energy-rich ingredient its protein contribution can also be of considerable nutritional benefit.

3.1.3 Seed  The seed wheat market requires varieties that cause acceptable farm profits, and multiply into grain which has the quality requirements for the other markets to which it is destined (i.e. milling grade or animal feed). Acceptable farm profits result from varieties that are high yielding, disease resistant, and capable of producing a grain that does not easily shatter and a straw that does not bend.

3.2 Flour Products

Wheat purchased by mills is milled principally into flour, although small quantities of wheat, semolina, bran and wheatgerm are required for breakfast cereals. Consumers of these products are often looking for health promoting qualities such as high fibre and high protein.

Common flour quality characteristics looked for by processors throughout the world are protein content, grain hardness and dough strength (Wrigley and Sheppard, 1974). This last characteristic is determined by the degree of water absorption, stability and extensibility. Processing considerations dictate that at any given protein level, grain hardness and dough strength must be in balance. That is, high protein wheats should be hard and exhibit strong dough characteristics, whereas low protein wheats should be soft and exhibit weaker dough characteristics. Of course there is a graduation of types between these two extremes. This balance requirement has led to the establishment of four internationally recognised quality/price classes (Appendix 3).
3.2.1 **Bread**  Flour is most commonly consumed as bread of one sort or another. The flour is mixed with water plus a leavening agent which is usually yeast. Sometimes other substances are added to produce a special flavour or texture or to encourage the growth of yeast. The mixture is then left for a time to rise and the resultant dough is baked into bread. The presence of gluten in the wheat flour is the reason why bread can only be made from wheat, rather than other cereal grains.

Throughout the world, the quality of bread flour desired by consumers comes from high protein relatively hard wheats exhibiting strong dough characteristics. In N.Z., bakers have identified protein, bake score and sprouting as the critical attributes determining the suitability or otherwise of wheat for bread (Hickin, 1981). New Zealand consumers are thought to demand bread which "consistently has good colour, fine texture and good keeping qualities" (p.133, Ireland, 1978). Fine texture implies a high volume of bread for a given weight. Evidence from a N.Z. survey (Brodie and Mellon, 1978) found that the main reasons influencing the buying decisions of white bread consumers were, in order of priority, freshness, whether bread was wrapped, crust, shape and finally price.

3.2.2 **Biscuits**  Most biscuits are automatically packaged: a process which requires a high degree of uniformity with respect to size and shape. These are requirements that demand a precise flour specification.

Biscuit makers require two classes of flour: a soft flour for sweet biscuits and a stronger flour for cracker biscuits (Lewin, 1981). The soft flour should be low in protein, have low water absorption, and produce a dough with extensible qualities. The stronger flour has a larger proportion of protein, absorbs large quantities of water and is used to produce a fermented dough. This stronger flour is approximately matched by breadbakers' flour in terms of protein and bake score.

3.2.3 **Cakes and Pastry**  Flour for fruit cake requires to be somewhat stronger and higher in protein than for a plain cake, and a similar requirement applies to puff (flakey) pastry compared with...
short pastry (Elliot, 1980). The most widely used cake flours are those made from a high ratio formula which contains a high percentage of fat and sugar and gives cake a very soft, fine texture. Low protein flour of finer granularity than bread flour and treated with chlorine gas to improve its batter making properties is required for this purpose.

3.2.4 Pasta Products Pasta products include macaroni, noodles, spaghetti and vermicelli. The flour qualities required by these products correspond to the qualities inherent in certain hard wheat varieties (e.g. Durum).

3.2.5 Starch and Gluten Starch produced from wheat is used in a range of industries. The main industries relate to food, paper, confectionary, canning and ice cream. The vital dry gluten, which is a byproduct from the wheat starch plant, is used by the baking industry to supplement low protein flours. These two products are obtained by mixing flour and water in a ratio of about 60/40 to form a soft paste which after a short relaxation time enters an extraction unit. Here, under a gentle kneading action, the starch is washed out of the paste leaving gluten behind which is dried separately into a white powder.

For starch and gluten to be economically obtained, the manufacturers desire flour that is high in protein content coupled with a high paste viscosity potential (Beishuizen, 1981).

3.3 Conclusions

Millers require to know whether the grain is hard or soft and whether it is commercially acceptable. Grain hardness is essentially a varietal characteristic. A commercially acceptable grain is one that is sound, well filled, with protein content and dough strength suitable to flour users. A sound grain has a low screenings content, low moisture content, low sprout index, and freedom from pest and bug damage. A well filled grain is indicated by a heavy weight.
Animal feed wheats need to have desirable nutritional qualities primarily in the form of high total energy yield. The total energy obtained is mainly determined by the tonnes harvested per hectare, although the energy content within each grain can also vary. Whilst wheat is traditionally viewed as an energy-rich ingredient, its protein contribution can also be of considerable nutritional benefit.

The seed wheat market requires varieties that allow acceptable farm profits, and multiply into grain which has the quality requirements for the other markets to which it is destined (i.e. milling grade or animal feed). Acceptable farm profits result from varieties that are high yielding, disease resistant, sprout resistant, and capable of producing a grain that does not easily shatter and a straw that does not bend.

The breakfast cereal market needs wheat, semolina, bran and wheatgerm. Consumers of these products are often looking for health promoting qualities such as high fibre and high protein.

Common flour characteristics looked for by processors are protein content, grain hardness and dough strength. Processing considerations dictate that at any given protein level, grain hardness and dough strength must be in balance. Desirable bread flour comes from high protein, relatively hard wheats exhibiting strong dough characteristics. Other products requiring this flour type are cracker biscuits, fruit cakes and puff pastry. "Biscuit" flour needs a lower protein, softer wheat exhibiting weaker dough characteristics. Products requiring this flour type are sweet biscuits, plain cakes and short pastry. Pasta flour is best made from certain hard wheat varieties. Starch flour needs a high protein content and a high paste viscosity potential.
CHAPTER 4

EXISTING QUALITY MANAGEMENT

An organisation that exercises considerable control over existing quality management is the N.Z. Wheat Board, best described as a quasi-government, monopoly marketing authority. The current authority derives its power from the Wheat Board Act 1965, and subsequent amendments. The functions that the regulations at present define for the Board include:

To be the sole buyer and seller of milling grade wheat;
To promote the development of the wheatgrowing and flour milling industries;
To encourage wheatgrowing in N.Z. and the use of N.Z. wheat;
To ensure adequate supplies of wheat and flour are available throughout N.Z.

The purpose of this chapter is to describe the present quality management that controls the distribution of wheat and flour. The discussion confines itself to the management considered most important, that is breeding, pricing and segregation.

4.1 Breeding

The present varieties available to N.Z. growers are primarily a result of N.Z. breeding efforts, although some varieties (e.g. Karamu, Gamenya) were imported. N.Z. breeders fall into two broad categories: those employed by government, that is the Crop Research Division of the Department of Scientific and Industrial Research, and those employed within the private sector.

Information on new cultivars bred either by government or private organisations is brought to the attention of the Wheat Research Committee who then make recommendations regarding the release or otherwise of the cultivars for growing in N.Z. In the light of any recommendation, the responsibility of either placing the new cultivar on the commercial market or withdrawing it remains with the breeder.
The Wheat Research Committee acts as "an effective forum for
discussion by all parties interested in wheat" (Langer, 1981). The
composition of this committee is detailed by the Wheat Research Levy
Act, and includes two millers, two bakers, two growers, one grain
merchant, one N.Z. Wheat Board representative, and up to three other
persons appointed as the Minister of Science may from time to time
determine. The Committee have on occasions decreed that any new
variety, to be eligible for release, must "be superior in one respect
to the existing standard variety and also be at least equal to the
standard variety in all other quality respects" (Smith, 1981). Quality
was taken to cover yield, milling and baking characteristics. In
recent times the criteria have become "more flexible but have not yet
been documented" (Gould, 1982).

Government wheat breeding objectives are targeted towards specific
markets: namely bread, pasta, animal feeds, biscuits and starch
(Smith and Bezar, 1981). The main changes in government breeding
programmes over the past two decades have been the expansion of breeding
targeted towards particular regions. Crop Research Division breeding
stations were established at Lincoln in 1929, Palmerston North in 1966
and Gore in 1972. These North Island and Southern South Island breeding
stations have concentrated on developing quality in spring sown culti-
vars. This has enabled the Lincoln Station to concentrate on develop-
ing quality in autumn sown cultivars. In addition, since 1979 the
Lincoln Station has also developed a breeding programme for early
spring sowings on irrigated light soils.

Private breeding has become profitable in N.Z. since the intro-
duction of the Plant Varieties Act 1973. This legislation granted
property rights to plant breeders and therefore enabled royalties to
be obtained by breeders patenting new varieties. The legislation
has caused an upsurge of private breeding activity by various commercial
firms. This upsurge has resulted in the formation of the N.Z. Plant
Breeding and Research Association, an organisation that seeks to
represent the private breeders.

At present a representative from the private breeders is able
to informally sit in on Wheat Research Committee meetings (Smith,
pers. comm.). This opportunity is being used because private breeders recognize that comments by the Wheat Research Committee might influence the Wheat Board's decision regarding the price differential that will apply to a new cultivar, whether it be bred privately or by government.

Since plant variety rights legislation was introduced a study (Agriculture Canada, 1980) has shown that N.Z. has witnessed an increase in private plant breeding, improved access to foreign plant varieties, an increase in the number of plant varieties available, and more rapid development of superior plant lines. The history of plant variety rights goes back to 1961 when the International Union for the Protection of Plant Varieties was established. By 1982, some 25 countries had introduced provisions for the granting of property rights in plant varieties (Ockwell, 1982).

The emergence of the Plant Varieties Act coincided with the introduction of a scheme for recording cultivar names on a national list of acceptable cultivars. This scheme assists N.Z.'s participation in the O.E.C.D. scheme for the varietal certification of seed moving in international trade. The scheme is administered by the Ministry of Agriculture and Fisheries, through the National List Authority.

4.2 Farm Prices

Up until 1980, direct negotiation between grower representatives with the N.Z. Wheat Board and the N.Z. Government determined milling grade farm-gate prices (i.e. the f.o.r. price for domestically produced milling grade wheat). A basic price was set for certain varieties and then premiums and discounts relating to other varieties were set about this basic price.

During 1980 the Minister of Trade and Industry announced that starting with the 1981 harvest the basic wheat price paid to growers would be fixed by a three year moving average of the N.Z. equivalent of the f.o.b. price for Australian standard white wheat. The quality of this wheat relative to other wheats is discussed in Appendix 3.
The calculation of the basic price includes the last two seasons' actual Australian prices and an estimated Australian price for the coming season announced in December. Concurrent with this change, Government decided that the fixing of variety premiums and discounts should be the sole responsibility of the Board (p.23, N.Z. Wheat Board, 1981).

When setting these price differentials the Board considers how well the qualities of a particular variety correspond to the qualities that it thinks are required in the market place. Advice about qualities that a new cultivar possesses is sought from the Wheat Research Committee. There is no self balancing mechanism that trades premiums off against discounts to ensure that Board total payments to growers remain constant at a predetermined budgeted figure (Elliot, pers. comm).

The Board encourages the production of high baking score wheats, particularly in the South Island, by announcing regional variety price differentials. For example, in the 1982 harvest a 17.5 per cent premium was paid for Hilgendorf whilst a 5 per cent discount was applied to Arawa, a 15 per cent discount was levied on South Island grown Karamu and a 7.5 per cent discount was applied to North Island grown Karamu. Consideration is being given to phasing out the Hilgendorf premium because varieties with this bake score are no longer in short supply. Farmers are now growing large quantities of Oroua, which have similar bake scores to Hilgendorf, although grain weights are lighter.

The above example shows that price premiums and discounts are used to encourage farmers to not only grow the more desirable quality wheats, but also to grow that variety which is more suited to their region. This practice is likely to be used more in the future because a greater range of new varieties could become available to growers, now that royalties can be obtained by breeders patenting new varieties. The Board says that encouragement will "be given to the growing of wheat cultivars in areas best suited to their quality characteristics" (p.24, N.Z. Wheat Board, 1981). This is sensible because wheat becomes recognised in terms of quality as much by the region in which it is grown as it is by variety. This philosophy is also consistent with
Australian practice where wheat is graded by region as well as variety (Appendix 3).

These premiums and discounts are not always appropriate for encouraging special purpose wheats. Where this is the case contracts are negotiated between millers and growers for a specified wheat area. Whilst the price paid to the grower is not constrained to the premiums and discounts set by the Board, the Board still needs to approve the contracts. Contract prices have been negotiated for specified areas of Durum wheat for the pasta market, Konini for the wheatmeal bread markets, and Karamu for parts of the biscuit market. This contract growing of special purpose wheats allows the appropriate area to be grown to meet market requirements.

4.3 Segregation

4.3.1 Milling Grade Wheat Most wheat grown domestically must be offered for sale to the Wheat Board. Exceptions include those lines purchased by the Ministry of Agriculture and Fisheries, as certified seed, and wheat that has been grown for special markets under contract. The wheat offered to the Board will then be purchased by the Board if rated as milling grade by the Wheat Research Institute. Wheat rated as non-milling grade is used for animal feed, either by growers themselves or by stockfeed manufacturers.

The current definition of milling grade wheat, as defined by the Wheat Board Act, is wheat which:

(i) is sound and sweet, free from smut, decay, damage by insect pests injurious to baking quality and any other blemish;

(ii) has a bake test score of at least 12 M.D.D. (Mechanical Dough Development); and

(iii) does not contain more than 0.5 per cent by weight of weed seeds; 5 per cent by weight of weed seeds, other extraneous matter, broken, immature or shrivelled grains; 15 per cent by weight of moisture; and 5 per cent of visibly sprouted grains.
This definition places heavy reliance on the bake test. This reliance is justified because the main end use of wheat is bread. In addition the bake test is appropriate for detecting bug damaged, sprout damaged or plant damaged wheat.

N.Z. is unique in that each wheat line purchased by the Board undergoes the bake test. For many years the Wheat Research Institute milled and baked a large number of test wheats submitted by millers after purchase from growers using a 125 gram loaf test. The problem with this approach was that much non-milling grade wheat was transported to millers unnecessarily. To avoid this unnecessary cartage, a rapid and inexpensive pre-purchase testing service was introduced in 1964 using a 50 gram loaf. The baking score was the combined total of points allocated for loaf volume (maximum 28), texture (14), and flour colour (8). Those lines scoring 30 or more were regarded suitable for milling (Cawley, 1979).

Major technological advances have occurred in the baking industry because of the need to reduce costs. This need resulted in many bakers replacing their bulk fermentation dough-making process, which takes several hours, with a faster mechanical dough development technique. The constraint of this faster system is that greater dough processing tolerances are required. In response to this change in commercial baking technology a 50 gram M.D.D. harvest test was introduced in 1981. This test also measures volume, texture and flour colour. Therefore, to avoid confusion, the M.D.D. test scoring system uses a different range of numerical values from the old bulk fermentation system. To satisfy milling grade standards, a line of wheat needs a bake score of at least 12 points under the M.D.D. system.

Milling grade wheat production is volatile. The size of Board purchases can range from 250-300 thousand tonnes per year (Stonyer and Durbin, 1981). This erratic production is caused by climatic fluctuations affecting wheat yields, bake scores, sprouting and shrivelling. Another contributing factor is the expected profitability of farm wheat production. As this fluctuates relative to the expected profitability of sheep farming, so also does the area of wheat grown. Imports of Australian wheat are used to supplement the
difference in those years when domestic production fails to reach the self-sufficiency level.

4.3.2 Flour Categories and Blends  The amount of wheat that millers want to purchase depends on how much flour they can sell. This variable is regulated by the flour quota which has been allocated to the mill by the Board. Through this system of quotas the Board controls not only flour supply, but also the location, number and size of mills.

The Board monitors the quality of flour produced from each mill through the results of tests on samples sent by mills to the Wheat Research Institute. For white flour, the N.Z. Health Department requires a minimum average flour extraction rate of 78 per cent from wheat. This is to ensure a high fibre and vitamin content is present in the end products. Enforcing this extraction rate is achieved by the Department of Trade and Industry assuming this rate when they calculate, on a cost plus basis, the flour price which millers are allowed to charge flour users. A higher extraction rate would result in a darkening of flour colour grade as more of the fibrous outer layer of bran is mixed in with the starchy endosperm.

Before 1980 flour processors had little choice regarding the quality of their purchases, since there was only one flour grade. The reason for this situation changing was that during the 1970's the Wheat Research Committee recommended the release of the government bred Karamu variety onto the domestic market. Growers were impressed by its much improved yield relative to other wheats, but bakers disliked the associated flour because of its relatively poor bake score. When Karamu flour was blended with flour from other varieties there tended to be a greater bake score variation.

This problem prompted the Wheat Board, in 1980, to instruct millers to segregate flour into two grades according to bake score and variety. Category A has high bake scores (M.D.D. 15 and above), whilst Category B flour has either a low bake score (M.D.D. 12 to 14 inclusive) or is made from the Karamu variety. Category A attempts to capture the "stronger" flour for use in bread, cracker biscuits,
fruit cakes, puff pastry, starch and gluten. Category B is the "weaker" flour to be used mainly for sweet biscuits, plain cakes, short pastry and household flour (Elliot, 1980).

The market demand for milling grade flour is around 85 per cent for Category A and 15 per cent for Category B. In contrast, about 80 per cent of the supply of domestic flour corresponds to Category A, whilst the remaining 20 per cent corresponds to Category B (Elliot, 1980). Therefore millers equate this category supply and demand through blending wheat before processing. This involves some wheat that corresponds to Category B being blended with the wheat that is to be processed into Category A flour. Of course, a cost of such a blending policy is to lower marginally the average bake score of Category A flour.

4.3.3 Storage and Transport The Board is responsible for the storage of milling grade wheat and flour, the transport of this wheat from the farmer's nearest rail station to mill, and for the transport of flour from mill to processor. Brokers, such as grain merchants and transport companies, are employed by the Board to ensure that wheat and flour are moved when required.

Milling grade wheat must be stored because it is harvested in a very short period of the year but required throughout the year for milling into flour. This storage operation can occur both on and off the farm, at shipping ports and flour mills. In the past, on-farm storage has been used most because of a general lack of centralised off-farm storage. Therefore it has been necessary that there be an almost continuous flow of wheat from on-farm storage facilities to mills throughout the entire year. Furthermore the rate of these flows must be such that the on-farm storage is emptied within the year, ready for the next season's harvest. Continuous flows also typify flour movements because most flour is handled in bulk, and there is a lack of bulk storage facilities at mills and flour processing plants.

Of the total N.Z. milling grade wheat production, the North Island contributes a small but increasing proportion. The smallness of this proportion is due in part to the low bake score wheat grown but also
to farm storage space constraints. Often it is more convenient and profitable for North Island farmers to illegally sell wheat of milling grade standard directly for feed rather than wait for a legal sale to the Wheat Board.

Most demand for milling grade wheat and flour is centralised in the Northern North Island areas where population densities are heavy, and yet the major supply sources are dispersed about the South Island and Australia. This results in significant trade flows from various points about the South Island and Australia to Auckland. By far the largest quantities are moved by three bulk ships, under contract to the Wheat Board, in multiples of 5,000 tonnes (Elliot, 1981a). It is possible to segregate in a vessel by hatches which hold between 1,000 tonnes and 2,000 tonnes, depending on the vessel. However, this segregation is not always practical due either to the unavailability of sufficient amounts of similar quality wheat or the inability of the receiving mill to accept large quantities of Category B wheat without detriment to the Category A market.

North Island demand is such that about 220,000 wheat equivalent tonnes need to be transported annually from the South Island or Australia (Borrell and Zwart, 1982). This wheat is moved by a mixture of transport modes in order to allow the Wheat Board flexibility to cover unplanned transport contingencies. Of the modes used, the 5,000 tonne ocean wheat shipment is probably the cheapest per tonne. A popular alternative is the 12 tonne drop of wheat in rail wagons or containers.

Storage appears to be the bottleneck in the process of aggregating and moving wheat from farm to mill. For example, the Wheat Board believes that "if we can segregate wheat satisfactorily, we are well on the way to market satisfaction, but there are problems" (Elliot, 1981a). Ideally each grower needs to store the produce of one paddock in at least one silo, and perhaps several silos if the soil type is particularly variable. However, the cost of silos are such that the produce of several paddocks are often stored in one silo. Ideally off-farm storage needs to be sufficiently flexible to be able to segregate wheat not only by variety, but by protein and bake score within each variety.
CHAPTER 5

SUGGESTIONS TO IMPROVE QUALITY

The purpose of this chapter is to suggest changes to the existing management procedures (Chapter 4) that would bring quality supplies closer to achieving the qualities required in the market (Chapter 3). The discussion considers the benefits of such changes, and where appropriate, whether the increased costs of the suggested changes would be economically acceptable to the affected parties.

5.1 Milling Grade Protein Payments

The Wheat Board takes final responsibility for setting milling grade price differentials (Section 4.2). Therefore the challenge facing the Board is to provide a pricing policy that encourages farmers to sow those varieties and apply those growing management techniques that bring forth the qualities desired by the market (Section 3.3).

Currently the Board uses price differentials to encourage the production of varieties with high bake scores. However, this quality characteristic is only required by bakers. In contrast, a characteristic required by all users of milling grade wheat is protein. Therefore an improvement would be to provide a pricing policy that rewards growers for applying those growing management techniques that cause a high protein content, in addition to the existing rewards available for planting the preferred varieties. In the 1982 harvest, protein levels in the national crop ranged from 7 per cent to 16 per cent, whilst the average was 10.9 per cent.

Such a scheme for N.Z. has been proposed by Cawley (1981). He suggests a common incremental protein payment be applied to the different milling grade farm variety prices. In turn each variety price would be obtained through a system of premiums and discounts similar to that which operates today. These protein payments would self-balance so that total Wheat Board payments would be the same both with and without protein increments. Two grower payments would be made: an immediate payment, based on an initial basic variety price and an end of season payment, based on the protein level of the individual crop relative...
to the average protein level found in that particular variety in that particular season.

The scheme is able to reward growers directly in proportion to the amount of protein they produce. It would only apply to wheat that has achieved the milling grade. The principle underlying the scheme is that protein within milling grade wheat is determined largely by variety and growing management. Therefore if the increments were big enough they could cause a greater effort by growers to select the best variety and apply the best methods of growing in relation to crop rotation, irrigation and fertilizer. This could result in the average protein level of milling grade wheat being raised, perhaps to the point where blending is no longer necessary.

The technology for measuring protein from large numbers of samples within a short space of time is now possible with new infra-red reflectance machines. These machines have been used since 1978 to check the consistency of pre-purchase wheat samples with that of all actual wheat delivered. Therefore a significant portion of the cost of these machines has already been absorbed by the industry.

At this stage of development in the industry, storage facilities are such that flour with different protein levels could be separated into only two categories: high protein and low protein. This could be done if the criteria for segregating category A and B flour was also protein content. This additional criteria would supplement the two criteria already being used, that is bake score and variety (Section 4.3.2).

More research is needed to quantify how growers in various regions would respond to different sized incremental payments, for both variety and protein. Results of such research would assist in the identifying of minimum price incremental payments needed to cause a change in variety and growing management practices so as to bring about a significant improvement in wheat protein supply. Unnecessarily large increments could be unacceptable to farming groups that seek to represent the financial interests of all farmers.
5.2 Animal Feed Contracts

Before any wheat can be grown under contract, the Wheat Board needs to give its approval (Section 4.2). The general policy of the Board is that "the growing of wheat for special purposes under contract" is permissible "where it is satisfied that the premium/discount system is not appropriate" (p.26, N.Z. Wheat Board, 1981). Therefore the challenge facing the Board is to know when the variety price differential payments are inappropriate for encouraging the qualities desired by the market (Section 3.3), and then to allow contract growing to occur in these circumstances.

As a general policy the Board prohibits contract growing of animal feed wheats, although some exceptions have been made in non-traditional growing areas such as Taranaki. Animal feed wheats are special purpose wheats in the sense that the associated market quality requirements are different to the qualities required of wheat for milling. The prime requirement of animal feed wheats is a high total energy yield. In contrast users of milling grade wheat are interested in grain hardness, protein content and dough strength. Therefore the Wheat Board should recognise this point and allow animal feed contracts to be negotiated between wheat growers and animal feed manufacturers.

An argument against contract growing of animal feed wheats is that it could be detrimental to the price which growers receive for milling grade wheat. This would come about because there would be "a substantial reduction in the markets for lower scoring lines of milling wheat surplus to the milling market's requirements and for undergrade wheat" (p.27, N.Z. Wheat Board, 1981). However, such an argument makes the value judgment that the quality requirements of animal feed manufacturers are less important than those of milling grade wheat users. Discussions with a representative from the feed manufacturers indicated that such a value judgment is questionable and that manufacturers would welcome the introduction of animal feed contracts. Such contracts would help counter the image of the animal feed wheat market as being just a dumping ground for sub-standard milling grade wheat.
Average feed wheat prices per tonne received by Canterbury growers in the seasons 1977-78 to 1980-81, never fell below 95 per cent of the basic price paid for milling grade wheat (Stockfeed Manufacturers, pers. comm.). This suggests that the prohibition of animal feed contracts may impose an opportunity cost on the poultry and pig industries, because it may result in feed wheat prices per unit of energy being more expensive than they would otherwise be if contracts were more readily available. For example, animal feed wheat contracts would allow specialist high yielding wheats to be planted. These higher than normal yielding wheats would result in a lower farm wheat price per unit of energy being negotiated, without any change to the associated farm profits per hectare. Since wheat contributes significantly as a stockfeed input, the lower feed wheat prices would cause a reduction in stockfeed prices and therefore production costs in the poultry and pig industries.

Animal feed contracts could cause the loss of milling grade wheat produced but not purchased by the Wheat Board, to be reduced. For example, in the 1982 season the Board was able to purchase only 272,471 tonnes despite samples representing 305,755 tonnes of milling grade wheat being tested by the Wheat Research Institute (p.15, N.Z. Wheat Board, 1982). These figures imply that many growers are selling milling grade wheat illegally for feed, rather than waiting for a legal sale to the Wheat Board. However, if feed wheat could also be grown under contract, then there would be less opportunity for these illegal sales.

5.3 Industrial Flour Category

The wide ranging functions conferred on the Wheat Board through legislation, means that the Board is ultimately responsible for deciding appropriate flour categories (Section 4.3.2). The challenge confronting the Board is to segregate flour in such a way as to ensure that the resultant categories have those qualities desired by the market (Section 3.3).

Eighty per cent of the market demand for flour is that of Category A for use in bread, cracker biscuits, fruit cakes, puff pastry, starch and gluten. However, within this category the industrial products
(starch and gluten) require a flour with different quality attributes to the human food products. The industrial products require flour with high protein content and high paste viscosity potential. The human food products require flour with high protein, originating from a relatively hard wheat and exhibiting strong dough characteristics. Therefore an improvement would be for the Wheat Board to instruct millers to segregate Category A flour into two separate categories: industrial and human food.

Such an improvement has been implied by an expert Australian observer (Moss, 1981) when he commented "that milling grade wheat should be further classified into "breadmaking, intermediate and biscuit/cake wheats". The change would also conform with the draft definition of new cultivars needed by the main sectors of the milling grade wheat market (Elliot, 1981b).

The benefit of this change is that the two market groups would obtain a more uniform quality of flour. For example the industrial flour category would tend not to be made from wheat originating in the Southland region, because often the viscosity of wheat grown in this region is too low. This change should cause an improvement in quality amongst the associated industrial products and human foods. The more uniform flour quality might also result in lower production costs per tonne for these flour based products.

The change could result in some additional fixed costs being passed onto the final users of these flour based products, as a result of increased handling and the additional storage facilities that might be needed both on and off farm at shipping ports and flour mills.

The evidence that is available suggests that users could be prepared to pay the cost of further segregating Category A flour. An American study (Chai, 1972) found that where products are derived from high protein wheat the associated consumers are prepared to pay for an increase in quality without any loss in sales. A N.Z. study (Brodie and Mellon, 1978) tends to support this conclusion because consumers were prepared to pay to procure the bread of their quality choice. Finally, high viscosity flour is regarded as a need, not a
want, for starch production (Beishuizen, 1981).

More research is needed to establish the demand schedules for flour exhibiting those qualities desired by the industrial and human food markets. These schedules could be simulated through a survey questionnaire approach that investigated how much the users within these two markets would be prepared to pay for various flour lots with different levels of paste viscosity and protein. The demand elasticities calculated from these schedules would assist in establishing whether further segregation of Category A flour would result in benefits outweighing costs.

5.4 Lower Extraction Rate

The N.Z. Health Department requires white flour to be extracted at a rate of 78 per cent. This rate is justified on nutritional grounds, that a high fibre and vitamin content is needed in flour based products (Section 4.3.2). However, these two characteristics are not significant in terms of flour qualities desired by the market (Section 3.3). Therefore it seems unnecessary for the N.Z. Health Department to enforce this high extraction rate.

The benefit of lowering the present extraction rate, by say 2 per cent, is that more pure flour would be obtained since there would be less bran and pollard present. This would improve dough processing tolerances, because not all wheat is capable of milling to 78 per cent flour without losing some tolerance (Moss, 1981). Improvements in dough processing tolerances are important now that most bakers use the fast mechanical dough development technique, rather than the slower bulk fermentation process. Improved dough processing tolerances would lead to an improvement in the quality of dough based products.

The cost of lowering the extraction rate is that the price of flour based products would increase since millers would expect a slightly increased processing profit margin to compensate for a greater proportion of the wheat grain having to be sold on the lower priced bran and pollard market. To establish whether the costs are outweighed by the associated benefits, more research is needed to identify the aggregate demand elasticity for flour.
5.5 **Minimum Grain Weight**

The Wheat Board is the sole marketing authority for wheat in N.Z., therefore it carries the responsibility for deciding the criteria used to classify wheat as either suitable for milling or unsuitable for milling (Section 4.3.1). The challenge confronting the Board is to ensure that the definition of milling grade wheat screens out those qualities that are undesirable to the market (Section 3.3).

The current definition as laid out by the Wheat Board Act meets the quality requirements of millers in all respects except minimum grain weight. This omission has resulted in Oroua wheat coming into disfavour with millers, because the associated light grain weights have been making the milling operation less efficient.

Therefore a legislative change that would improve the milling qualities of wheat would be for the Board to initiate writing a minimum grain weight into the definition of milling grade wheat. A weight suggested by millers has been 40 grams per 1,000 kernels (Ireland, 1981). The Australians have incorporated this requirement into their quality control system, through milling wheats needing to have a minimum weight of 68 kilograms per hectolitre (Australian Wheat Board, 1980-81). The introduction of a similar testing system should not cause significant user cost increases, although growers may find that a greater proportion of certain wheat varieties fail to satisfy the new milling grade standard.
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APPENDICES
APPENDIX 1

Glossary of Terms

Cultivar: Another name for variety

Extensibility: Degree to which dough can be stretched without rupture

Extraction Rate: The amount of flour produced as a proportion of the wheat from which it was milled.

Flour Colour: Flour becomes contaminated with bran specks as extraction increases. A whiter colour grade means more freedom from branny specks.

Gluten: Nitrogenous part of flour.

Viscosity: A type of fluid flow in which there is a continuous steady movement of particles within the fluid. A high paste viscosity implies a slow movement and therefore a thick paste.

Pollard: Small bran particles.

Semolina: The gritty or grain like portions of wheat retained in the bolting machine after the fine flour has been passed through.

Stability: Ability of dough to withstand mixing or other manipulation. The mixing time or development time indicates dough stability.

Strength: A general term embracing water absorption, stability and extensibility. Adequate levels of each are required of a strong flour (dough), whilst lower levels characterise a weaker flour (dough).

Tolerance: Range of variation. A wide dough processing tolerance allows a reasonable product to be made under conditions which are not quite ideal.

Water Absorption: The proportion of water to flour which will give dough a desired consistency.
Grain hardness is a general term embracing water absorption, protein content, and granular texture. Adequate levels of each are required of a hard grain whilst lower levels characterise a soft grain. Grain hardness determines the degree of starch damage in the milling process and this is an important factor in many processes. Low starch damage is required for the biscuit and starch industries. A higher degree of starch damage is required for breadmaking and certain other uses. Excessive starch damage is generally undesirable.

Grain hardness is essentially a varietal characteristic. There are thousands of wheat varieties in the world yet all are of two basic types - soft or hard. Soft wheats are further categorised as red or white. Soft wheats usually grow where there is plentiful rainfall; hard wheats grow in climates that are more arid.

Flour made from soft wheat is called "weak" flour. It has larger and softer grains of starch than flour made from hard wheat. Soft wheat flour has a smooth powdery texture, a small proportion of gluten, and it will absorb a small quantity of water. A reason for low milling performance with soft wheat is the difficulty of freeing endosperm from the bran.

Hard wheat flour is classified as "strong". It has harder and smaller grains of starch, usually with a large proportion of gluten and its texture is granular. Hard wheat flour will absorb large quantities of water. Hard wheat gives better extraction rates although requires more power for milling into flour, than does soft wheat.
APPENDIX 3

International Wheat Segregation

With Particular Reference to Australia

The quality requirements of flour processors throughout the world have led to the establishment of four clearly identifiable international wheat quality/price classes, within which the major exporters compete for sales to importing countries. These classes are:

1. The hard, high protein, strong bread wheats such as the Australian Prime Hard, Canadian Western Red Spring, and U.S. Dark Northern Spring.

2. The intermediate protein hard wheats, such as Australian Hard and U.S. Hard Winter.

3. The medium to low protein wheats consisting of mixtures of hard and soft grain, such as the Australian Standard White and the U.S. Hard Winter (ordinary).

4. The low protein soft wheats such as Australian Soft and U.S. Western White.

In Australia, as in other countries, grain hardness and dough strength tend to be correlated with protein content, although variations do occur. The Prime Hard class consists of those hard grained varieties with over 13 per cent protein. Gabo is a standard variety in this grade. The Hard class consists of a wide range of hard grained varieties from 11 per cent protein upwards. Condor is a standard variety in this grade. In each area where these two classes are recognised the remaining wheat becomes more uniform. The Standard White class includes those varieties with a protein content ranging from 9.5 per cent to 12 per cent. Gamenya is a standard variety in this grade. The Soft class covers certain varieties with protein below 10 per cent; a standard example would be the Pinnacle variety (Wrigley and Sheppard, 1974). Almost 70 per cent of Australian grown wheat falls into the Standard White class.
Several different grades exist within each of these classes. In each class wheat is graded according to the region where it was grown. These regions are Northern New South Wales, South/West New South Wales, Queensland, Victoria, South Australia, Western Australia and Tasmania. Grades based on minimum protein levels, of 13 per cent, 14 per cent and 15 per cent, are also established within the Prime Hard class.
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