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### The basic principles of wheat marketing—part I

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# The Basic Principles of Wheat Marketing

THE "Fair Average Quality" standard (which custom has abbreviated to "F.A.Q.") originated in South Australia in 1888 soon after that State entered the export wheat market. It was designed as a wheat trading standard to meet the needs of overseas buyers and was later adopted by the other Australian States.

## WHY THIS ARTICLE WAS WRITTEN

I first became associated with the fixing of the F.A.Q. standard in New South Wales over half a century ago. Soon after coming to Western Australia in 1911 I became official "striker" of the bushel measure, a position which I hold at the present time. During the whole of this lengthy period, I have been impressed by the meticulous care taken to ensure the accuracy of the declared bushel weight of the season's crop.

Until the end of World War I, I was not directly interested in the F.A.Q. standard as a means of evaluating parcels of commercial wheat, and I accepted it as an entirely satisfactory standard for assessing the value of Australian wheat.

As Commissioner of the Wheatbelt in or about 1920, I was called upon to issue official certificates for cargoes and parcels of wheat affirming that the "milling value" of the wheat in question was not less than that of the F.A.Q. standard. It was quickly discovered how useless the declared bushel weight was for this purpose and how completely unsatisfactory were the results of comparing or "matching" samples of wheat for certification with the F.A.Q. standard sample, even when this work was carried out by experienced inspectors.

Under this method, disputes as to the soundness of the inspector's judgment constantly arose. The position became intolerable and compelled a search for a better method.

This was eventually found by defining in simple language the physical characteristics of the F.A.Q. standard being used which were capable of being measured. These included, as a main feature, the percentage of millable wheat.

The merits of the new method were soon apparent and the fears that it would be responsible for delaying the departure of ships soon vanished when it was found that a certificate as to weight and quality was available within 20 minutes of the last bushel being placed on board. The position improved immediately, the attitude of the shippers towards the inspectors changed, and arguments and disputes became a thing of the past, because, in a case of doubt, reference could be made to the result of measurable factors.

Since the new method was introduced, over 200,000,000 bushels have been certified in this manner without complaint.

Having overcome one difficulty, another soon arose, due to the original defect in the F.A.Q. system which prevented the F.A.Q. standard

from being fixed until the end of the harvest and delivery season by which time three to four months of the shipping season had expired. During this interim period there was **no official standard** for the marketing of wheat in Australia.

In about the year 1922 the Department of Agriculture was asked by The Westralian Farmers Limited to issue a certificate for an export cargo to Chile, affirming that the cargo was equal in milling value to that of the F.A.Q. standard. The position was fantastic and impossible for at that time the F.A.Q. standard did not exist as the harvest and delivery season had not concluded. The difficulty was overcome by creating a permanent and defined standard which was called the "W.A. Standard White". This standard was about the average of what the F.A.Q. standard had been for the previous ten years, and it was accepted by the Chilean buyer and has continued to operate ever since, during the interim period when the F.A.Q. standard for the year had yet to be fixed. The principle worked so well from the time it was introduced until 1935 that, after a conference with Messrs. C. W. Harper and J. Thomson, the Minister for Agriculture (The Hon. M. F. Troy) had it incorporated in the Bulk Handling Act of that year.

Since I became officially interested in the marketing of wheat in 1920, much thought and study has been given to wheat marketing methods and, as it was believed desirable that the results of my experience and studies should be available to others, this article has been written.

Though its purpose is to advocate a modern wheat evaluation unit, to replace an obsolete one, I have deemed it advisable to include an outline of the wheat marketing methods of three other great wheat exporting countries for the information of wheat growers and to enable the proposals submitted in this article to be more readily considered in their proper perspective.

In recent years, with the production of high-yielding "medium strong" varieties there has arisen the need for an improvement in the Australian wheat marketing system which will ensure that growers will receive higher prices for these varieties because of their greater strength. A practical method of meeting this need is outlined.

(Sgd.) GEO. L. SUTTON.

26/3/53



# THE BASIC PRINCIPLES OF WHEAT MARKETING—Part 1.

By GEO. L. SUTTON, former Director of Agriculture, Western Australia.

**I**F we had a ton of screws to sell and wished to obtain the greatest possible monetary return for them, we would certainly not ask a price for them as a "job" or mixed lot. Even a very elementary knowledge of business principles would teach us that to obtain the best price they should first be sorted into lots according to the materials from which they were made—whether brass or other metals; sorted according to their type—whether they were round-headed, flat-headed, etc.—and then according to their length and thickness. In other words, they should be sorted into lots so as to indicate to the prospective buyer the "utility value" of each lot offered for sale.

Applying these principles to primary production we find that Australian apples are first sorted into classes—that is they are classified according to variety so as to indicate to the buyer the purpose for which they are most suited. They are then sorted into lots according to their size and condition, again to indicate their relative values. The different lots in each class are called grades and these are the same for each class. The defined classes and grades are the standards by which their value is assessed.

The classification of commercial commodities according to their relative "utility value" and with their defined standards may thus be accepted as a sound principle of commercial trading.

Though not very generally recognised this applies to wheat as well as to other commercial commodities for, as stated by Fisher and Jones (3):—"In selling and buying wheat, standards of quality are just as necessary as with other commodities."

It is obvious, therefore, that if the wheatgrower is to obtain the maximum price for his product it is necessary to have standards of quality which set out in a clear, defined and positive manner the character of the wheat offered for sale so that the prospective buyer may assess with confidence its potential value to him. This is especially the case when distance separates the seller and the buyer.

Unless such standards of utility value are laid down there will always be some uncertainty about the character of the wheat being offered for sale. It naturally follows that the prospective buyer, in order to protect his own interests, must "play safe" and will reduce the price by a contingency or risk margin to protect himself against possible loss.

This reduction represents a loss to the seller, in this case the wheatgrower. It is still the wheatgrower's loss even though the sale is not made directly by him but through a merchant or other marketing organisation.

Because of the immense volume of the world trade in wheat it is most important in the interests of Australia's national economy that the standard of evaluation should be defined clearly. During the 13 years, 1940 to 1952, for which statistics are available, the Australian marketable

crop of wheat amounted to 2,643,000,000 bushels. A contingency risk reduction of only one penny a bushel on this quantity would have entailed a loss of £11,000,000 to the national income and to the wheatgrowers. (1).

It was a realisation of this enormous loss and of the fact that well-defined "utility value" standards are essential for securing the best monetary returns for the grower, which led to the reform of the marketing system for wheat and other grains in the U.S.A. (2).

To the man in the street, wheat is just a grain from which flour or wheatmeal is produced either for human consumption or for feeding stock. To those interested in wheat marketing it soon becomes evident that the bulk of the world's wheat is used for human consumption in the form of flour or meal. In consequence, the flourmiller is the principal user or buyer of wheat and his requirements are influenced by those of his clients. These may be bakers who use about 65 per cent. of his products (11), biscuit makers, pastrycooks or the manufacturers of macaroni, vermicelli and similar products.

## THE BUYER'S NEEDS

The flour requirements for these various purposes are by no means the same; flour required by the pastrycook is quite different from that required by the bread baker, whose needs again are quite different from that of the macaroni maker.

Obviously, therefore, the buyer needs to be supplied with information concerning the kind of flour his wheat will produce so that he will know whether it is suitable for his clients. It is upon this information that the "utility value" of the wheat to the miller will be based, indeed it is this information which will cause the prospective buyer to decide whether or not he will consider the purchase of this wheat and if so what price he will pay for it.

Experience has also taught the miller that wheat varies with regard to the quantity of flour which can be gristed from a given quantity of wheat. Obviously then the relative value of different parcels of similar wheats will also depend upon the quantity of flour which can be gristed from each parcel.



# THE WORLD'S WHEATS

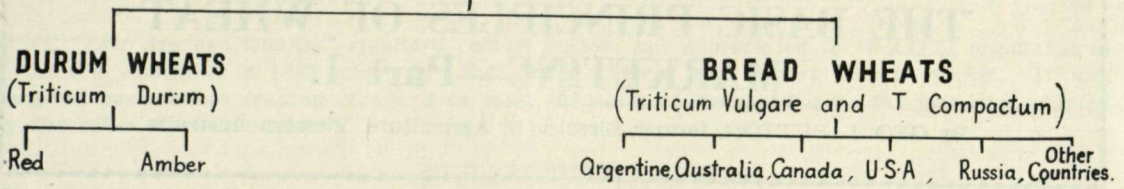


Fig. 1.—The first stages in classifying wheat according to the kind of flour they will yield. The Durum wheats are preferred for making macaroni and similar foods. They are subdivided according to colour. The bread wheats are broadly classified according to the region of growth.

The “utility value” of wheat is therefore based upon—(1) The kind of flour it will produce; (2) the quantity of flour which can be gristed from it.

## THE TWO MAIN GROUPS

To indicate the kind of flour which a wheat will produce, that cultivated for human consumption may be divided broadly into two groups—that which belongs to the Durum group

(*Triticum durum*) and that belonging to the bread wheat group which includes two species the common wheat (*Triticum vulgare*) and club wheat (*Triticum compactum*). (See Fig. 1.) There is a marked difference between the kinds of flour produced from wheats belonging to each of these groups. That from the wheat of the Durum group is not so suitable for bread making as the wheat from the other group.



Fig. 2.—Species of wheats used in international trade. Left to right: awned club wheat; awnless club wheat; Durum wheat; awnless common wheat; awned common wheat.



Durum flour is especially suitable for the manufacture of macaroni and similar edible pastes. In Britain where it was regarded for many years as being quite unsuitable for making bread, the derogatory name "goose" was given to Durum wheat imported from Canada, and it was generally regarded by millers as a commodity of relatively poor quality. Flour from Durum wheat, however, has long been used for bread-making in Eastern Russia where it is claimed that the bread keeps fresh longer than that made from flour obtained from the bread wheats (*Triticum vulgare*).

The grain of Durum wheat is hard and rather tough and horny, and its contents are extraordinarily difficult to pulverise. The character which rendered it unpopular among British millers was unquestionably its difficult milling character rather than its alleged unsuitability for bread making. The striking developments in the art of wheat conditioning have removed this obstacle and Durum wheat is now frequently incorporated with mixtures of other wheats when milling flour for making bread (4).

The first step to indicate for trade purposes the kind of flour which the wheat will produce is to place it in one of these two main groups into which the wheats of international commerce can be divided. Because of the distinctive characteristic appearance of wheats belonging to the respective groups it is fairly easy to determine by visual examination to which of these two main divisions the wheat belongs.

The grain of Durum varieties is long, narrow, very hard, and more or less pointed at both ends with a permanent ridge on the back. (See Fig. 4.) The contents of the grain are flinty and the colour ranges from red to amber. For trade purposes the Durum group is divided into two classes according to their colour and named respectively "Amber" and "Red" in the U.S.A. and Canada.

The grain of varieties belonging to the bread group is quite different. In contrast to the angular character of Durum wheat it is plump and rounded. That belonging to the common wheat (*Triticum vulgare*) may be mealy or flinty in consistency and its colour red or white. The



Fig. 3.—Species of wheat not generally used in international trade. Left to right: Emmer (*Triticum dicoccum*); Polish (*T. polonicum*); Miracle or Mummy (*T. turgidum*); Indian Dwarf (*T. sphaerococcum*); Spelt (*T. spelta*); Einkorn (*T. monococcum*).



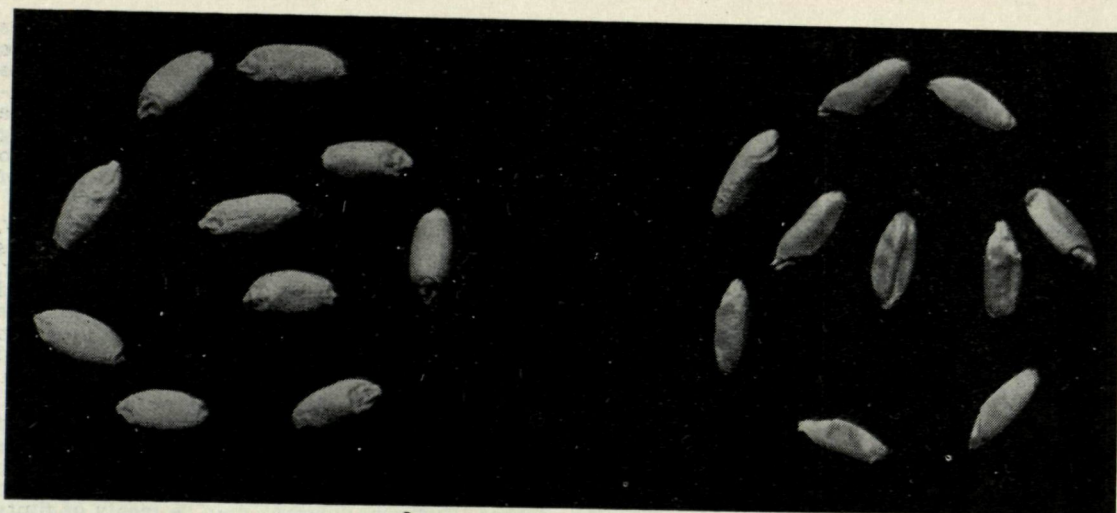


Fig. 4.—Comparison of bread grain (left) and Durum grain (right).

grain of the club wheats (*Triticum compactum*) is plump, soft, mealy and white similar to that of the white wheats of the *Triticum vulgare* class.

The division to which the bread wheats belong is by far the larger one. It has been estimated that there are between 10,000 and 20,000 varieties included in this group. With so many varieties of grain grown in different places, under different climatic conditions and with varying farm practices it can be realised readily that there are considerable differences in regard to their relative suitability for making bread, biscuits or pastry. There are great differences from the millers' standpoint, mainly with regard to "baking quality".

#### BAKING QUALITY

In order to indicate the utility value of the wheat it is necessary, therefore, to subdivide the bread wheat group into appropriate baking quality classes and for marketing purposes the comparative baking quality is best measured by the **general strength** of the flour produced. (See Fig. 5.)

#### AUSTRALIAN WHEATS

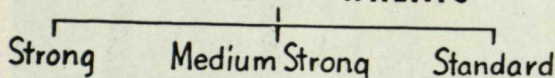


Fig. 5.—The broad division of Australian wheats according to baking quality.

Due to various influences it becomes the practice to grow the same type of wheat and adopt the same farming techniques in regions with similar climatic conditions and this tends to produce wheat of a similar baking quality from that region. The primary classification of the bread wheat group into baking quality classes would therefore be according to the region of growth and consequently, wheats in the international trade are known as American, Argentine, Australian, Canadian, Russian, etc. (Fig. 1).

As there is usually a range of difference between the kinds of wheat grown within any country, finer classifications according to district and type are made. Consequently we have "Hard" and "Soft Red Winter" and common "White" wheat in the U.S.A.; "Barusso", "Rosafe", and "Baril" for Argentine wheats; with "South Australian" and "Victorian" for Australian wheats. This, in effect, is a rough classification by that composite character known as "strength" and which can be measured in several ways. The strength of flour, or of the wheat from which the flour is produced, is considered by Kent-Jones (4) to be:—"That characteristic which will enable large, well-shaped loaves of good texture to be produced, provided the gas production is sufficient."

The ability of the wheat, or rather its flour, to provide material for the production of gas for, and during, the fermentation process of bread making is due to its power to change the unfermentable starch into fermentable sugar by diastatic enzymes and this is known as its "diastatic activity" or its "gassing" power. This is an essential feature of baking quality, but with normal wheat it is not a characteristic which needs to be considered when indicating or assessing its utility value for trade purposes. If lower than is essential for best results, it is easily remedied in modern baking practice, usually by the addition of malt flour or a suitable flour improver. The diastatic activity of wheats may therefore be ignored when comparisons are being made according to relative strength.

#### THE IMPORTANCE OF GLUTEN

The relative strength of wheat depends upon the quantity and quality of the gluten it contains. Of all the cereal grains wheat is the only one which contains the two proteins—glutenin and gliadin—of which this gluten is formed. It is this gluten which makes wheat flour or wheatmeal unique in the making of aerated or leavened bread. Aeration is possible because the gluten has the ability to retain the



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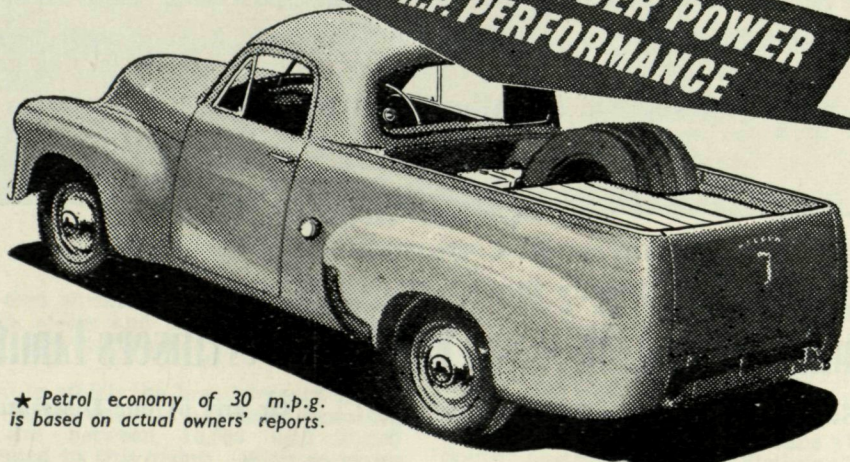
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gas produced by the fermentation of the dough during the bread-making process. Rye contains only one of the necessary proteins, hence bread made solely from rye does not rise.

The strongest wheats in the international wheat trade (i.e., those richest in good quality gluten) are grown in Minnesota, Manitoba, Hungary and Russia.

The grain of such strong wheats is usually translucent or "flinty" and, unless properly conditioned, is hard to mill. In Canada and the U.S.A., such wheats are usually called "Hard"

wheats. The wheats that are weak or lacking in strength are opaque or floury, easy to mill and of a soft texture in comparison with the strong wheats, hence they are referred to in the trade as "Weak" or "Soft" wheats.

### TESTING FOR STRENGTH

The best test of the strength of wheat which of course is the dominant factor of its baking quality is a baking test of its flour. Such a test is not a practical one for marketing purposes as it is too slow, so other tests have been devised.

Probably the first test used was a rough test of the gluten carried out by chewing a few grains of wheat. As the gluten is insoluble in water, a strong wheat left a small pellet of gluten in the mouth as the result of swallowing the starch mixed with the saliva. Crude as this test was, many millers, as the result of long experience, could form a reasonably good idea of the baking quality of the wheat in this manner. Later, chemists applied laboratory methods to this test by making the flour into dough, allowing the dough to remain in water for an hour or longer, and then washing the starch away in running water. The residual gluten was then weighed, before and after drying, and the results expressed as a percentage of the quantity of flour used.

Such tests were not always satisfactory because the personal factor entered into them to a considerable extent and results from different operators did not always agree. Because gluten is one of the wheat proteins, many cereal chemists now prefer to assess the strength of the wheat by its protein content. This can be determined with a high degree of accuracy by methods in which the personal factor can be largely eliminated. The protein test has in consequence very largely replaced the gluten test but since gluten is protein it is possible to have flour which is rich in total protein but of low strength because the gluten is of poor quality.

As the protein determination gives no indication of protein quality it cannot be regarded as an infallible measure of the strength of the wheat.

A realisation of this led to the development of the "Pelshenke Fermentation Time Test" and the production of mechanical dough testing apparatus. The Pelshenke time test is a more satisfactory test than the protein determination when comparisons for general strength are desired as it is also a measure of some of the quality factors of the proteins concerned.

The Pelshenke test is carried out by making a ball of dough with the wheatmeal, water and yeast and then placing the dough-ball in distilled water under controlled temperature conditions. After a time the dough ball disintegrates. The time taken to achieve this disintegration indicates the general strength of the wheat. The longer the time taken the stronger the wheat. The Pelshenke method has its limitations, but experience has shown that this test is satisfactory to determine classifications of wheat into "Weak", "Medium Strong" and "Strong Classes". As only small quantities of wheat are required for this test it has been found suitable



Fig. 6.—Head and grain of rye.



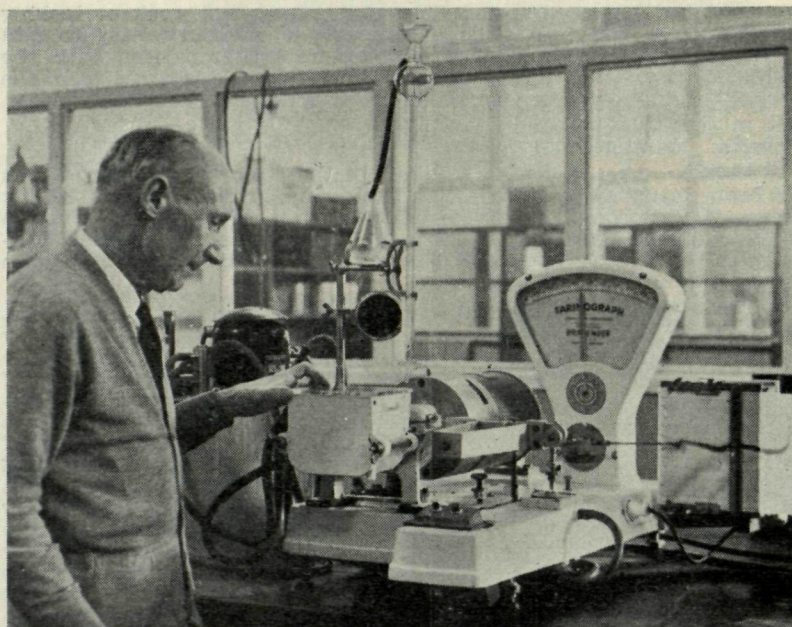


Fig. 7.—Operating the Brabender farinograph.

for determining the strength of new cross-bred varieties in order to place them in their appropriate strength groups.

Although the Pelshenke test is satisfactory for determining the general strength of wheat for marketing purposes it is not informative enough to provide the information which the miller needs for blending purposes. Neither is it accurate enough for the cereal chemist, who requires more detailed information concerning the strength characteristics of the flour. This information is supplied by special dough-testing instruments.

Among the best known dough-testing instruments used in Australia are the "Brabender Farinograph" (see Fig. 7) and the "Chopin Alveograph" (see Fig. 8), a new form of the "Chopin Extensimeter". Others being used are the Brabender Extensograph and the Research Extensimeter.

In the Farinograph the character of the flour made from a chosen sample of wheat is recorded as a "Farinogram"—a wide band marked on a sheet of squared paper revolving at clock speed during the test, so that the strength is measured by the number of minutes which elapse from the time when the band passes the zero mark (indicating the time when the dough mixing starts) and the time when the top of the band reaches the median line marked 500 and begins to fall below it. This is called the "Strength Figure" or "S.F." The Farinogram also denotes other characteristics such as dough stability which are valuable for the guidance of the miller and cereal chemist but are not vital to wheat marketing purposes where concentration is on the single characteristic of general strength as indicated by the "S.F."

The Farinogram shown in Fig 9 is that of the wheat variety Kondut, the winner of the 1952-53 Millers Crop Competition. The strength figure shown is of  $10\frac{1}{2}$  minutes, while that of the F.A.Q. sample for the same season is  $4\frac{1}{2}$  minutes.

In the Alveograph the characteristics are similarly recorded on a sheet of paper which moves progressively as the test is made. The diagram of curve so regarded is known as an Alveogram.

A number of Alveograms (about quarter size illustrative of the baking quality of typical wheats from different countries of the world are reproduced from "The Practice & Science of Bread Making" in Fig. 10.

Dr. Kent-Jones points out that there may be considerable variation in the wheats grown in the same country but the diagrams may be taken

as fairly typical of the wheats represented and may be regarded as the average in each case.

I am indebted to the Director of the Bread Research Institute of Australia (Mr. Eric Bond)

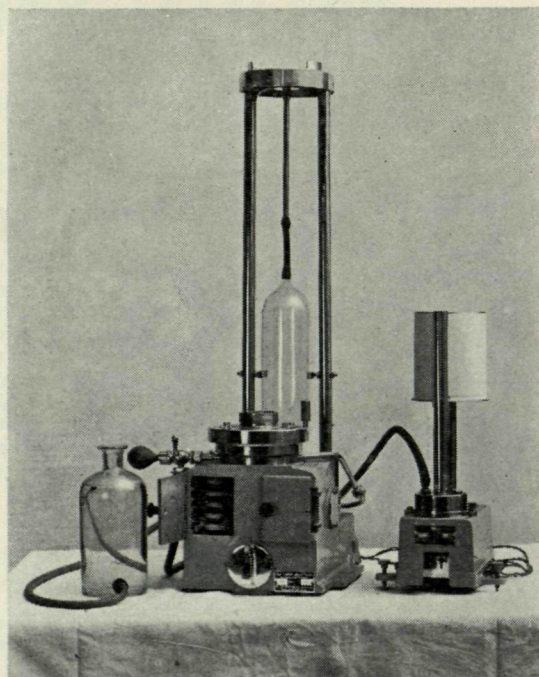
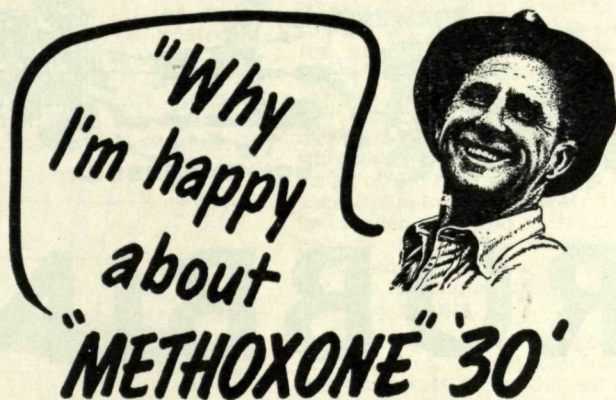


Fig. 8.—The Chopin alveograph.





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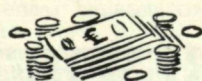
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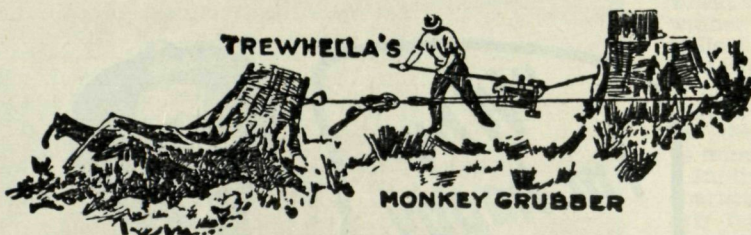


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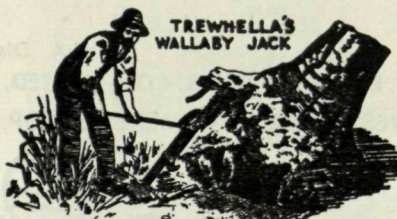
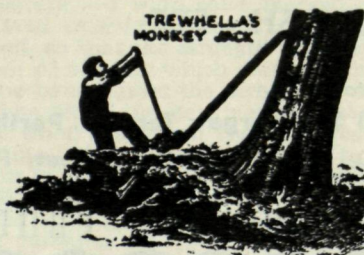
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for calculating the areas of the curves and stability figures which were not given in the original illustration.

The total area under the curve, which is a measure of the total work done on the dough before rupture, would appear to be related to what the baker calls in a somewhat vague manner, the strength of the flour. The relative areas of the different Alveograms are indicated by the horizontal number in each one and these numbers indicate the comparative strength of the wheat testing.

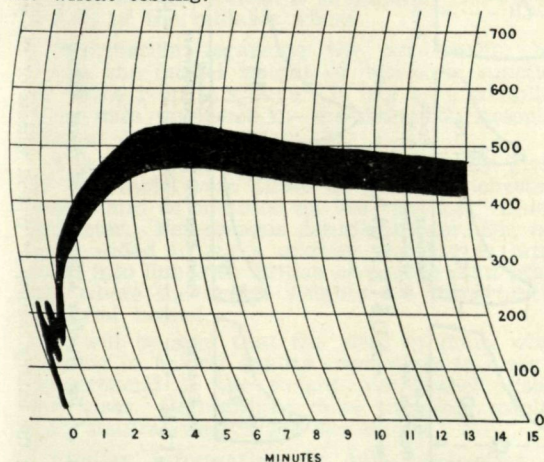


Fig. 9.—A Farinogram, the visual record of flour character made by the Farinograph.

### DESIRABLE CHARACTERISTICS OF FLOUR

Experience has shown that in addition to carrying enough gluten to make it strong, the flour should carry gluten of such character or quality that the dough will have sufficient stability or stiffness to enable it to retain its shape for a reasonable time after being moulded; also that it shall have adequate elasticity or "stretching power" to enable it to retain sufficient gas to produce a large loaf. This latter character is known as its "distensibility". A flour of the best baking quality, in addition to being sufficiently strong, will have these characteristics well balanced. This will be indicated by the height and width of the curve being approximately equal, with a maximum allowance of some 20 per cent. on either side.

While a certain degree of strength is essential to ensure a loaf of good volume, that of the Canadian "Manitoba Number 1 Hard" or of the "Hard Red Spring" wheat of the U.S.A. is considered unnecessarily high. That of the "Medium Strong Argentine" and "Good Australian" has been found to be sufficiently strong for the making of excellent bread according to British standards.

Medium strong wheats of this type are called "filler wheats" in the British trade. This is because, although they are not strong enough to carry an admixture of weaker wheats, they do not require support from stronger wheats and may therefore be added in any quantity as a filler for making up quantity in recognised British grists.

The diagrams recorded by the dough-testing instruments such as the Farinogram (Fig. 9) and the Alveogram (Fig. 10) provide far more information regarding the baking quality of the wheats tested than does the Pelshenke test, although the latter provides sufficient information for grouping them as "Strong" or "Hard"; "Filler, Medium Strong" or "Medium Hard"; and "Weak" or "Soft". The characteristic shape of the Farinogram or Alveogram is not merely a measure of the general strength but indicates whether the wheat has a deficiency or surplus of some other characteristics, and in consequence they indicate to the miller how the wheats may be blended and used to the best advantage. They provide the cereal chemist with information which enables him to advise the baker concerning the techniques which should be followed for the best results.

Summarised, the dough-testing instruments are regarded as suitable for conducting supplementary tests after the wheat has been placed in its appropriate strength class by the Pelshenke test.

### DOUGH TOLERANCE

Flour strength is not only necessary to produce a large loaf of good texture but is also required to provide a high degree of dough "tolerance". This is the term used to indicate the capacity of the dough to remain at the "ripe" or mature stage for a reasonably long time without deterioration. The stronger the wheat the better the tolerance. Strong Canadian or U.S.A. wheats may give a tolerance of as long as an hour or more; that of the weak wheats is short or sharply defined and may only last a few minutes.

It will be noticed that with the exception of "White Pacific" (one of the club wheats not generally regarded as being well adapted for bread-making) (5) the wheats of the U.S.A. are not represented in Fig. 10. Because of the great variations in climatic conditions there are just as wide differences between the strongest and weakest wheats grown in the U.S.A. as those which have been illustrated. These range from the weak "White Pacific" to the strong "Hard Red Spring" which is equal in strength to that of "Number 1 Manitoba Hard" which has been and is still, recognised as the standard for wheat strength the world over.

It is thus apparent from the Alveograms in Fig. 10 that there is a wide difference in the strength of the bread wheats grown throughout the world, ranging as they do from a maximum of 78 for the strongest "Number 1 Manitoba Hard" to 16 for the weakest "White Pacific", "Poor Australian" and "Poor English". Hence the great need for informing the buyer (that is the miller) to which of the strength classes the wheat being offered belongs. Appropriate baking quality classes for Australian wheat are shown in Fig. 5.

### MILLING VALUE

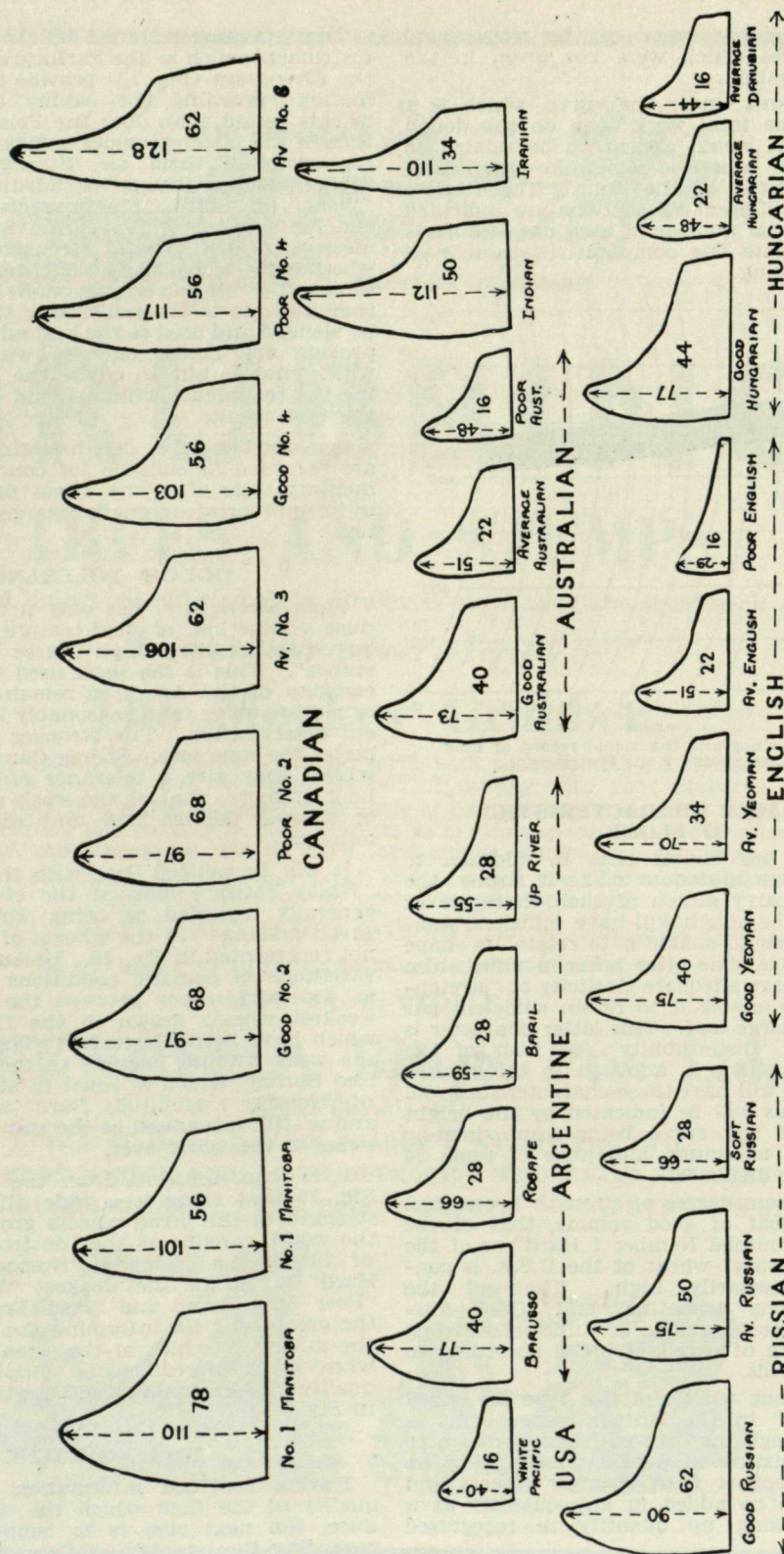
Having provided information regarding the quality of the flour which the wheat will produce, the next step is to supply information regarding the quantity of flour it will yield.



# ALVEOGRAMS SHOWING RELATIVE STABILITY and STRENGTH OF FLOURS

Vertical numbers indicate Stability

Horizontal numbers indicate relative areas - Strength



By Courtesy of Kent-Jones & Price. Joint authors of 'The Practice & Science of Bread Making.'

Fig. 10.—A series of Alveograms (about quarter size) illustrating the baking quality of typical wheats of the world.



This will depend in the first instance upon the percentage of millable grain in the commercial wheat as this is the basis of its flour yield. This is readily ascertained by removing the unmillable material from a sample by mechanical means as is done in Western Australia, the U.S.A. and Canada, where unmillable material is known as "dockage". In the second place the yield will depend upon the quantity of flour which can be gristed from that particular millable wheat. Very reliable information in this connection is supplied by the bushel weight of the millable wheat.

Information regarding the relationship between the bushel weight of wheat is supplied in Table 1 on this page. It has been compiled from data published by the American Association of Cereal Chemists (3).

The test weights per bushel originally given in the table were those of the "Winchester" bushel and as obtained on the "Boerner" Chondrometer. For reasons described later, 4lb. has been added to these original weights to bring them into line with British and Australian practice where the bushel weights are those of the Imperial bushel.

It will be seen that the yield of flour, while varying in baking quality from class to class is proportional to the weight per bushel within that class. High milling value, therefore, implies high natural weight per bushel.

Similar information in this connection is supplied by the graph (Fig. 11) which has been taken from a table prepared by the United States Department of Agriculture (5) correlating the weight per bushel of clean and scoured wheat with a percentage of straight run flour, and in which are summarised the results of experimental milling over three years and including all varieties.

TABLE 1.

Average yield of flour from the five classes of American wheats of various weights per bushel.

Test Weight Per Bushel.	Class of Wheat.				
	Hard Red Spring.	Hard Red Winter.	Soft Red Winter.	White.	Durum.
lb.	%	%	%	%	%
67	73.8	73.3	72.4	70.3	72.9
66	72.8	73.5	71.6	70.3	72.4
65	71.8	72.5	70.7	70.8	71.0
64	71.0	71.8	69.6	70.4	70.3
63	70.8	71.3	69.6	70.3	69.2
62	69.7	70.8	68.3	69.7	68.7
61	69.0	70.7	67.9	69.2	66.8
60	68.0	70.5	67.3	68.3	65.1
59	66.4	69.1	67.0	66.9	64.3
58	65.8	68.3	66.3	66.3	62.5
57	64.5	66.6	....	65.1	....

As in Table 1, an addition of 4lb. has been made to American bushel weights for the same reasons as will be described later.

These results show a definite, but slightly irregular, increase in flour yield as the weight per bushel increases and it will be noted that once again the high bushel weight indicates high flour yield.

From some unpublished records which were made available to the author there is similar evidence that the bushel weight of Australian millable wheat is also correlated with its flour yield.

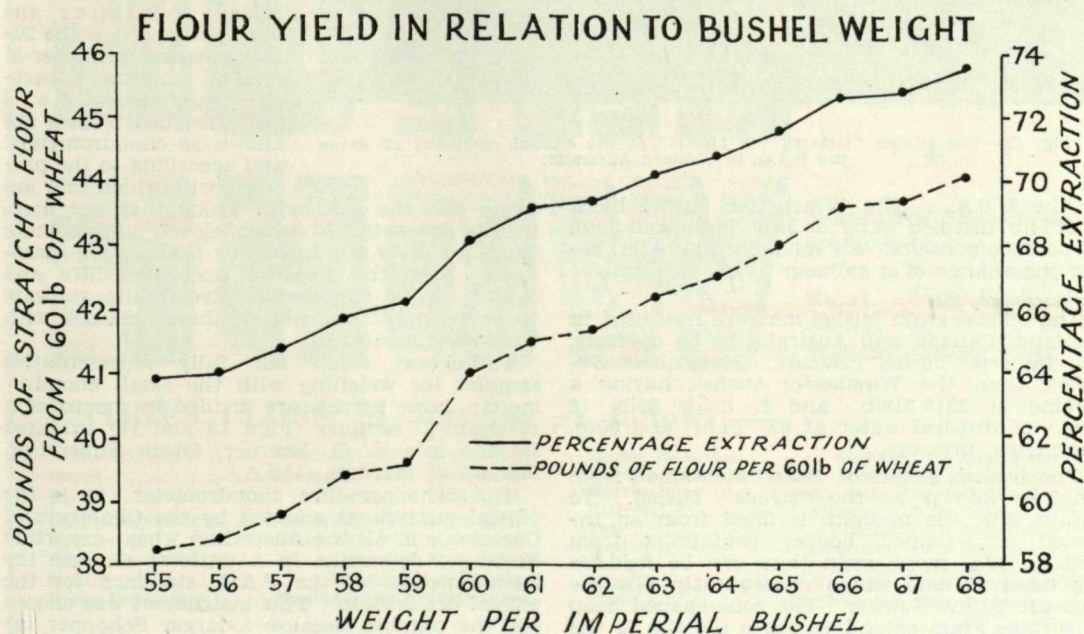


Fig. 11.—This graph shows the correlation between bushel weight of clean grain and percentage of straight run flour.



These examples indicate that the bushel weight of millable wheat is a very reliable guide to the quantity of flour which can be obtained from it. The flour yield increases progressively with an increase in bushel weight.

### OBTAINING THE BUSHEL WEIGHTS

It is a simple matter to ascertain the bushel weight of a given sample of wheat either by means of a bushel measure or by the use of smaller instruments known as chondrometers which are designed for this special purpose. To obtain consistent and comparable results it is essential that whatever method is used all operations must be carried out with care and in the approved manner. Each operation must be carried out in exactly the same way on each occasion.

Formerly the receptacle used in England for measuring grain was the Winchester bushel measure, which is still the official measure used

straight-edge with a half-round base firmly across the top edges of the measure. (See Fig. 12.)

The grain left in the measure is the "struck" bushel and it is the weight of this that is taken. Provided that care is taken to avoid any jarring of the contents of the measure before the measure is struck and during the striking, this method is satisfactory.

To minimise possible variations due to personal factors, striking by mechanical means has been found desirable, and this has been achieved with great success in the McGuirk machine, which is used by the Liverpool Corn Trade Association to determine the bushel weight of wheat submitted for grading under its contracts for future delivery (5).

The same principles of mechanical operation have been achieved in the design of the Louis Schopper 20-litre instrument (holding slightly more than half a bushel) used by the London

Corn Trade Association. The weights from this instrument are in grammes, but by means of tables prepared by the German Imperial Standards Commission the weight in grammes is translated to kilogrammes per hectolitre to meet the requirements of one section of international trade, and to pounds per bushel to meet those of British trade.

To obtain the bushel weight accurately with smaller quantities of grain than that required for determination by means of either the bushel measure or the 20-litre measure a number of smaller and more portable instruments have been designed. These are known as chondrometers, and according to the precision with which they are

made and the care with which they are used, results are obtained which closely approximate those given by the bushel or the 20-litre measures. Even the smallest sizes of  $\frac{1}{4}$ -litre and  $\frac{1}{2}$ -pint can be expected to give results accurate to between  $\frac{1}{16}$  lb. and  $\frac{1}{8}$  lb. of those obtained with the larger measures.

To obtain small but fully representative samples for weighing with the small chondrometers, large parcels are divided by means of a mechanical sampler (Figs. 13 and 14) invented by the late E. G. Boerner, Grain Supervisor, Bureau of Markets (U.S.A.).

The Schopper litre chondrometer (6) is the official instrument adopted by the Chambers of Commerce in all the Australian wheat-exporting States to determine in a uniform manner the bushel weight of the F.A.Q. standard for the official declaration. This instrument was chosen for the purpose because a larger Schopper instrument of 20-litre capacity is, as previously



Fig. 12.—The author "striking the bushel" at the annual ceremony of fixing the F.A.Q. in Western Australia.

in the U.S.A. The Winchester bushel holds 77.6274lb. distilled water at 39.8° Fahr. and 30in. barometric pressure. Its volume is 2150.42in. being the volume of a cylinder 18 $\frac{1}{2}$ in. in diameter and 8in. in depth.

The official grain bushel measure now used in England, Canada and Australia is, by courtesy, the Imperial bushel measure. It is about 3% larger than the Winchester bushel, having a volume of 2218.219in., and it holds 80lb. (8 gals.) of distilled water at 62° Fahr. and 30in. barometric pressure.

The bushel weight of grain is obtained from what is known as the "struck" bushel. To obtain this, the measure is filled from an inverted cone-shaped hopper containing from 20% to 30% more grain than can be held by the measure, and which consequently fills the measure to overflowing. The cone-shaped heap of surplus grain extending above the rim of the measure is then carefully removed by drawing a





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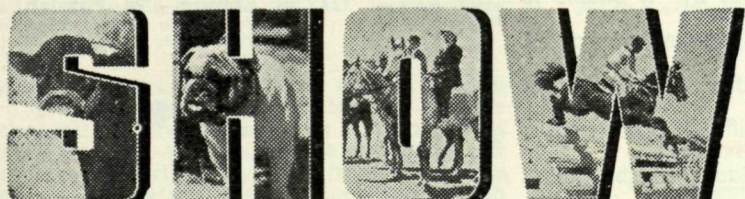
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stated, used by the London Corn Trade Association for determining the bushel weight of wheat cargoes sold under some of its numerous contracts in which the weight per bushel is one of the integral conditions of the contract.

The Schopper litre chondrometer is a well-made instrument of great precision and as its name indicates, its capacity is one-twentieth of

two occasions it has been 2lb. heavier and for the current—1952-53—season the difference is 1½lb. The Schopper litre chondrometer is too delicate for silo, mill or warehouse work.

The Somner and Runge chondrometer is of similar design to the Schopper and is made in ¼-litre and litre sizes.

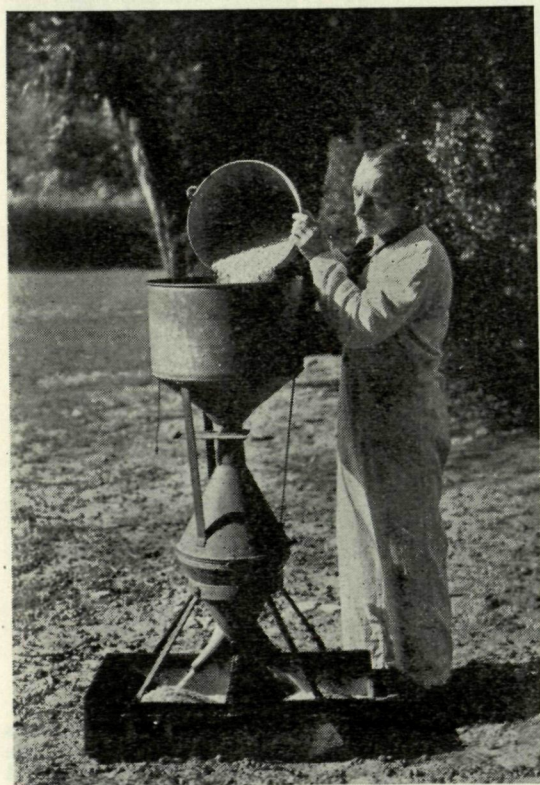


Fig. 13.—To obtain small samples for use with a chondrometer, large parcels of grain are divided as accurately as possible by means of the mechanical sampler shown here. It was invented by the late E. G. Boerner, Grain Supervisor, Bureau of Markets, U.S.A. Fig. 14 explains its construction.

that of the official instrument of the London Corn Trade Association. Although not entirely mechanically operated its design is such that it reduces personal variations to a minimum. It eliminates the striking by hand in favour of the mechanical operation of a V-shaped knife which fits accurately into slots, the bottom edges of which coincide with the top of the litre measuring cylinder. The scale for weighing the wheat is of the two-arm equal balance type. The wheat in the measuring cylinder is weighed in grammes and converted into pounds per bushel or kilogrammes per hectolitre by means of the tables compiled by the German Imperial Standards Commission. (See Fig. 15.)

The declared bushel weight as found by the Schopper litre chondrometer is usually about 1½lb. heavier than that actually obtained with the hand-struck Imperial bushel measure. On

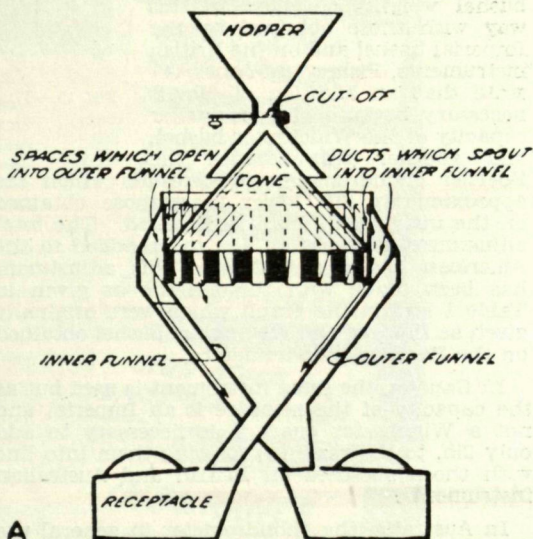
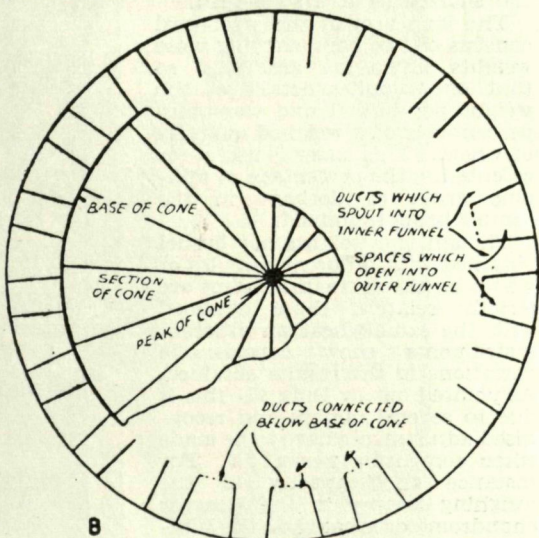


Fig. 14.—Diagram of Boerner sampling device. The grain flows from the hopper through an outlet controlled by a slide on to a cone which performs the actual mechanical division. To do this the cone is provided with perpendicular vanes which form ducts down which the grain flows. In this way the parcel is divided by random into as many parts as there are ducts. The device is provided with two outlet spouts, which deliver grain to their respective receptacles. The grain from one set of alternate ducts is diverted to one outlet and the grain from the remaining ducts is diverted to the other spout. In this way the parcel of grain is divided by random into two samples of equal size and delivered to their respective receptacles. (A) Vertical cross section of device showing paths taken by the grain in passing from the hopper to the receptacle. (B) Cross section of the device at the base of the cone.



The Boerner chondrometer (5) is the instrument used for grain grading in the U.S.A. and Canada. (See Fig. 16.) In this chondrometer the capacity of the measure is one Winchester quart and when being weighed it is suspended from the short arm of a steel-yard.

The long arm of the steel-yard consists of two bars carrying poise weights which are graduated so that one supplies details of the weight per bushel and the other percentages of a weighed quantity of wheat. This latter is useful for calculating the percentage of millable grain or dockage in the sample being examined.

Though the weights per bushel obtained with different samples of wheat on the same instrument are strictly relative, those obtained with the same wheat on different instruments show considerable variations in the results obtained. As pointed out by Duly (5) this is due to several factors and recognised adjustments have to be made when comparing results. For instance the capacity of the weighing hopper in the Boerner chondrometer is based on the Winchester bushel. To compare the bushel weights obtained in this way with those obtained by the Imperial bushel and on the British instruments, Fisher and Jones (4) state that an addition of 2lb. is necessary because of the smaller capacity of the Winchester bushel, and another 2lb. because the Boerner chondrometer gives results which are approximately 2lb. lower than those obtained on the instruments used in England. The total adjustment is therefore 4lb. to be added to the American bushel weights and this adjustment has been made with the weights as given in Table 1 and in the graph which were originally given as those of the Winchester bushel obtained on the Boerner chondrometer.

In Canada, the same instrument is used but as the capacity of the measure is an Imperial and not a Winchester quart it is necessary to add only 2lb. to the readings to bring them into line with those obtained on British and Australian instruments.

In Australia, the chondrometer in general use is known as the Australian Standard Chondrometer. (See Fig. 17.) The size most commonly used has a measuring cylinder of one Imperial pint, although a smaller half-pint size is also available. Its construction is similar to that of the Schopper Litre chondrometer except that it has a steel-yard like the Boerner instead of the two equal balance arms. The weight per Imperial bushel can be read directly from markings on the long graduated arm of the steel-yard. The Australian Standard chondrometer is of more sturdy construction than the Schopper Litre instrument and is admirably suited for use in the mill, silo or warehouse.

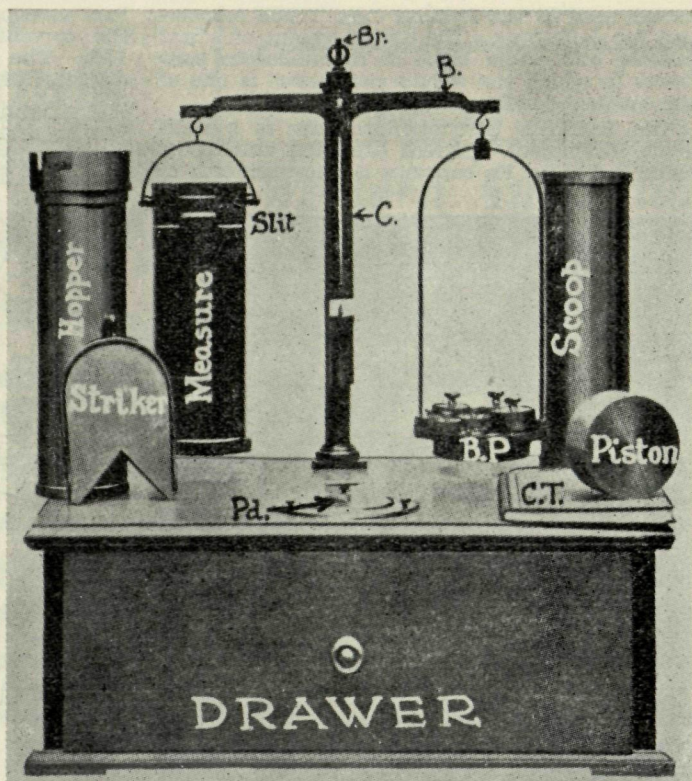


Fig. 15.—The Schopper one-litre chondrometer showing component parts.

At the annual ceremony of fixing the F.A.Q. standard by the Perth and Fremantle Chambers of Commerce, the results obtained with the several standard chondrometers operated on that occasion for checking with the actual struck bushel weight have been found to be almost identical with those obtained with the bushel measure.

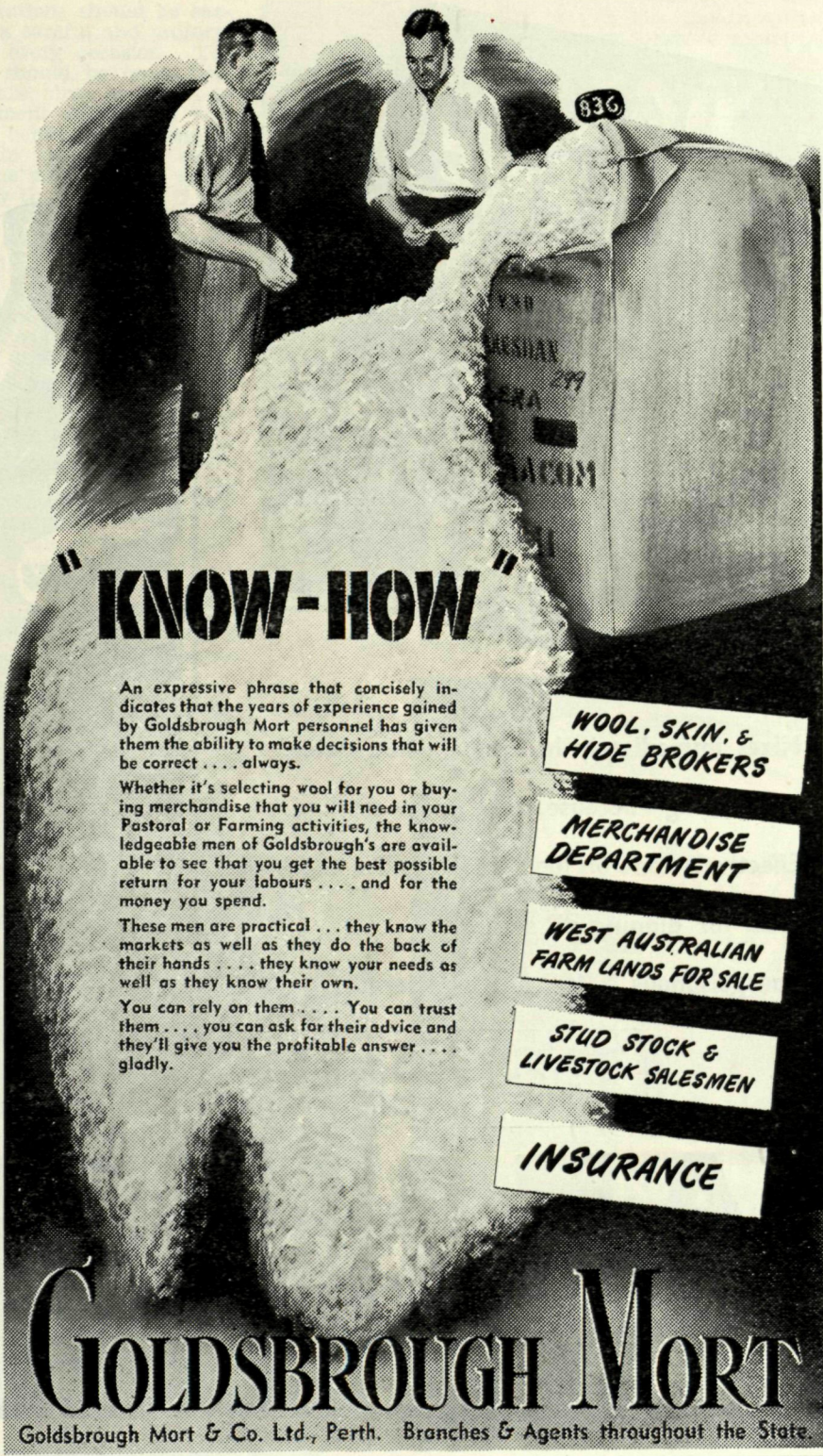
An Australian Standard Chondrometer has been made with graduations on the reverse side of the bar so that, like the Boerner, a quantity of wheat can be weighed in it and the percentages of millable and unmillable material ascertained from the graduated scale on the bar.

The Avery chondrometer (see Fig. 18) is a British instrument and, except that the wheat in the measuring cylinder is weighed on a separate scale, there is considerable similarity between it and the Schopper litre chondrometer. Both have a measuring cylinder, an upper container, a filling cylinder, a plunger and a striker with a sharp V-shaped slot.

The measuring cylinder holds one quart and the scale gives the weight per bushel in pounds and quarter-pounds on the upper set of graduations and the actual weight of the wheat in the cylinder in ounces and fractions on the lower set.

Although a high degree of accuracy may be obtained with any of the chondrometers described it must again be emphasised that the





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various operations should be carried out in a careful and uniform manner on every occasion. The instrument should be on a firm base and care must be taken to avoid movement during the test. A slight jar before striking causes the grain to settle down more closely in the measure and weigh more heavily than it would if the instrument was undisturbed.

### THE EVALUATION OF WHEAT

Though a high bushel weight of millable grain is associated with a high flour yield, it is not related in any way to its baking quality. This should be clearly understood. Milling value is dependent upon the quantity of flour which may be obtained from a given quantity of wheat. Baking quality is dependent upon the strength of the flour—in other words the quantity and quality of its gluten—and this is ascertained by the various strength tests which have been described earlier in this article.

When we speak of the “utility value” of a wheat parcel we are referring to both these factors—

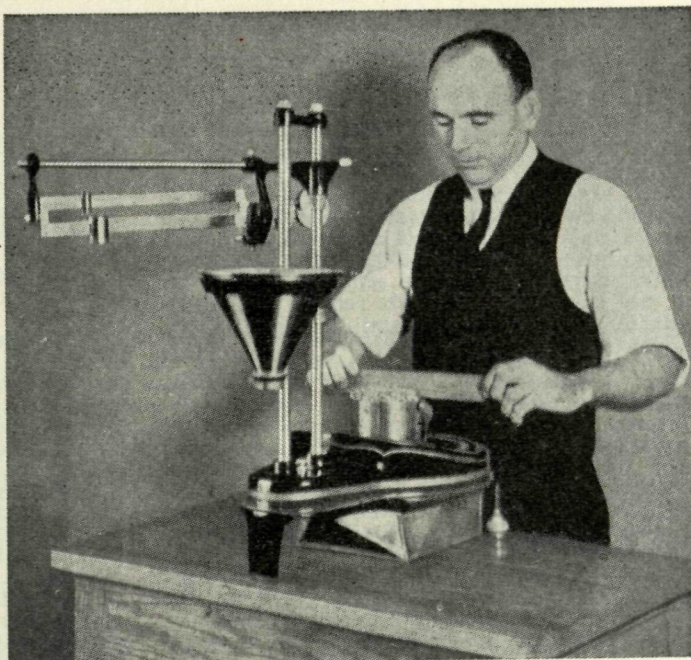


Fig. 16.—The Boerner chondrometer.

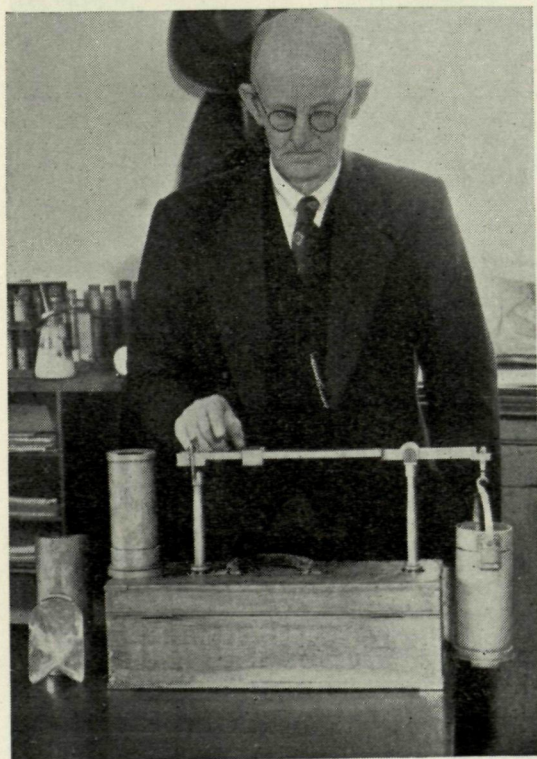


Fig. 17.—The Superintendent of Wheatfarming (Mr. I. Thomas) operating the Australian Standard chondrometer.

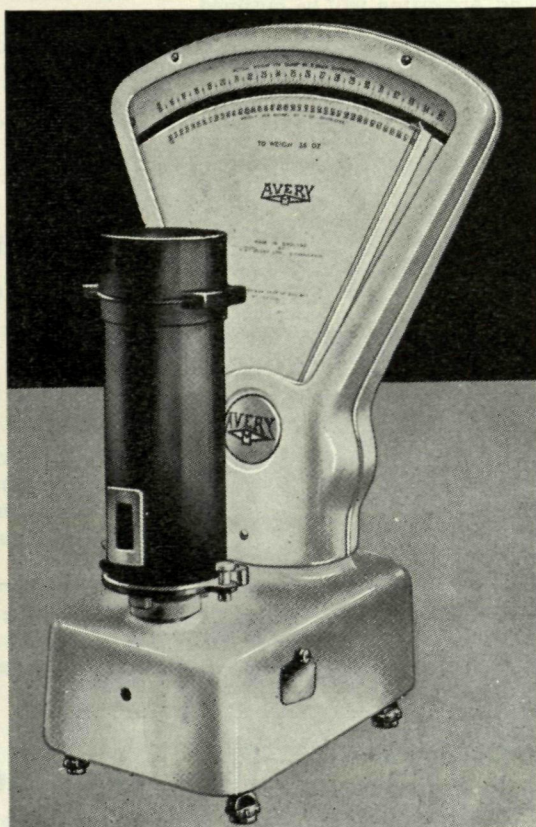


Fig. 18.—The Avery chondrometer.



in other words both the **quality** and **quantity** of the flour which may be obtained from the parcel.

From this it follows that the evaluation of wheat for marketing purposes requires that the wheats shall first be grouped into classes according to the relative general strength and baking quality and that each such class shall be divided into milling value units according to the relative flour yield of each. Such a classification and segregation is necessary for the guidance of prospective buyers and also to protect the interests of the growers whose cash returns should be adjusted according to the utility values of the wheat they offer for sale.

It is not generally realised that there are now methods by which the foregoing can be satisfactorily achieved. The marketing system of any wheat-producing country should be founded upon the basic principles underlying the sound evaluation of wheat for marketing purposes. Obviously the number of baking quality classes and milling value units will be governed by the types and varieties of wheat grown and the variations in the climatic conditions and farming methods employed in those countries. It follows, therefore, that in different countries the wheat marketing systems may differ in detail although they remain similar in general principles. In the next section of this article the wheat marketing systems of the U.S.A., Canada and Argentina will be outlined.

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(To be continued)

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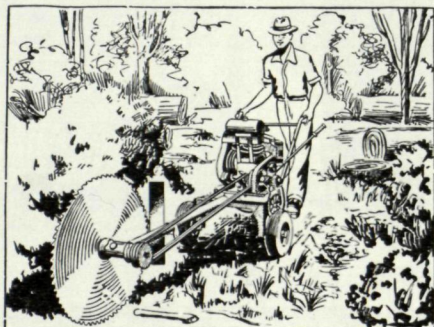
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