



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

# W H E A T   S T U D I E S

OF THE  
FOOD RESEARCH INSTITUTE

VOLUME II

NUMBER 4

PROTEIN CONTENT: A NEGLECTED  
FACTOR IN WHEAT GRADES

STANFORD UNIVERSITY, CALIFORNIA

February 1926

# THE FOOD RESEARCH INSTITUTE

STANFORD UNIVERSITY, CALIFORNIA

Established in 1921 jointly by the Carnegie Corporation of New York and the Trustees of Leland Stanford Junior University, for research in the production, distribution, and consumption of food

## DIRECTORS

CARL LUCAS ALSBERG

JOSEPH STANCLIFFE DAVIS

ALONZO ENGLEBERT TAYLOR

## W H E A T   S T U D I E S

Published by Stanford University for the Food Research Institute.  
Entered as second-class matter February 11, 1925, at the post-office  
at Stanford University, California, under the Act of August 24, 1912

The central feature of the series is a periodic analysis of the world wheat situation with special reference to the outlook for supplies, requirements, trade, and prices. The volume opens with a review of the previous crop year. Subsequently three surveys of current developments are made at intervals of about four months.

These surveys are supplemented by intensive studies bearing on the appraisal of the wheat situation and outlook and upon related matters of national policy. Typical subjects are indicated in the list of studies shown on the fourth cover page of this issue.

Volume II will comprise ten issues to be published monthly from November 1925 to September 1926, except April 1926. Issues may be secured by subscription at \$10.00 for the volume, including a temporary binder. Address: FOOD RESEARCH INSTITUTE, STANFORD UNIVERSITY P.O., CALIFORNIA. European subscriptions, at £2 2s., will be accepted by the Northern Publishing Co., Ltd., 16, Fenwick Street, Liverpool, England.

*Copyright 1926, by Stanford University Press*

# WHEAT STUDIES

## OF THE FOOD RESEARCH INSTITUTE

VOL. II, No. 4

STANFORD UNIVERSITY, CALIFORNIA

FEBRUARY 1926

### PROTEIN CONTENT: A NEGLECTED FACTOR IN WHEAT GRADES

#### SUMMARY

The official wheat standards of the United States are losing much of their value because of the changes that are taking place in the trade practices of evaluating wheat. The standards do not directly consider protein content of wheat, whereas millers in the last decade have come to consider it seriously because bakers have come to demand flour of specified protein content. This new trade custom is having profound effects upon the grain trade, and especially concerns the wheat grower, the miller, and the public.

The baker regards the protein content of his flour as an important index to the quantity of bread he can bake from a given quantity of flour. With technical methods now available, it is possible to secure a fairly close approximation to the protein content of flour, though not of the quality of the gluten. By a similar process one may obtain the approximate amount of protein in wheat, from which one may estimate the protein content of the flour that can be milled from it.

The official standards for wheat do not at present include any reference to protein content, and contain no element that constitutes a reliable indication of protein content. There are great variations in the protein content of wheats of a given grade.

Consequently, because of the importance of this factor in millers' requirements, there is commonly a far greater range of prices for wheats of the same grade but of different protein content, than between average prices for adjacent grades.

The premiums that millers pay or are willing to pay for high-protein wheats are not yet, under present conditions, at all

fully reflected back to the wheat grower. This operates to the disadvantage of the producers of some of the choicest wheats, notably the dry-land farmers. These are distant from milling centers and terminal markets, can practice but limited diversification, and are especially subject to crop failures. The tendency of wheat breeders in various countries is to work toward varieties of higher

protein content. To have premiums for protein content reflected back to producers is important both for the high-cost producer and in order to raise the general milling quality of our wheat.

The practice of buying wheat on protein analysis, dissociated from grades (in particular from the "contract grades" deliverable on futures contracts), reduces the miller's ability to insure against risks of price changes by hedging. He cannot accept delivery on his futures contract, because the

#### CONTENTS

	PAGE
<i>Some Technological Considerations . . . . .</i>	164
<i>Protein Premiums and the Producer . . . . .</i>	167
<i>Protein Premiums and Domestic Milling . . . . .</i>	169
<i>Protein Premiums and the World Trade . . . . .</i>	172
<i>Protein Premiums and the General Public . . . . .</i>	174

deliverable wheat does not suit his requirements. This difficulty tends to prevent cash prices and futures prices from fluctuating in their normal relations, to force the miller to assume speculative risks, and to afford greater scope for types of speculative activity making for price instability. Moreover, the same conditions give a special advantage to large millers and dealers operating at or near terminal markets, except perhaps in the hard winter wheat section. Unlike their smaller competitors, they are able to secure an advantage by analyzing wheat at terminals and mapping tributary areas according to protein content.

The demand of American bakers for flour of high-protein content tends to lower the average milling quality of our export wheat, indeed in some years largely to restrict our exports to wheat of relatively low-

protein content; the consequence is to impair its reputation and to reduce its price abroad. The same demand from domestic bakers puts the American miller at a disadvantage in buying domestic wheat to mill for export.

If, as seems probable, the tendency to evaluate wheat with reference to protein content becomes general, countries able to produce high-protein wheats will enjoy an advantage in the world wheat trade over countries unable to produce such wheats, and production of high-protein varieties will tend to increase at the expense of yield per acre.

The indications are that it is feasible to make protein content a specification in wheat grading. In the interests of producers, millers, and the general public, this is greatly to be desired.

## I. SOME TECHNOLOGICAL CONSIDERATIONS

In order to understand the reasons for the baker's demand for flour of a specified protein content,<sup>1</sup> the reader must know some simple facts concerning the chemistry of wheat and flour and concerning the technology of milling and baking.

While the trade practice of using protein content as an important factor in evaluating wheat is on the increase, knowledge of this factor by no means supplies millers and bakers with all the information desired. The greater part of the protein in flour is gluten. Protein content is therefore merely an index to gluten content. But the baker is interested both in the amount of gluten in a flour and also in its quality, that is, its physical texture and its water-absorbing capacity.

The amount of gluten is important to the baker because, no matter how good its

quality, if the percentage in a flour is too low, good bread of American type cannot be baked from it. But there is another reason why the amount of gluten in a flour interests a baker. It is that the amount of water a flour will absorb to produce dough of ideal consistency depends both upon the quantity and upon the quality of the gluten contained therein. The more gluten, the more water will the dough hold without becoming slack. Also the better the quality of the gluten, the more water will each unit of gluten hold. Now the more water a flour takes up to form dough of the proper consistency, the more loaves per barrel of flour a baker obtains. Naturally upon the yield of bread his profits in great measure depend. Accordingly a baker is interested in the amount of gluten in the flour he buys, not merely because the more and the better the gluten, the better the bread he will bake, but also because he will obtain more loaves of bread per barrel of flour. The baker looks closely at the amount of water a flour absorbs when doughed, since upon it so largely depend his profits. He calls flours that absorb much water and make large, well-piled, silky loaves with uniform small-pored texture, "strong" flours; and, conversely, those having none of these

<sup>1</sup>Proteins are nitrogenous substances which are present in large amount in such foods as white of egg and lean meats. In wheat there are several, of which only two are important in bread making, viz., gliadin and glutenin. When the mixture of these two, as it exists in flour, is wetted, it absorbs much water. It forms a tough, elastic, rubbery mass that is termed gluten. Upon the amount of water the gluten of a given flour absorbs and upon its elasticity and physical texture depend, in the main, the quality of bread that can be baked from that flour.

traits, "weak" flours. Since the amount and kind of gluten in a flour so largely determines whether a flour is weak or strong, bakers prefer flours with much gluten.

Now the separation and measurement of the amount of gluten that is present in a flour is difficult and inaccurate. This cannot be made the basis for the evaluation of flour, though it is attempted in some countries, notably in Australia. Since gluten consists of protein and since the gluten proteins represent the great bulk of the proteins in flour, if one determines the total protein content of flour, one at the same time determines with sufficient accuracy the gluten content, for the amount of protein other than that in the gluten is so small as to be for practical purposes negligible.

In flour, and also in wheat, there is only a negligible quantity of nitrogenous material other than protein. Therefore if the percentage of nitrogen in the wheat proteins be known and the quantity of nitrogen in a given sample of flour or wheat be determined, it is a matter of simple multiplication with a factor to estimate the percentage of protein, and, therefore, of gluten. The wheat proteins contain 17.62 per cent of nitrogen. Therefore the percentage of nitrogen in a sample of flour being known, all that is necessary is to multiply that percentage by the factor 5.7 to know the percentage of protein, and this tells the percentage of gluten closely enough for all practical purposes.

As it happens, there is a very exact method for estimating the percentage of nitrogen in such materials as flour. It is the Kjeldahl method, so called after its inventor, a Danish chemist. To determine with considerable accuracy the gluten content of a flour, all that is necessary is to ascertain, by the Kjeldahl method, the percentage of nitrogen in it, and to perform the necessary multiplication. The result may be taken as slightly greater than the gluten content.

Now the knowledge of the protein content alone does not necessarily tell the baker much concerning the probable "strength" of a flour. It does not tell him much concerning the quality of the gluten or how much water the flour will absorb. There are types of wheat, as for example

durum wheat, which contain very high percentages of gluten yet are unsatisfactory for bread-baking purposes because their gluten is not of the proper quality. It is too tough. Moreover, a wheat with a good quality of gluten may have too much gluten for the best results. Such a flour is said to be "gluten-bound." However, a wise baker is glad to get such a flour since he has merely to dilute it suitably by mixing with some weak flour to make an excellent product. Furthermore the amount of gluten, the value for bread-making purposes, and the capacity to take up water do not always go parallel. Thus flours from durum wheats, while they contain high percentages of gluten and take up very great amounts of water, are not of high value for bread-making purposes even when diluted. Therefore the amount of water that flour will take up when doughed, the "absorption" as it is called, is not by itself a reliable index to flour quality or baking strength, though it is so used apparently in Australia and also to some extent in England.

Nevertheless, all things considered, the amount of gluten, that is, of protein, seems in the light of the present-day knowledge to be the nearest approach to an ideal index of baking strength available. The baker who depends upon it alone will now and then be deceived. If, however, he knows the variety and place of origin of the wheat from which the flour is milled, he will less often be misled.

The protein content of wheat is estimated in the same way as the protein content of flour. There is, however, this difference: The protein in flour is nearly all gluten; the protein in whole wheat is part gluten, part bran proteins, part germ proteins. In the milling process the bran and the germ are removed as completely as possible. Now both the bran and the germ contain a greater percentage of protein than that part of the wheat berry which yields flour and is known as the endosperm. Although the bran and the germ together are less than 17 per cent of the weight of the whole wheat berry, they contain nearly 27 per cent of all the protein.<sup>1</sup> From this it follows that flour

<sup>1</sup> T. B. Osborne and L. B. Mendel, *Journal of Biological Chemistry*, 1919, XXXVII, 557.

contains a lesser percentage of protein than the wheat from which it is milled. The discrepancy varies somewhat according to the amounts of bran and germ. These vary with the size and shape of the wheat berry and the thickness of the bran coat. Ordinarily the difference in protein content between wheat and flour is not much more and not much less than one per cent of the wheat or flour, respectively, though there are cases on record in which the difference has been much greater. Normally the miller can count on a flour with about one per cent less protein than the wheat from which it is milled.

So important has the protein content of wheat become to the miller that some mills have provided themselves with a large number of storage bins, each devoted to wheat of a definite protein content. Such a mill is able to manufacture flour to any given protein specification.

Now the present system of wheat grading, in the United States and most other countries, neglects this factor of protein content. With some modification, the trade practices of the years immediately preceding 1917 were made the basis of the United States standards for wheat. The aim of the Department of Agriculture was to set the limits at such a level that the great mass of wheat which theretofore had been given a certain grade commercially would continue to receive that grade.<sup>1</sup> The result is an inflexible set of standards. Granting, as many experts would not, that the grades represented fairly the milling value of wheat as estimated by the trade at the time the standards were promulgated, the standards, being inflexible, have stood still, while the trade has progressed. In consequence the grades are becoming obsolescent.

The most important index to quality in the grades is the statement concerning the kind of wheat. For purposes of grading,

wheat is divided into classes as "Hard Red Spring Wheat," "Durum Wheat," "Hard Red Winter Wheat," "Soft Red Winter Wheat," "White Wheat," and "Mixed Wheat." Within each class there are separate grades designated by numbers. Certain of the classes are subdivided into subclasses. Knowledge of the class or subclass to which a wheat belongs tells the experienced much concerning its quality, whether it is hard or soft and whether, therefore, it is good for bread flour or for cake flour. To some extent even the class or subclass designations indicate what type of bread flour or cake flour can be made from it.

There is another criterion of grade that is also to some extent a criterion of quality. It is the percentage of hard kernels required as a minimum in the grades of hard wheat. Such kernels are described as dark, hard, and vitreous; hard and vitreous; or simply as hard, as the case may be. They are the kernels that are hard, translucent, and neither soft nor chalky. They are regarded as superior in quality, and the greater their percentage in a parcel, the higher its quality, though to this rule, too, there are numerous exceptions.

The chief positive indices of quality found in the United States wheat grades are, then, (a) class (or subclass) designations and (b) percentage of hard kernels. Until a few years ago this was enough for most purposes. Today, when many bakers demand that flours shall have a certain minimum protein content, a mere statement of the kind of wheat does not give the miller all the information he needs. He must also know the protein content. In this regard the United States grades leave him almost wholly in the dark. The percentage of dark and vitreous kernels was once supposed to be an index to the protein content. Today it is known that it is not necessarily true.<sup>2</sup>

The protein content of wheat may vary greatly in a given locality from year to year and in different though neighboring localities in the same year. Thus in North Dakota the protein content ranged in 1924 from 9.56 per cent to 13.18 per cent, and in 1923 from 11.68 per cent to 14.99 per cent.<sup>3</sup> Hence in the years when high-protein wheats are scarce, millers are compelled to

<sup>1</sup>The Department subsequently stated that this had been accomplished. *Weekly News Letter*, United States Department of Agriculture, October 24, 1917, p. 6; July 24, 1918, p. 15.

<sup>2</sup>C. E. Mangels, "Protein Content of North Dakota Wheat," *Bulletin 191, Agricultural Experiment Station, North Dakota Agricultural College* (July 1925). John H. MacMillan, Jr., "Federal Spring Wheat Grades—A Discussion of their Shortcomings and Suggested Remedies," *Cereal Chemistry*, 1924, I, 68.

<sup>3</sup>Mangels, *op. cit.*

pay whatever may be necessary to secure them. There have been occasions when prices have ranged from more than five cents a bushel discount below the option to more than seventy-five cents premium above it. In recent years the average protein premiums for spring wheat have varied about one cent per bushel for each one-fourth of one per cent fluctuation in protein content.<sup>1</sup> Indeed by no means infrequently wheat is graded low because it is of light test-weight,<sup>2</sup> yet has a very high-protein content. So it happens not at all uncommonly that such wheat, despite the low flour yield it is sure to give, sells for a higher price than that of the option of the next higher grade because it is profitable to mix it with low-protein wheat.

The lack of correspondence between grades and values, due largely to variations in protein content, is indicated by a day's quotations of cash sales of carload lots in leading cash markets such as Minneapolis or Kansas City. Thus on a recent date in Minneapolis, the median<sup>3</sup> prices of No. 1, No. 2, and No. 3 Dark Northern Spring (omitting smutty and musty lots) were, respectively, \$1.70½, \$1.68½, and \$1.66½; but the range of price in No. 1 was \$1.64½–\$1.80½, in No. 2, \$1.62½–\$1.77½, and in No. 3, \$1.56½–\$1.77½. In other words, the range of prices within each grade was four or five times as great as the difference between the median prices of No. 1 and No. 3; and the lowest tenth of cars graded No. 1 sold below the median price of No. 3.<sup>4</sup>

## II. PROTEIN PREMIUMS AND THE PRODUCER

The effect upon wheat growers of the new method of evaluating wheat was at first small. Buyers who were expert quietly picked up the choice high-protein carloads at the regular price for the grade. As more and more buyers became informed, the competition for the choice high-protein parcels led to the payment of premiums, which, as has been pointed out, at times become very high. At first the premiums were not often reflected back to the country shipper except when wheat was consigned to a commission man at the terminal market. Some of these advertised, in order to secure business, that they had wheat consigned to them analyzed in order to secure good premiums for their clients. Gradually the premiums are coming to be reflected back more and more to the country points, though probably only a

minority of the growers as yet get the premium to which they are entitled. The reflection back of the premiums seems to have come somewhat earlier in the hard-winter-wheat section of the Southwest than in the hard-spring-wheat section of the Central Northwest. This is probably due to the fact that in the Southwest milling is less concentrated than in the Central Northwest. In Kansas there are many good-sized mills scattered over the state right among the wheat fields. These are dependent upon the local wheat. To keep running they must meet the premiums which Kansas City offers. The effect has been to reflect premiums back to growers somewhat earlier and probably more completely than in the Central Northwest, where milling is more concentrated at terminal markets. As compared with Kansas, for example, there are relatively few large-sized mills in North Dakota. The country elevators also are largely controlled there by terminal market interests, whether mills or grain companies. The consequence seems to be that the premiums are not so well reflected back to the grower. Indeed, there can be no doubt that, largely because protein content forms no part of the grading basis, the premium is less than it would otherwise be, at least in years of low average protein content of wheat. In consequence the virtues of his

<sup>1</sup> Cf. MacMillan, *op. cit.*

<sup>2</sup> By "test-weight" is meant the weight of a measured bushel of wheat that has had the readily separable admixed foreign matter removed. For No. 1 Hard Red Spring wheat it is 58 lbs., for No. 2, 57 lbs., for No. 3, 55 lbs., for No. 4, 53 lbs., for No. 5, 50 lbs. For the correspondingly numbered grades of Hard Red Winter wheat it is 60 lbs., 58 lbs., 56 lbs., 54 lbs., and 51 lbs. The "test-weight" is the principal index of flour yield. For a given class or subclass of wheat the higher the test-weight, the higher the yield of flour per hundredweight of wheat, though to this rule there are exceptions.

<sup>3</sup> The middle of the items arranged in order of size.

<sup>4</sup> Data from *Daily Market Record*, Minneapolis, February 9, 1926.



wheat are not pointed out to the seller, nor to the smaller mills who are unable to maintain their own expert buyers. In consequence, too, the few mills able to maintain skilled buyers at terminal markets secure relatively superior wheat at smaller premiums than they would if the inspection certificate more truly indicated wheat quality. As a result the general level of premiums must be lower than it would be if sellers and especially smaller buyers had as much information concerning wheat offered as large buyers at terminal markets, whether millers or grain merchants.

Now since the amount of the premium actually paid for wheat in good condition and reasonably free from inseparable foreign matter is proportionate to the protein content and the test-weight, individual wheat growers are affected to different degrees according as the protein content of the wheat they offer is relatively very high or low. It follows that the producers of really choice wheat—heavy in weight, high in protein, and low in moisture—are injured more than producers of wheat of only average or less than average quality.

Since the choicest wheat is produced more often by the dry-land farmer than by the farmer in more humid regions, it is he who is most affected. Now the dry-land farmer is exactly the one who is usually in the poorest economic position. The farther westward one goes, the higher the elevation, as a rule, and also the less the rainfall. The dry-land farmer is farthest from the terminal markets. Moreover, because of the low rainfall there are only a few field crops he can produce. General diversified mixed farming he can practice to a limited degree only. In many localities altitude shortens the growing season so that there is danger of producing frosted wheat; rainfall is uncertain so that a certain average number of crop failures must be counted upon; finally, the yields are relatively low. It seems to be a fact that high quality and high yield are usually incompatible. The world over the best wheat is produced where yields are low because of low rainfall and where in consequence there is always danger of a crop failure. Where great yields are obtained, as in England, quality is very poor, at least in respect

to protein content. High yields depend in part upon the wheat variety, but in part also upon abundance of moisture in the soil. Where in dry-land regions irrigation is practiced, yields go up but protein content usually goes down. Our wheats of highest protein content come from Montana.

It must by this time be obvious to the reader that the dry-land farmer is often a marginal producer, usually a high-cost producer. Not merely that; his production is a very uncertain quantity because of danger of crop failure. A good example is to be found in Canada, where much of the wheat production is by dry-land methods with summer fallow. In the last five years the crop has fluctuated between 474 million bushels in 1923 and 262 million bushels in 1924. It is therefore especially important that the full maximum premium be reflected back to the dry-land farmer, not merely for his own sake, but for that of the general welfare; for undoubtedly the premium will make it possible to keep under the plow a large amount of semi-arid land that otherwise could be used only as range for cattle or sheep.

On the other hand, the payment of protein premiums would undoubtedly work a disadvantage to the irrigated-land farmer in the dry-land regions. Before wheat was so extensively analyzed chemically for protein content his wheat, coming as it did from a dry-land region, was likely to be lumped in with the larger volume of dry-land wheat coming from that region. As time goes on, of course, he will not get the premiums received by his dry-land neighbor. However, his yields are generally higher and less uncertain; and he can diversify his farming operations.

The greater demand today for high-protein wheat has modified the objectives of wheat breeders. In former years their aim was to secure varieties that in a given region would produce maximum yields. Today, while high-yield qualities are of course very welcome, much of the breeders' efforts are devoted to the development of high-protein strains. Thus one of the results of the war has been to stimulate the development of high-protein wheat varieties for England, the object being to lessen

the amount of high-priced, high-protein wheat that must be imported to make good the protein deficiency of English-grown wheat. It is true, to be sure, that the protein content of wheat may be raised by suitable fertilization with nitrogen or by planting wheat in a legume rotation. However, nitrogen fertilization is not now practiced to any great extent in the United States, probably it is not yet profitable; and in dry-land regions a legume rotation is not always practicable. Efforts, similar to those of the English, to raise the average protein content of the wheat of our soft-winter-wheat areas would seem to be desirable everywhere in the United States. Notable results have already been achieved in Indiana and Michigan, and a movement looking toward the improvement of the quality of local wheat has been inaugurated in Pennsylvania.

It may be objected that the country is already overproducing wheat and compelled to sell the surplus in foreign markets. This may be true, but the wheat that is exported is not choice premium wheat but largely nondescript wheat that our millers and bakers reject. In the typical year there is no surplus production of the choice hard,

heavy, high-protein wheat of the dry-land farmer; though in an occasional year there is the unusual combination of a good or large crop of hard wheat and a short crop of good soft wheat. Since soft wheat has its special uses for crackers, biscuits, cakes, and pastry, in such an unusual year the common price-relationship between hard and soft wheat may be reversed so that certain kinds of soft wheat sell at a higher price than hard wheats. In such a year we may even export some of the better qualities of hard wheat. However, in most years our surplus production of soft winter wheat is largely incidental to mixed farming.

The paying of premiums for high-protein wheat and their reflection back to the producer is wholly in the public interest. It is even in the ultimate interest of the producers of soft or low-protein wheat. The high premiums that will from time to time be paid upon high-protein wheat will cause millers and bakers to use them as sparingly as possible. They will use the soft wheats as much as they can. The result must be to tend to raise somewhat the price level of the better low-protein wheats and to keep the premiums on the high-protein wheats from soaring.

### III. PROTEIN PREMIUMS AND DOMESTIC MILLING

The practice of buying wheat on protein analysis makes hedging a less perfect protection to the miller against unusual fluctuations in the price of his raw materials. For example, a miller may have occasion to make a forward sale of a lot of flour to a jobber without actually at the time having on hand the wheat with which to fulfil the forward sale. He accordingly hedges by buying a future to an equivalent amount. Later the miller purchases the wheat and "closes out" his hedge by "selling out" his future. If the price of "cash" wheat and of the future have converged in the theoretically normal way, the miller's operation has been insured completely. What he loses or gains by the sale of the future, he gains or loses in the purchase of the "cash" wheat. Fluctuations in the wheat market would trouble him not at all. Unfortunately, the insurance that can be obtained

by hedging is not as perfect as this, since "cash" and "futures" prices do not always fluctuate in exactly the same way. Any lack of correspondence between the two results in a speculative loss or gain to the hedger. This is known as the "basis" loss or gain. It is usually very much less than the loss or gain the miller *might* have had if he had not hedged, and over a period of years it is assumed that "basis" losses will offset "basis" gains. The system of hedging is therefore a very valuable factor in keeping the miller a manufacturer and merchant rather than a speculator.

It is true, to be sure, that in the Southwest, especially in Kansas and Oklahoma, and in the Pacific states, many mills do not hedge and do not believe in the practice. The difference in practice between the Central Northwest and the Southwest is very largely the result of the difference in dis-

tribution and size of mills. In the Central Northwest the bulk of the milling capacity is concentrated in or near terminal markets; in the Southwest there are many mills of moderate size out among the wheat fields that have first choice of good wheat produced locally and are thus reasonably assured of a good supply from month to month.

Whatever may be the views and the practices of different sections of the grain and milling trades, the fact is that the financing of the marketing of the wheat crop is very largely facilitated by the practice of hedging, for the banks in important terminal markets hesitate to make large advances upon grain unless it is hedged. No doubt if hedging were impossible, ways and means would be found to finance the movement of the crop, but it may be questioned whether bankers, since the risk would be greater, would be willing to furnish the funds at as low interest rates as at present.

There can then be no question of the valuable service hedging performs, and equally there can be no doubt that anything that impairs the security to be achieved by hedging is a serious matter. Now the practice of buying wheat and flour on protein analysis threatens to impair the value of hedging under existing grades—at least to the miller. To that extent the practice is a serious matter.<sup>1</sup>

The reason why the practice has impaired the value of hedging to the miller is simple enough. Hedging is based on the assumption above stated that “cash” and “futures” prices move together. If they do, the miller is protected, assuming that he is in a position to use wheat that is delivered on a future contract, that is, wheat of contract grade. It has long been objectionable to millers to use this wheat if they can avoid it, because wheat of contract grade is so often the minimum deliverable under the grade. The official wheat standards are not high. Elevators, therefore, in delivering wheat of contract grade debase it to the minimum quality permissible under the

grade. A decade ago the practice was limited to mixing inferior with superior wheat, to the addition of screenings and the like. Today, when so much wheat is sold on protein analysis, elevators may deliver in the contract grade wheat with as low a protein content as they can achieve for the particular class of wheat delivered. Under the circumstances, millers who have contracts for flour of high-protein content cannot take delivery of the contract grade. They could not produce from it flour of the protein content called for by their customers. In such cases millers must sell their futures and, so far as they are able, buy on sample or on protein analysis. Millers, therefore, want high standards for the wheat grades. Fobbers<sup>2</sup> and exporters on the contrary desire low standards for the grades.<sup>3</sup>

The payment of premiums for protein is not the only factor that has contributed to alter the insurance value of hedging. Perhaps an even more important factor has been the change in the rules of the grain exchanges, permitting delivery on contract (with specified price adjustment) of a larger number of kinds of wheat than formerly. With this situation, however, the present study does not deal. Suffice it to say that the miller today has several difficulties to face in accepting delivery on a futures purchase if he must produce a specified kind of high-protein flour. His mill may be so situated with reference to the market in which delivery is made that he cannot for that reason use the wheat. He may not be offered the class and grade of wheat he needs. He is pretty certain to be offered the minimum permissible under the grade. He is not likely to receive high-protein wheat, whatever the class or grade offered.

It may be objected that even before the days of trading in wheat on protein analysis millers hedged in the main as a pure matter of insurance without any intention of accepting delivery. That is quite true; but it is the realization that the miller may elect delivery, and that he will do so if it is profitable for him, that holds the cash and futures prices to a definite relationship. Anything that makes it more difficult for the miller to accept delivery, whatever the miller's intentions may be, tends to disturb the rela-

<sup>1</sup> Cf. Editorial, *Northwestern Miller*, November 18, 1925, p. 643.

<sup>2</sup> Those who buy wheat at interior points for delivery to exporters at seaboard.

<sup>3</sup> Cf. *Northwestern Miller*, loc. cit.

tion of cash and futures prices, and this in turn to make it more difficult for the miller to accept delivery. A number of factors have combined to create much difficulty, not the least of which is protein premium. Knowledge, formulated or subconscious, that acceptance of delivery on future purchases has become less likely, has undoubtedly tended to influence the spread between cash and futures prices unfavorably to the miller. Protein premiums have therefore played an important part in lessening the value of hedging.

Protein premiums have given to dealers and mills situated at or near terminal markets notable advantages over their competitors located at a distance. Such dealers and mills have first choice of wheat that comes upon the sample market. They may—and do—cull out the choicest high-protein parcels. Other dealers and mills can do so only through brokers at terminal markets or by maintaining their own expert buyers there. Obviously this is beyond the power of small mills. They must buy on specifications and will have to pay the full premium. They will be unable to pick up bargains as can mills with expert buyers and laboratories on the ground. Except perhaps in Kansas small concerns not situated at terminal markets are today, because of protein premiums, in a less strong competitive position than formerly.

Mills and dealers at terminal markets possess another competitive superiority. Many of them find it advantageous early in the season, as soon as threshing begins, to make a survey of the quality and protein content of wheat county by county or even township by township. They are then guided through the rest of the season by the information thus obtained. Those mills and grain companies that operate lines of elevators in the hard-wheat producing sections, analyze the wheat from each township tributary to each elevator, and base upon these analyses their instructions to elevator managers in regard to premiums to be paid. Mills and grain companies unable to do this, labor under great handicaps, the smaller concerns being especially at a disadvantage.

As suggested above, it has been possible for years to make profits by cleaning, dry-

ing, and mixing grain in elevators. The demand for high-protein wheat has widened these opportunities and has given occasion to raise protein content by using, whenever profitable, certain kinds of wheat which, while containing much protein, are not esteemed by millers as bread wheats, for example durum. This is possible because the presence of a small amount of foreign wheats is permitted by the official grade specifications.<sup>1</sup> Moreover, the mixing of wheat on a protein basis has attracted into the grain business more millers than were in it formerly, for the miller naturally is the best connoisseur of wheat quality. Certain concerns favorably located are picking up and holding high-protein wheat with the intention either of mixing it themselves or of selling it later to mixers or others who may need it badly. They thus capitalize their special opportunities and their superior expert knowledge.

In the last year a new development has occurred which still further complicates the situation for the miller. The combinations which have developed in the bakery industry<sup>2</sup> are in a strong bargaining position because of their size. Some of these would like to contract for their flour for a long period in advance. Millers are loth to make such contracts because of the difficulty of forecasting the premiums upon high-protein wheats. In other words, they find it difficult to insure their operations by hedging. Moreover, some of the large baking concerns have been attempting to introduce a novel method of buying flour. It is to base the price of flour on the nearest wheat future, in other words to say to the miller what his margin on a barrel of flour shall be. If it were possible for a miller to protect his operations completely by buying or selling a future according as he was "long" or "short" of wheat, the proposition would not necessarily be unfavorable to him. The important point would be how good a bargain he could make with regard to the milling margin. Or if the great bakery corporations were willing to take a wide range of qualities of flour, the propo-

<sup>1</sup> *Northwestern Miller*, November 18, 1925, p. 665.

<sup>2</sup> Cf. C. L. Alsberg, *Combination in the American Bread-Baking Industry, with Some Observations on the Mergers of 1924-25*. Food Research Institute, Miscellaneous Publication No. 3, January 1926.

sition might also be favorable to efficient millers. However, large bakers are more likely than small ones to be particular concerning flour, since they employ experts to examine deliveries. Therefore, the miller is faced with the dilemma that he may either accept such an offer based on the nearest future, hoping that the milling margin allowed in the price will be adequate to cover the cost of premium wheat, manufacturing operations, and leave a profit besides, or he may refuse to do business on the proposed basis. Some of the largest milling companies have taken the second position. A struggle is now in progress between bakery combinations and millers, in which the latter are not at as great a disadvantage as they might seem to be, since the bakery combinations probably use less than 15 per cent of the bread flour produced in the United States. The situation, however, serves to emphasize the inadequacy of hedging, and this inadequacy is due in part to protein premiums.

The miller is the buyer of about 80 per cent of the farmer's wheat. Anything, such as protein content, which tends to reduce the minimum quality of wheat admissible to the better grades below the standard requirements of mills grinding that variety of wheat, deprives the market for those grades of its greatest stabilizing buying

power. This must play havoc with the course of wheat prices and especially with the relation between "cash" and "futures" prices. All this, together with the uncertainty concerning protein content, much diminishes the protection the miller can secure by hedging. It increases his risks, makes it difficult to accept long-time contracts, compels him to carry larger stocks—in short, makes his operations more hazardous. It handicaps the miller at a distance from terminal markets, since unlike his competitor at these markets he cannot easily buy on sample and pick and choose his wheat. He must depend upon agents or brokers to do this for him. The very fact that because of low or inadequate standards certain types of wheat command high premiums, makes it difficult for the miller far from terminal markets to secure such wheat, for it is soon withdrawn from the channels of trade to a considerable extent. Millers who can get such wheat store it, as far as they are able, against future needs, since it is uncertain at what price they might have to purchase when it is needed later in the season. Thus the effect of low or unsuitable standards upon the wheat market causes good wheat to be withdrawn from the channels of trade, with resulting disturbances in the normal prices of such wheat.

#### IV. PROTEIN PREMIUMS AND THE WORLD TRADE

If most of the high-protein wheat is picked out by domestic consumers, the general average bread-making quality of the wheat exported must sink. And this will affect the reputation and also the price of American wheat abroad. If, because all the best wheat is retained in the United States, only cull wheat is exported, United States wheat will be discounted more or less abroad and the price received for it will be relatively low. In years of short domestic crops and small exports, there will be no, or at least little, effect upon the domestic price. Just what the effect is likely to be in years of large crops and much exportable surplus it is not yet possible to say. The data to make possible such prediction are not yet at hand. The present wheat tariff and cer-

tain Canadian developments are of too recent a date.

The high premiums that are coming to be paid for high-protein wheat handicap a different part of the country's export business, milling of domestic wheat for export. Flour milled in whole or in part from domestic high-premium wheat may have to compete with wheat milled where the custom of buying on protein analysis does not prevail. The American miller may therefore be at a disadvantage in the purchase of his raw material. No doubt Europe will ultimately come to including protein content<sup>1</sup> as a fac-

<sup>1</sup> There are, of course, some European millers who already analyze wheat for protein, but European bakers do not as yet demand flour of specified protein content.

tor in the evaluation of wheat. When it does, this handicap of American millers may become an asset, provided, of course, there is at that date any flour available for export. The more rapid expansion of Canadian exports of flour as compared with ours is largely a result of the high-protein content of Canadian wheat.

If the world generally follows the example of the United States in regard to using protein content as a factor in evaluating wheat, as no doubt the world ultimately will, there will be important effects upon the world trade in wheat. Canada is already following the example of the United States. Australia is discussing it. England is working toward raising the protein content of its home-grown wheats. The result will be to place all the countries exporting high-protein wheats in an even more advantageous position than they occupy today. The principal countries of this group are Canada, Russia, parts of Argentina, and in some years the United States. High-protein wheats are produced in limited regions elsewhere, but play no important rôle in world trade. Those countries which produce medium and soft wheats will correspondingly suffer. The principal ones of these are Australia, parts of Argentina, India, the United States, and most of Europe, except Hungary and Southern Russia. The competition between Russia and Canada, should Russia again export any large volume of wheat, will be sharpened; and both countries, together with the United States, will be at greater advantage as compared with Australia and most of Argentina than at present. The result will no doubt be to stimulate the cultivation of higher-protein varieties all over the world at the expense of some loss of yield; Argentina is now planting "registered" Marquis and Kanred wheats. It will force into other forms of agriculture many marginal acres in regions producing low-protein wheat, and may bring into wheat production not inconsiderable tracts of semi-arid land, on which the premiums for quality will overbalance the hazards of production.

It may be objected that already in Europe premiums are paid or discounts deducted according to country of origin because millers are well aware of the different char-

acteristics of the wheat of different regions and because these characteristics depend in large measure upon the protein content of the respective wheats. This no doubt is true. However, in European markets, wheats imported from a given region are very largely classed together, as is indicated by the following quotation from an English authority:

The somewhat elaborate grading, and varieties, at the native grain ports of the respective wheat, are usually merged into a few on this side, for convenience of buying, and because also, when the different wheats of the world are brought together into the open markets here, slight differences (and the many centres from which the wheats are drawn), causing the local subdividing abroad, are lost sight of or ignored.<sup>1</sup>

It may be questioned that when the majority of European millers come to realize the value of chemical analysis, the protein content of different shipments from the same country will continue to be "lost sight of or ignored." Certainly before the introduction of protein analysis American millers were at least as well informed in regard to the baking value of the wheats from different sections of the United States as European millers are today in regard to the world's wheats; yet American millers and bakers are finding protein analysis invaluable. Even in Canada, where the average protein content of wheat is higher than in the United States and the range of protein content in the grades less, some Canadian millers are buying on protein content and paying premiums. It is hard to believe that European millers and bakers would not experience the same benefits. Indeed, today the Canadian wheat pool, at present the world's greatest exporter of high-protein wheats, endeavors to educate British millers and bakers concerning the value of protein content as an index to baking value.

If European millers and bakers come to the use of protein content as a factor in determining wheat and flour values, then methods of trading will have to be changed. Either F.A.Q. ("fair average quality") basis of trading will have to be abandoned entirely or it will at least have to be materially modified.

<sup>1</sup> P. A. Amos, *Processes of Flour Manufacture*, Longmans, Green & Co., London, 1920, p. 29.

## V. PROTEIN PREMIUMS AND THE GENERAL PUBLIC

It may be asked whether harm is done by standards that are inappropriate in that they ignore protein content, since economic forces inevitably tend to re-establish an equilibrium such that values seek their proper levels. The harm to producers, to millers, and to the general public may be material. This section is devoted to an analysis of such effects.

Under existing standards, the producer of high-quality wheat does not regularly get the premiums to which he is justly entitled. Even if his wheat brings a premium at the terminal market, this premium is not necessarily reflected back to him. The inappropriate standard merely decreases the discount at which poor wheat sells under good. The producer of good wheat is injured and the producer of poor not benefited.<sup>1</sup> A powerful stimulus for the production of high-quality wheat is withheld. Less of that commodity is produced; its price rises. The result is disadvantageous to the nation and especially disadvantageous, as already pointed out, to the dry-land regions which form so large a portion of the United States.

A large part of the milling industry is injured by inappropriate standards, because insurance of operations through hedging is seriously impaired. Millers are compelled more and more to be speculators in raw materials rather than manufacturers pure and simple. There was always some speculative element in hedging, because insurance never has been perfect. There was always doubt concerning the "basis" loss or gain. For the reasons set forth above, these losses or gains are much greater than formerly. The miller is therefore compelled to do business on a wider margin.

The uncertainty of hedging is driving millers more and more into speculative transactions in grain. More and more they are endeavoring to take speculative advantage of the growing unreliability of hedging. It is becoming more and more usual for millers to shift their hedges, not merely from one month to another, but also from

one market to another, not merely for the purpose of increasing their hedging insurance, but also with the hope of speculative gain. No doubt this element has always existed to some extent in hedging, but the divergence between the basis for purchasing and for grading wheat has given it great encouragement. Aside from the fact that combining manufacturing and speculation is bad for an industry and bad for the public, the practice gives the great corporations decided advantages over the small millers. The great corporations are able to employ a staff of experts; they are strong enough to stand an occasional heavy loss. The small miller can do neither and is correspondingly handicapped. The result must inevitably tend toward centralization of the milling industry in relatively few great corporations. It may be questioned whether or not this will prove in the public interest.

The general public is injured by inappropriate standards, especially when they take no cognizance of some important factor of quality or purity as in the case of protein content of wheat. With such standards, the risk of doing business is increased. If risk is increased, the expense of doing business is advanced, for more capital is required, financing is more expensive, credit risks are greater, larger inventories must be carried. Just who bears the increased expense depends upon circumstances. It is ordinarily stated that it is deducted from the price the producer receives or added to the price the consumer pays or is distributed between them. This is, however, not necessarily always the case. In any event, whoever pays, the process is an economic waste and to that extent a national misfortune.

Obviously the chief beneficiaries are certain of the middlemen. They are put more or less in position to manufacture the particular kind of grain that at any moment is in short supply and, therefore, "out of line" in price. The middleman is thus a factor in stabilizing prices. In judging the rôle he plays in the grain trade, the beneficial and harmful effects of his operations must be weighed against one another.

The incongruities of the situation are coming to be recognized. The matter of

<sup>1</sup> *Hearings (June-July, 1921) on H.R. 7401 (the Steenerson Bill) before the Committee on Agriculture of the United States House of Representatives (Preliminary Print), p. 147.*

taking protein content into consideration in grading wheat is already being agitated in Canada and in the Central Northwest States. More progress has been made in Canada where the problem has been brought before the Dominion parliament. In the United States, the first and, it seems, the only step in this direction has been taken by Mr. Sinclair, who on December 7, 1925, introduced a bill "To authorize the Secretary of Agriculture to make protein tests of wheat."<sup>1</sup> However the trade in Minneapolis, more alert than the government, has taken practical steps by including protein content among the factors used in determining closing prices of wheat. A committee of the Chamber of Commerce, known as the Closing Committee on Wheat Prices, endeavors to arrive at the values of the different grades on which closing prices are placed and also of the various qualities of the grades.

The Chamber employs a man to assist the Closing Price Committee. This man sees the various buyers for the mills, terminals and shippers, and also the salesmen for the commission firms, and gets their ideas of the value of the different grades and the different qualities of grain in the different grades. This material he then takes to the members of the Wheat Closing Committee who check it from their own knowledge. This Committee is made up of men who are specializing in the buying and selling of wheat. The Committee checks the information gathered for them with their own knowledge, and bases the value for the different grades and qualities on the basis of a premium over or discount under the futures.

At the present time, closing prices are made on No. 1 Hard Spring Fancy and No. 1 Dark Northern Spring Fancy from Montana, and No. 1 Hard Spring; also No. 1 Dark Northern Spring, No. 2 Dark Northern Spring, and No. 3 Dark Northern Spring. The closing prices on these three grades are divided into three sections—choice to

fancy, good to choice, and ordinary to good. No. 1 Northern, No. 2 Northern, and No. 3 Northern Springs are not subdivided into qualities. These divisions are based on the quality of the wheat in these grades and represent variations in the quality in the grades, being based mainly on the weight, foreign material, and protein content, also all the factors of the grade. These values as placed represent prices paid and bona fide bids for certain qualities of grades at the close of the market.

It is always easier to point out defects than to suggest remedies. And so it is for the protein factor in evaluating wheat. Given a properly equipped laboratory and an adequately trained personnel, the determination of protein in wheat presents no difficulties. There are laboratories in which two low-salaried men make as many as one hundred and fifty analyses in a day. Where large numbers of analyses are required, they can be made cheaply, expeditiously, and accurately. However, the present method of determining protein cannot be employed at country elevators. Having the analysis made after the grain has been sold to the country elevator and has arrived at the terminal market would not always help the farmer. What is badly needed is a test that will do for protein in wheat what the Babcock test does for butter fat in milk and cream.

Meanwhile, even if the test is not made until the wheat has arrived at the terminal market, much is to be gained by making protein content a factor in grading. Though the price warranted by the quality is not always reflected back to the wheat grower, the advantages are great. All the world could then know in any given year from what towns and counties the high-protein wheat was coming.<sup>2</sup> This would tend to reflect premiums back to the farmer. Those who shipped on consignment would be more likely than at present to get the price to which they might be entitled. Consignors might send samples for analysis in advance of shipment and receive a report before arrival of the car at the terminal market, being thus put in a stronger bargaining position. The Canadian method of selling grain to a country elevator "subject to inspector's grade and dockage," so modified as to be "subject to grade, dockage, and

<sup>1</sup> H. R. 5241, 60th Congress, 1st Session.

<sup>2</sup> The great value of publicity of this kind has been recognized by Professor C. E. Mangels of the North Dakota Agricultural Experiment Station. He has analyzed wheat from as many stations as he could early in the season and has made the results public as soon as possible.



protein analysis," might become general. According to this method, the farmer stores his grain in the country elevator and at the same time the elevator manager and the farmer take a joint sample, seal it and send it to the government inspector for grading. When the official report on the grade is received, the farmer may sell to the country elevator, ship, or continue storage, settlement being upon the grade given on the official certificate. Such a system is already in process of evolution in the United States. It would surely reflect back the premium to the farmer. The country buyer need not be hurt thereby, since the protein contents of two parcels of wheat are additive when they are mixed.

The introduction of a protein factor in the grading would stimulate the producer to bend his efforts to the securing of high-protein wheat as well as high yields. In the soft winter wheat area much could be accomplished in this direction. With the shortage of high-protein wheats that recurs from time to time and the permanent shortage that will arise in the future with population growth, this is a most important matter. The addition of a protein factor to the basis of the country's wheat standards is important not merely as an act of justice to the quality producers and to the lesser millers, but also as an important element of the country's national policy in providing for the future.

*This issue has been written by Carl L. Alsberg*

# A PARTIAL LIST OF CONTRIBUTIONS

## FROM THE FOOD RESEARCH INSTITUTE

(Reprints, chiefly of journal articles. Free on request. Order by key number.)

- No.
- G 5. "The Future of the United States as a Food Exporter," A. E. Taylor. *Manchester Guardian Commercial*, November 16, 1922
- G 14. "The Future of Wheat Export from the United States," A. E. Taylor. Kansas State Board of Agriculture *Quarterly Report*, March 1924
- G 15. "Consumption, Merchandising, and Advertising of Foods," A. E. Taylor. *Harvard Business Review*, April 1924
- G 16. "Progress in Chemistry and the Theory of Population," C. L. Alsberg. *Industrial and Engineering Chemistry*, May 1924
- G 17. "Forecasting Conditions in Europe," J. S. Davis. Reprinted from chap. xx of *The Problem of Business Forecasting* by Warren M. Persons and Others. The Pollak Foundation, 1924
- G 18. "Economic and Financial Progress in Europe, 1923-24," J. S. Davis. *Review of Economic Statistics*, July 1924
- G 19. "New Books on the Principle of Population," C. P. Wright. *Quarterly Journal of Economics*, August 1924
- G 20. "The Effect of Scientific Food Consumption in Increasing Wealth," C. L. Alsberg. *Annals of the American Academy of Political and Social Sciences*, September 1924
- G 21. "The Problem of Delivery Equipment [in the Baking Industry]," Wilfred Eldred. *Management and Administration*, December 1924
- G 22. "Economic and Financial Developments in Europe, 1924-25," J. S. Davis. *Review of Economic Statistics*, April 1925
- G 23. "A Method of Measuring Managerial Ability in Farming," M. K. Bennett. *Journal of Farm Economics*, July 1925
- G 24. "Future Trading as Insurance in the Cotton Oil Industry," C. L. Alsberg. *Journal of Oil and Fat Industries*, April 1925
- G 25. "Disbursement of the Family Income," A. E. Taylor. *Journal of Home Economics*, September 1925
- G 28. "Our Future Flour Supply," C. L. Alsberg. *Journal of Home Economics*, February 1926
- G 29. "The Development and Purposes of Farm-Cost Investigation in the United States," M. K. Bennett. *Quarterly Journal of Economics*, February 1926
- ER 1. "A Viscosimetric Study of Wheat Starches," O. S. Rask and C. L. Alsberg. *Cereal Chemistry*, January 1924
- ER 2. "On the Gelatinization by Heat of Wheat and Maize Starch," C. L. Alsberg and O. S. Rask. *Cereal Chemistry*, May 1924
- ER 4. "The Effect of Grinding upon Starch and Starch Pastes," C. L. Alsberg and E. E. Perry. *Proceedings of the Society for Experimental Biology and Medicine*, 1924
- ER 5. "Some Critical Considerations of the Gluten Washing Problem," D. B. Dill and C. L. Alsberg. *Cereal Chemistry*, September 1924
- ER 6. "Preparation, Solubility, and Specific Rotation of Wheat Gliadin," D. B. Dill and C. L. Alsberg. *Journal of Biological Chemistry*, September 1925
- ER 7. "The Effect of Fine Grinding upon Flour," C. L. Alsberg and E. P. Griffing. *Cereal Chemistry*, November 1925
- ER 8. "The Composition of Crude Gluten," D. B. Dill. *Cereal Chemistry*, January 1925
- ER 9. "The Effect of Dry Grinding upon Gels," C. L. Alsberg and E. P. Griffing. *Proceedings of the Society for Experimental Biology and Medicine*, 1925
- ER 10. "Starch Grains of Wheat Considered as Partially Dehydrated Amylose," H. L. Van De Sande Bakhuyzen. *Proceedings of the Society for Experimental Biology and Medicine*, 1925
- ER 11. "The Structure of Starch Grains from Wheat Grown under Constant Conditions," H. L. Van De Sande Bakhuyzen. *Proceedings of the Society for Experimental Biology and Medicine*, 1926

# WHEAT STUDIES

OF THE  
FOOD RESEARCH INSTITUTE

## VOLUME I

DECEMBER 1924—SEPTEMBER 1925

376 folio pages, including tabular appendixes and analytical index, bound in red buckram  
Price \$10.00

No.

1. *The World Wheat Situation, 1923-24: A Review of the Crop Year.* \$2.00
2. *Current Sources Concerning Wheat Supplies, Movements, and Prices: A Select List, with Comments.* \$1.00
3. *Developments in the Wheat Situation, August to December, 1924.* \$2.00
4. *The Dispensability of a Wheat Surplus in the United States.* \$1.00
5. *Developments in the Wheat Situation, January to March, 1925.* \$2.00
6. *Average Pre-War and Post-War Farm Costs of Wheat Production in the North American Spring-Wheat Belt.* \$1.00
7. *European Wheat Production as Affecting Import Requirements.* 50c
8. *Canada as a Producer and Exporter of Wheat.* \$2.00
9. *The Disposition of American Wheat Supplies: A Critical Appraisal of Statistical Procedures.* \$1.00
10. *Developments in the Wheat Situation, April to July, 1925.* \$2.00

## VOLUME II

NOVEMBER 1925—SEPTEMBER 1926

Subscription price:  
\$10.00 for the volume of ten issues

No.

1. *The World Wheat Situation, 1924-25: A Review of the Crop Year.* November 1925. \$2.00
2. *The Wheat Situation, August to November, 1925.* December 1925. \$1.00
3. *A National Wheat-Growers' Co-operative: Its Problems, Opportunities, and Limitations.* January 1926. \$1.50
4. *Protein Content: A Neglected Factor in Wheat Grades.* February 1926. 50c

## MISCELLANEOUS PUBLICATIONS OF THE FOOD RESEARCH INSTITUTE

No.

- M 1. *Stale Bread Loss as a Problem of the Baking Industry,* J. S. Davis and Wilfred Eldred. February 1923. 70 pages. Paper, 50c
- M 2. *The American Baking Industry, 1849-1923, as Shown in the Census Reports,* Hazel Kyrk and J. S. Davis. September 1925. 108 pages. Cloth, \$1.50; paper, \$1.00
- M 3. *Combination in the American Bread-Baking Industry, with Some Observations on the Mergers of 1924-25,* C. L. Alsberg. January 1926. 148 pages. Cloth, \$2.00; paper, \$1.50

For subscriptions, completed volumes, and individual publications, address

FOOD RESEARCH INSTITUTE  
STANFORD UNIVERSITY P.O., CALIFORNIA

European subscriptions to *WHEAT STUDIES*, at £2 2s., will be accepted by the Northern Publishing Co., Ltd.,  
16, Fenwick Street, Liverpool, England