The economics of marketing high protein hard red spring wheat in the North Great Plains region of the United States
by John A Parfett

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Agricultural Economics
Montana State University

Abstract:
The following dissertation is an attempt to focus attention on the individual and social economic problems relating to marketing high protein hard spring wheat.

The introductory chapter outlines the purpose of observing, assembling, classifying and analyzing information of economic significance to individuals, social segments and consumers. Particular emphasis is devoted to producer problems in performing the segregative and allocative function in the market place, The relation of economic theory to price as a function of supply of and demand for hard red spring wheat is contained in Chapter Two, which consists of three parts. Part I relates to the theory of supply of high protein hard red spring wheat; Part II presents those factors which are assumed to affect the elasticity of and changes in the demand schedule; and Part III combines the theoretical assumptions of supply and demand and their relation to protein premiums. Substantiation for particular phases of the theoretical assumptions is found interspersed with theory. Included in Chapter Two are the references to the results of previous theoretical and empirical investigations. Results of tabulations of secondary data contained in the appendix have been mainly associated with Part III, Chapter III pertains to theory of sampling and practical applications of sampling in determining supplies of milling classes of wheat.

Results of the investigation and implications directed toward future research are summarized in Chapter IV.

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CONTENTS

Title	Page
List of Tables	6
List of Figures	8
Acknowledgements	9
Abstract	10
Chapter I: INTRODUCTION	11
Part I. The Problem	11
1. Initiation of Inquiry	11
2. The Problem Statement	12
3. Limits of the Study	12
Premium	13
The Marketing Segments	14
Wheat Quality in Relation to Premium	16
The Geographic Area	16
History of Development of Protein Premiums	17
The Legal Institution and Customs	18
Part II. Marketing Problems	19
1. Producers	20
2. Elevator Operators	24
3. Commission Firms and Brokers' Problems in Allocating Wheat	25
4. Millers	25
5. Bakers	27
6. Consumers	27

Title	Page
7. Social Welfare	28
Part III. Wheat Quality and Protein Premiums	31
1. Producers	31
2. Millers	32
3. Bakers and Consumers	36
Part IV. The Geographic Area	38
1. Area of Production	38
2. The Consumers of High Protein Hard Red Spring Wheat	40
Part V. History of Development, Custom, and Laws Pertaining to High Protein Hard Red Spring Wheat	42
1. Research and Technology	42
2. Legal Institution and Custom	43
Chapter II. THEORY OF PRICE IN RELATION TO SUPPLY OF AND DEMAND FOR HIGH PROTEIN HARD RED SPRING WHEAT	46
Part I. Theory of Supply	46
1. Definition of Supply	46
2. Short Run Supply	49
3. The Market Supply	53
4. The Long Run Supply Schedule	55
Part II. Theory of Demand in Relation to High Protein Hard Red Spring Wheat	61
1. Introduction	61
2. Long Run Demand	65
3. Short Run Demand	67
4. Market Demand	70

Title	Page
Part III. Protein Premiums as a Function of Supply and Demand	72
1. Premium Fluctuations	72
2. Blending Wheat	75
3. Exchange Prices and Elevator Prices	76
4. Storage Loan Program	76
5. Protein Premiums in Imperfect Markets	77
Chapter III. CRITICAL ANALYSIS OF METHODS OF DETERMINING THE SUPPLY OF HIGH PROTEIN HARD RED SPRING WHEAT ..	82
Part I. Sampling Considerations	82
1. Reasons for Determining Supply	82
2. The Statistical Population of Wheat	82
3. Description of the Marketing Process Relative to Sampling Possibilities	83
4. Sampling Theory	85
5. Estimating a Cumulative Frequency Distribution	86
6. Premiums in Relation to Historical Data	89
7. Prerequisities of Sampling	93
Factors of Supply and Demand	93
Timeliness	94
Part II. Appraisal of Techniques in Use	96
1. Applied Sampling Techniques	96
Chapter IV. SUMMARY AND CONCLUSIONS	100
Part I. Reasons for and Purpose of the Study	100
1. Observation and Classification	100

Title	Page
Part II. Solution of the Problem	103
1. Factors Affecting Premiums	103
2. Theoretical Implications	104
3. Requirements for Determining Supply and Demand Schedules	104
Part III. Economic Implications of the Problem	106
1. Producers	106
2. Millers	106
3. Society	107
APPENDIX (Statistical Tables)	108
BIBLIOGRAPHY	141

LIST OF TABLES

Number	Title	Page
I	Relation of Average Protein Premium for Hard Red Spring Wheat to Average Protein Content and Loaf Volume of 4 Classes to Milling Wheat, 1947-1951	90
II	Spring Wheat Yield and Production in Montana, North Dakota, South Dakota, and Minnesota, 1933-1952	109
III	Seasonal Trend of Wheat Prices and Protein Premiums, 20 Year Average, by Months, Dark Northern and Northern Spring Wheat	110
IV	Distribution by Per Cent Protein of Yearly Average of Mid-Month Premiums for Number 1 Dark Northern and Northern Spring Wheat for 20 Years, 1933-1952.....	111
V	Mid-Month Base Price and Protein Premium of Number 1 Heavy Dark Northern and Northern Red Spring Wheat, by Months, 1933-1953	112
VI	Report of all Carloads of Wheat Originating at Montana Stations for Fiscal Year (Ending in Year Specified), 1940-1951, (Excluding 1941, 1942, and 1943).....	122
VII	Seasonal Trend of Number 1 Dark Hard Winter and Hard Winter Wheat Prices and Protein Premiums, 20 Year Average by Months, 1933-1952	123
VIII	Blending Hard Red Spring Wheat, Based on Average Values for 20 Years, 1933-1952	124
IX	Blending of High Protein Hard Red Spring Wheat, 1951	125
X	Average Monthly Premium, 15 Per Cent Protein, No. 1 Dark Northern Spring Wheat, Minneapolis, 1933-1952	126
XI	Average Monthly Price Per Bushel of Number 1 Dark Northern Spring Wheat (Ordinary Protein), Minneapolis, 1930-31 to January 1953.....	127
XII	Average Monthly Price Per Bushel of Number 1 Dark Northern Spring Wheat (15 Per Cent Protein), Minneapolis, 1930-31 to January 1953	128
XIII	Nominal Cash Prices Being Paid at Local Elevator in Montana for Number 1 Heavy Hard Red Spring Wheat, 1951 and 1952 ...	129

Number	Title	Page
XIV	Frequency Distribution by Per Cent Protein of Wheat Crop Survey of Montana Dark Northern Spring Wheat, 1945-1952 ...	130
XV	Base Price No. 1 Dark Hard Winter and Hard Winter Wheat (Price Computed from Mid-Month Quotations of Great Falls Tribune), 1933-1952	131
XVI	Protein Premiums for 14 Per Cent Protein Dark Hard Winter and Hard Winter Wheat, 1933-1952	132
XVII	Price Quotations for 14 Per Cent Protein Dark Hard Winter and Hard Winter Wheat, 1933-1952	133
XVIII	Base Price and Protein Premium for Number 1 Heavy Dark Hard Winter and Hard Winter Wheat, by Months, 1933-1952...	134

LIST OF FIGURES

Number	Title	Page
1	Theoretical Supply Schedules Comparing Elasticity in the Market Supply S_m, the Short Run Supply S_s, and the Long Run Supply S_l, for High Protein Hard Red Spring Wheat (Over 12 Per Cent Protein Content)	52
2	Indifference Curves Showing Consumer Preference Between Leisure and Disposable Income	63
3	Theoretical Demand Schedules Comparing Elasticity in the Market Demand D_m, the Short Run Demand D_s, and the Long Run Demand D_l, for High Protein Hard Red Spring Wheat (Over 12 Per Cent Protein Content)	69
4	Theoretical Short Run Demand Schedules for Two Crop Years Showing Elasticity and Shifts or Changes of Demand	70
5	Interaction of Supply and Demand Schedules in Establishing Premiums for High Protein (Over 12 Per Cent) Hard Red Spring Wheat, by Crop Years	73
6	Imperfect Competition and Distribution of Economic Surplus, Assuming the Supply Schedule is (1) Perfectly Inelastic (Q_lC) and (2) Highly Inelastic (Q_lS)	78
7	Confidence Interval (Assuming Stratified Random Sampling) for Probability Equals 195 that the Distribution of the Cumulative Frequency of a Population is Within a Band of 16 Percentage Units Wide, 8 Units Above and Below the Cumulative Frequency Distribution of a Sample, Size 280 Units	88

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ABSTRACT

The following dissertation is an attempt to focus attention on the individual and social economic problems relating to marketing high protein hard spring wheat.

The introductory chapter outlines the purpose of observing, assembling, classifying and analyzing information of economic significance to individuals, social segments and consumers. Particular emphasis is devoted to producer problems in performing the segregative and allocative function in the market place.

The relation of economic theory to price as a function of supply of and demand for hard red spring wheat is contained in Chapter Two, which consists of three parts. Part I relates to the theory of supply of high protein hard red spring wheat; Part II presents those factors which are assumed to affect the elasticity of and changes in the demand schedule; and Part III combines the theoretical assumptions of supply and demand and their relation to protein premiums. Substantiation for particular phases of the theoretical assumptions is found interspersed with theory. Included in Chapter Two are the references to the results of previous theoretical and empirical investigations. Results of tabulations of secondary data contained in the appendix have been mainly associated with Part III.

Chapter III pertains to theory of sampling and practical applications of sampling in determining supplies of milling classes of wheat.

Results of the investigation and implications directed toward future research are summarized in Chapter IV.

Chapter I.

INTRODUCTION

Part I. - The Problem

Initiation of Inquiry.

Since 1925 additional payment in the form of protein premiums have been paid to producers of hard red spring wheat in the Northern Great Plains area of the United States. In Montana protein premiums added about $10 million additional income to farmers for the year 1951. If protein premium values were considered separate from wheat, wheat protein would be the fifth largest crop produced in the State of Montana, exceeded only by wheat, cattle, sheep and dairy. 1/ In economic terminology, any payment for a commodity or service is the function of the supply of that commodity or service in relation to the demand for it. Protein premiums become a measure designed to allocate the scarce commodity; high protein wheat. In some years there appears to be very little or no premium, while in other years the premium for protein in hard red spring wheat reaches substantial amounts. Premium fluctuations are not confined to stable amounts within the marketing year but vary from day to day and month to month. Both the variations in and the level of premiums are accompanied by economic problems related to the segments of society performing the function of marketing high protein hard red spring wheat.

1/ H. R. Stucky, Looking Ahead With Montana Farmers and Ranchers, Montana Extension Service, Montana State College, Bozeman, Montana, Folder 22, September 1, 1952.

The Problem Statement

The function of the research upon which this report is based is to observe, assemble, classify, define and analyze those facts relating to protein premiums as they create problems of economic significance to various segments of society. Particular emphasis is concentrated on the economic problems encountered by producers in their attempts to maximize net revenue in marketing high protein hard red spring wheat. On the basis of the facts compiled and presented in this report it is hoped that further research of a problem solving nature will be conducted at some future date.

Limits of the Study

Economic theory, and the utilization of visual descriptive economic models, serve as a means of explaining the economic conditions surrounding the marketing of high protein hard red spring wheat. It becomes necessary to set limits on the area of the study. The study will be concerned only with the economic aspect of marketing hard red spring wheat of high protein content. Not all of society is necessarily concerned with protein premiums unless they feel that there is mal-allocation of resources through the present method of marketing. In describing the marketing of hard red spring wheat containing high per cent protein, it is necessary to outline the geographic area in which the particular class of wheat is produced as well as the area in which this particular class is marketed and consumed. Reasons must be outlined why protein premiums are paid and to whom they are paid. Answers to the following questions must be found: What particular qualitative characteristics are represented in the payment

of a premium? Have legal and moral institutions grown out of the marketing of high protein hard red spring wheat and what is their relationship to the problems that confront the producers, and other members of the grain trade attempting to allocate high protein hard red spring wheat?

The Premium:

Hard red spring wheat is one of seven classes of wheat produced in the United States. Further subdivision creates three sub-classes; dark northern spring, northern spring and red spring wheat. Members of the grain industry concerned with the marketing of hard red spring wheat further differentiate the classes and sub-classes on the basis of the protein content into ordinary protein and high protein hard red spring wheat and hard red winter wheat. Ordinary protein hard red spring wheat is generally considered to be wheat of less than 12 per cent protein content. The term "high protein" is reserved for hard red spring and hard red winter wheat classes and sub-classes containing greater than 12 per cent protein. Protein determinations are based on chemical tests of the quantitative characteristics of nitrogen as a measure of the proteins inherent in the wheat. There is an association of the quantity of protein and the quality of the wheat which causes millers to bid premiums for the high protein wheats. Protein premiums are paid on the basis of the per cent protein over 12 per cent and are expressed as an increasing premium for each one-tenth or one-half per cent protein over 12 per cent. A typical bid for high protein wheat would be: 1 cent for each one-tenth of one per cent protein over 12 per cent, up to 15 per cent then $1\frac{1}{2}$ cents for each one-tenth of one per cent protein from 15 per cent protein up to

16 per cent protein, then one cent for each one-tenth of one per cent over 16 per cent protein.

The Marketing Segments:

Marketing hard red spring wheat of high protein content is considered to start with the producer. From the producer the wheat generally goes to the country elevator where it is accumulated for shipment. Commission firms and brokers may play an important role in further marketing of the wheat or it may go direct from the country elevator to a miller or terminal elevator. Speculators on the commodity exchange may contribute by assuming risk of ownership through price changes in the time lapse between producer marketing and milling of the wheat. Millers buy the high protein wheat for specific milling and blending purposes as a service to the commercial bakers. Bakers are also a service organization to the extent that they attempt to maximize consumer satisfaction by baking bread which meets with consumer's desire.

The area of study is mainly confined to the description of economic problems related to marketing that are associated with producers, elevator operators, commission firms, and millers. Particular reference is made to the problems of producers. The impact of premiums for high protein hard red spring wheat is assumed to be insignificant in relation to the consumer section of society. Protein premiums are a payment for a supplementary product which constitutes only an infinitesimal portion of consumers income. Bread purchases represent only a small portion of the consumer food purchases, and wheat flour is only one of many ingredients utilized in the production of bread. One estimate of the value of the

wheat which went into the production of a loaf of bread shows that in 1951 the producer only received 2.85 cents for the wheat that is required to produce the loaf. 1/ On the basis of this estimate and the fact that protein premium for 15 per cent protein hard red spring wheat was about 10 per cent of the value of the wheat, the value of the protein in the loaf of bread would be about one-third of a cent for each loaf of bread.

From the standpoint of the producer, if premiums are ten per cent of the value of the wheat, the payment represents a considerable portion of the producer's gross income. If the cost of wheat is 10 per cent higher to the miller because of the additional increment of a protein premium, it constitutes a significant cost to the miller's cost of production of flour and must be taken into account. Commission firms assume very little risk of price fluctuations in performing their function of bringing buyer and seller together for specific lots of wheat. Line elevator operators and terminal operators are not able to hedge the premium along with the base price of the wheat and therefore are obliged to receive a portion of the premium offered by the miller to cover their cost of risk associated with the rise and fall of premiums over time.

Some aspects of marketing which impinge on the welfare of society are included throughout the following chapters. Questions concerning society's interest in the production of high protein hard red spring wheat are related to the political aspects of the problem. Should producers

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1/ National Federation of Grain Cooperatives, "Congress Told Farmers Receives 2.8 Cents of 16 Cent Loaf of Bread", Grain Quarterly, (Reprint from the Evening Star, Washington, D.C., April 27, 1951). Summer 1951, p.70.

receive a larger portion of the premium? Will society benefit by a net gain through some other allocation of factor inputs than the present allocation of inputs utilized in the production of high protein hard red spring wheat? Can the present factor inputs be utilized more efficiently in terms of production of a greater amount of high protein wheat than is presently being produced? Will some other allocation of premiums among wheat marketing segments of society increase total welfare in terms of greater national product? These questions are related to what changes might be made to increase the welfare of society. However, the complete answers to these questions are related to a hierarchy of economic goals beyond the scope of the present investigation.

Wheat Quality in Relation to Premiums:

For the purpose of conducting an economic study of protein premiums protein content, and quality require limited definition. Some assumptions are necessary regarding the quality that protein represents. To producers, the term "protein premium" signifies high quality wheat; to millers high protein wheat and quality of wheat are not always synonymous terms. Bakers have a different definition of quality depending on the results they expect to obtain through the use of high protein wheat flour. In the introductory phase of the study restrictions on the meaning of quality are presented to avoid confusion and to permit an orderly investigation of protein premiums in relation to economic problems.

The Geographic Area :

Not all wheat producers receive protein premiums for the wheat they sell. Even in the Northern Great Plains there are certain areas in which

it is practically impossible to produce high protein wheat of the hard red spring class. Under certain types of farming techniques, like irrigated production, producers are more concerned with growing high bushel yielding varieties of wheat than with high protein yielding varieties. High protein wheat production is influenced mainly by the environment and is associated with the amount of rainfall and the temperature as well as the soil and the variety of wheat grown. Montana produces the highest protein hard red spring wheat and Northeast Montana is consistently more suitable to the production of high protein wheat than other areas in the State. Millers and elevator operators have long been aware of the importance of establishing supply sources in the high protein producing area of northeastern Montana. (See Table II, Appendix).

It is necessary to know the uses of high protein wheat, and to know the areas both in the States and abroad to which the commodity moves. Geographically, the market is known to be mainly of a domestic nature. Foreign buyers have mainly confined their United States purchases of wheat to the ordinary protein wheat. For this reason it may be assumed that the world price establishes the price of ordinary protein wheat and the millers in the United States establish the premium which will be paid to keep high protein wheat out of foreign consignments. In the latter portion of the introductory chapter the geographic area of supply and demand are given considerable attention.

History of Development of Protein Premiums:

Producers of high protein hard red spring wheat have only recently, within the past thirty years, been faced with the problem of attempting

to market their product in such a way as to gain maximum net income. The conversion of consumer habits, from performing their own bread baking to reliance on commercial bakeries, since the first World War has created a shortage of high protein wheat required by bakers for the production of a uniform quality bread. Actually the premium is a function of increasing technology in bread baking techniques that had its beginning with the first grinding of the wild wheat by primative man. The historical nature of protein premium development should add to the reader's concept of the problems associated with premiums and for this reason it is added in the first chapter.

The Legal Institution and Customs:

Laws and regulations have been established governing the marketing of high protein wheat. Beyond the Federal Grade Regulations which establish the grade of ordinary protein wheat there are the State regulations which have grown out of the customs associated with the production and marketing of high protein hard red spring wheat. It is important to know the legal limits and the restrictions that they impose on various segments of society associated with the marketing. The influence of protein regulations on private problems of the producers, millers and other members of the grain trade are outlined in the final phase of the introductory chapter.

Part II -- Marketing Problems

Five distinguishable economic groups are concerned with the movement of high protein wheat through the market channels. These groups perform certain functions in segregating, blending, allocating, risk bearing, milling and baking the high protein wheat to meet the demand imposed by consumers. These groups are: (1) producers, (2) elevator operators (country and terminal), (3) commission firms, brokers and speculators, (4) millers, and (5) bakers. The members of each of the groups are presumed to attempt to operate their firms in such a manner that net income will be maximized.

In attempting to maximize net income, each segment and firm is assumed to desire as large a portion of the protein premium as possible. What apparently occurs, is that consumer desire for particular qualitative characteristics creates an increase in price for the bakery product which meets consumer acceptance. The increased price for the product stimulates demand for the type of flour used in the production of the bread. Bakers are thereby compelled by competition to bid against one another to maintain a constant flow of the sometimes scarce flour of specific qualitative characteristics which meets baker's requirements. Miller competition necessitates bidding high protein hard red spring wheat above ordinary wheat in order to attract it out of other trade channels, such as export markets, feed and industrial uses. Speculators assume risk in buying high protein wheat in anticipation of increased prices. Brokers and commission firms provide a service to millers in seeking out buyers and sellers. Terminal operators and country elevator operators purchase and

store high protein wheat, segregate, blend and allocate it as the needs of millers dictate. Producers are at the opposite extreme from consumers in the breakdown of marketing into its specialized functions. After each of the specialized organizations has computed the cardinal costs associated with performing their service to society, the balance of premium reflects to producers. Thus, the price of flour utilized in the production of high protein products may have only a small range of variation from year to year, whereas the range in premiums may vary a considerable portion. It is not appropriate to conclude that the marketing segments gain monopolistic profits in the form of economic rent through the stickiness in price assumed to be associated with flour sales. In some years (when premiums are high) it could be feasibly concluded that millers and bakers realize losses in order to supply their customers with uniform lots of flour or bread. Long run profit maximization may be more applicable to the large scale organizations associated with marketing high protein hard red spring wheat.

There is the individual problem of each specialized industry attempting to gain as large a share of the premium consistent with short or long run profit maximization. Theory relating to the distribution of premiums between millers and producers is reserved for Section III of Chapter II.

Producers:

Producers of high protein hard red spring wheat face the problem of uncertainty and risk in attempting to perform their function in the market. The economic motive for producing and marketing is monetary reward; a return on the land, labor and capital sufficient to maintain or increase

production of the particular commodity. Uncertainty and risk of premium fluctuations creates problems of production as well as marketing for producers of high protein hard red spring wheat.

Within the confines of economic terminology, hard red spring wheat growers produce that supply of wheat which equates the marginal cost of an additional unit of input (land, labor or capital) to the marginal return realized from the additional product. Thus the cost of producing an additional unit is just equal to the price received for it. At this level of production producers maximize net revenue. The implications of the theory in relation to supply of high protein wheat which will come on the market is reserved for Chapter II. It is significant to note here the fact that premiums fluctuate from year to year as well as within the year. Table III, (Appendix,) records the 20 year average premium, by per cent protein, paid to producers in Montana. The premium by years for wheat of 12 per cent to 17 per cent protein is presented in Table IV (Appendix). It will be seen from these tables that yearly average premiums for 15 per cent protein ranged from an average of 3.1 cents in 1934 to 25.5 cents in 1948. In 1952, the premiums for 15 per cent protein averaged 6.4 cents. Producers are also uncertain of the amount the premium will fluctuate from month to month within the crop year. Table V records the mid-month base price and protein premium quoted for 20 years, from 1933 to 1952, inclusive. In 1951 the range in mid-month quotations for 15 per cent protein was from a low of 6 cents in December 1951 to a high of 22 cents in July 1951. Adjusting the production and marketing costs to the price received requires more adequate knowledge of price fluctuations than is presently available

to the producers.

It may be argued by some that the costs of producing high protein hard red spring wheat are covered by the base price received for ordinary protein wheat. Some justification for the argument is found in the nature of cost associated with production in the following statement:

> "The foregoing review of literature indicates that precipitation, temperature, and soil, are the chief environmental factors affecting the protein content of wheat". 1/

The question arises as to what portion of the marketing function is or can be performed by the producer and at what cost? Producers perform part of the function of allocation through the methods employed in binning. They may mix high protein hard red spring wheat with low protein hard red spring wheat or they may keep separate bins. Producers may also special bin high protein wheat at the local elevator and ship on consignment. They may or they may not use high protein wheat for seed and feed. It is reasonable to assume that producers could initiate substantial costs in segregating and allocating the high protein wheat produced on their farm. Most of the segregation decision would be required at harvest time. Once the wheat has been segregatively placed in bins it may be mixed to varying protein contents later in the season. With respect to allocation during the market year, producers may market in the Fall or hold wheat for a more timely period. Some knowledge relative to premium fluctuations may guide producers' decisions relative to orderly marketing of the product.

1/ J. Ansel Anderson and William J. Eva; Variation in the Protein Content of Western Canadian Wheat 1927-1938, Board of Grain Commissioners for Canada, Grain Research Laboratory, Winnipeg, Manitoba, Bulletin No. 4, June, 1943, p. 21.

Legal requirements, (page 44) designed to protect producers of high protein wheat, do not adequately reflect premiums to high protein wheat producers in all areas of production. Producers in Montana are paid on the basis of individual protein determinations, whereas producers in North Dakota receive a station average premium. If an individual producer in North Dakota had 16% protein wheat on his farm and the station average protein content was established by elevator operators at 15 per cent, the producer would lose the amount of premium established on the Grain Exchange between 15 per cent and 16 per cent wheat. But some other producer within the station area stands to gain on the basis of station average protein marketing. If a producer had 14 per cent wheat and the station average was 15 per cent, his gain would be the difference in premium between 14 per cent and 15 per cent protein.

One other aspect of the protein premium which is of importance in maximizing individual profit is the factor associated with the qualitative characteristics, in relation to quantitative determination of protein in the wheat. Some varieties of wheat are of poor quality protein, that is, there is not a good correlation between baking quality of flour and protein content. There are some varieties of hard red spring wheat which produce high bushel yields and high protein content but the protein does not have the milling and baking characteristics of other varieties (see "quality", p. 31). Millers tend to pay a premium below what they could pay if only the quality of wheat they desire were allocated to them. Thus, producers of better quality wheat must take less than they might otherwise receive, and producers of poorer quality wheat gain a gratuity to the

extent that they are paid the same premium for an undesired variety of 15 per cent protein as the producer growing the desired variety.

Elevator Operators' Problems.

Elevator operators--terminal or country operator--are able to hedge the risk of price fluctuations of ordinary protein wheat, and thus substantially reduce the marketing risk associated with purchases and sales. In the handling of high protein wheat there is no possibility of hedging against premium changes and elevator operators must bear this risk. The function of blending, storing, and risk bearing constitute costs associated with elevator operators' portion of marketing high protein wheat. Elevator operators mix various grades of wheat to obtain the desired bushel weight and moisture content as well as proteinper cent. The facilities of country and terminal operators are far more adequately organized to permit the performance of this function than are the facilities available to producers. Producers generally lack the variety of grades and protein contents of wheat available to elevator operators for making suitable blends to meet various market situations. If a line elevator operator receives an order for a carlot of 15 per cent protein, No. 2 hard red spring wheat, containing 14 per cent moisture, his facilities can be readily utilized to blend from various bins to obtain the desired specifications. Considerable blending knowledge, acquired through practical experience over a number of years, is associated with the satisfactory performance of this function.

The risk and uncertainty of price changes places elevator operators in a speculative position in marketing high protein wheat. To reduce the

risk and uncertainty, it becomes imperative that more adequate knowledge be acquired relative to factors affecting supply of and demand for high protein hard red spring wheat and the consequential effects on premiums.

Commission Firms' and Brokers' Problems in Allocating Wheat.

Mill buyers often turn over the problem of acquiring specific quantities of high protein wheat to the commission firm or broker. The allocative function is subject to a fixed charge for bringing buyer and seller together. As such, the Commission firm assumes very little risk in handling the contracts. On rare occasions the commission firm will enter the speculative market by assuming the risk of ownership for a day or two, but it is not common practice.

Millers

The private problem of the miller is similar in economic respect to the private problem of the producer. Millers today attempt to maintain good customer relations through quality control in the product they sell. Storck and Teague sum up the private problem of profit maximization in the following statement:

> "For a time the large-scale miller, like many industrialists of a buccaneering era, often prided himself on a 'hard-headed realism' which was really a short-sighted opportunism. In the 80's the miller frequently summarized his economic philosophy in the statement that 'the best miller is the one that makes the most money'. But this slick maxim would soon be superseded by another, less grounded in immediate expediency but more in harmony with the new industrial order then beginning to take shape. This revised rule states that 'the best mill is the one that continues to make the most money'." 1/

1/ John Storck and Walter Dorwin Teague, Flour for Man's Bread, Minneapolis, University of Minnesota Press, 1952, p. 325.

The primary function of the miller, as a specialized industry, is to provide the service of grinding the wheat for the baker. Bakers require flour of specific qualitative standards and order partially on the basis of quantitative specifications. There is a rigid limit to the tolerance the baker will allow relative to baking quality. A particular mill order will specify the desired protein content, ash content, color index, pH (a measure of acidity), water absorbtion capacity and other factors, depending on the type of bread they wish to produce. The following statement by Storck and Teague shows the complexity of the problem confronting millers in attempting to provide the service of grinding flours to bakers' specifications:

> "It was not until after 1900 that the expansion of large-scale baking opened up a constantly growing demand for types of flour quite different from those used in the home, flours adapted to high-speed mechanical mixers and to quick, absolutely dependable fermentation. Today approximately three-fifths of the call for American flour comes from bakeries, while another one-sixth arises from institutions and from industrial users, leaving about one-fourth of the demand as the share of the home. From about 1900, as this market began to grow, millers took to calling second-grade flours, formerly 'bakers', by the new name of 'clears'. The modern baker has little use for nondescript flours. Millers, in fact, were increasingly asked to build flours to precise bakery specifications where an excess of otherwise good qualities was just as undesirable as a deficiency; for satisfactory bread an unusually strong flour would make it necessary to change formulas and procedures. The millers also found themselves dealing with highly-price-conscious purchasers, driven by competition and familiar with every known factor in good bread making and therefore able to choose a number of ways of reaching a desired result. As a consequence wheat blending began to play a more important part in American milling." 1/

1/ Ibid, p. 274.

Bakers.

The profit motive is essentially the same for bakers as for other segments of society; in marketing high protein wheat, the method differs. High protein flour and water absorbtion capacity are compatible characteristics of hard red spring wheat. With a greater number of loaves of bread obtainable from a given quantity of wheat flour, bakers acquire a more favorable competitive position.

Bakers are also keenly aware of the necessity of being consistent in the quality of the bakery products they produce. For this reason, based on the maximizing of profit in the long run, bakers are required to utilize a flour containing specific quantities of protein. Mixing tolerance of the dough produced from high protein hard red spring wheat varieties is a measureable quality. Severe losses may be created through utilization of low protein wheats or high protein wheats which have a tendency to break down under mechanical mixing devices utilized in the mass production of bread.

Consumers.

High protein wheat loses its identity as such in most bakery products. Consumers' tastes are a combination of factors (outlined in Chapter II, p. 65) relating to maximum satisfaction through the utility of the commodity consumed. Protein content is positively correlated with the freshness, volume, and texture of an ordinary loaf of bread, but protein content and loaf discoloration are also positively correlated. Consumers generally react favorably to bakers' advertisements concerning the whiteness of the loaf so it would appear that some favorable characteristics of high protein

wheat flour are off-set by adverse characteristics.

There appears to be very little relationship between desirable characteristics expressed by consumers to the nutritional value imparted into the bread by high protein flour. Ordinary baker's bread requires approximately 11.3 per cent to 12.5 per cent protein flour, produced from a 13.5 per cent wheat. 1/ The demand for higher protein wheat (16 per cent and over) originates with consumer preference for a particular loaf of bread such as the French loaf which requires high protein flour. Ethnic groups create an additional demand for high protein wheat flour (14.25 to 14.50 protein) for the production of unleavened bread. A limited special flour export trade requires a 14.75 per cent and 15 per cent protein wheat which should produce a flour ranging from 13.25 per cent to 13.50 per cent protein. 2/

Social Welfare.

Governmental action has historically been sympathetic to increasing the share of the social product going to farmers. The increased portion of gross national income received by primary producers provides impetus for increased productivity. If social action were to intervene in allocating a minimum premium for high protein wheat producers of this wheat would, theoretically be induced to increase the production, analogous to the present parity pricing and its consequential effect on the production of corn, ordinary wheat, and cotton.

1/ Personal correspondence with Henry O. Putnam, Northwest Crop Improvement Association, 408 Flour Exchange, Minneapolis 15, Minnesota, May 5,1953.

2/ Ibid.

If the premium to producers is not sufficient to induce further production of high protein hard red spring wheat, and if premiums are regarded as strictly a supplemental price to the base price for wheat, and if cost of production of high protein are mainly gratuitous, then producers may gain an increment of social product in the form of economic rent (an additional profit above normal returns to land, labor and capital) through the receipt of a compulsory minimum protein premium. Further, if the economic rent did not induce increased productivity, or if the absence of a premium did not reduce the amount of high protein premium coming on the market, millers would not be required to pay premiums in order to receive high protein wheat, or they could pay any amount up to the profit they would gain through the use of high protein hard red spring wheat. Social welfare would not be increased under the foregoing assumptions if producers were made better off in terms of increased satisfaction by the fixing of a minimum premium to them.

Reder defines economic welfare as:

> "Welfare increases (decreased) whenever one or more individuals become more (less) satisfied without any other individuals becoming less (more) satisfied." 1/

With Reder's definition applied to the above assumptions, economic welfare would not be increased through the distribution of premiums among marketing segments. Millers would lose that portion of economic rent which producers would derive, and the amount of high protein wheat avail-

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1/ Melvin Warren Reder, Studies in the Theory of Welfare Economics, New York, Columbia University Press, 1947, pp. 14 and 17.

able to consumers would neither be increased or decreased. 1/

It is not impractical to assume that, given a fixed amount of wheat for the crop year, producers could increase the amount of high protein wheat which enters the market by special binning techniques, feeding and seeding low protein wheat and marketing the high protein wheat. If the market operates within the concept of monopolistic control, millers would not purchase as large a quantity as would be purchased under conditions of perfect competition. Society would lose a portion of high protein wheat in terms of mal-allocation (it may be seeded, or fed to hogs).

1/ Theory of economic rent under assumptions of imperfect competition is presented in Chapter II, Section III.

Part III -- Wheat Quality and Protein Premiums

Producers.

To most producers of high protein hard red spring wheat protein content is assumed to be the indicator of quality. The assumption that the quantitative measure is also a qualitative measure is economically valid for producers because there is no difference in the premium for different varieties within the hard red spring wheat class. For example, the price quotations for protein and also the base price for Thatcher variety and for Spinkota variety are the same even though Spinkota is not a recommended variety because it produces fine granulated, weak flour and a poor loaf of bread. 1/

In referring to quality it is important to define the term within limits according to the segment of society specifically concerned. For economic analysis, price is a measure of utility, and the term "quality" may reasonably be considered analogous to the term "protein content" when we analyze the individual problem of the producer, particularly with reference to his attempt to maximize net income in the short run. There are indications that the producer segment is becoming more aware of the long run advantages of fitting their production planning to the needs of the miller and baker in the production of a differentiated product. Recent attempts to organize crop improvement associations in the hard red spring wheat area of the United States are meeting with favorable producer re-

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1/ J. Allen Clark and B. B. Bayles, Distribution of the Varieties and Classes of Wheat in the United States in 1949, U.S.D.A., Washington, D.C., Circular No. 861, March, 1951, p. 49.

sponse. Some producers feel that the continued production of varieties that are high yielding but have poor milling and baking quality is creating a reduction in the favorable competitive position of the hard red spring wheat class of wheat.

Millers.

Protein premiums, as an economic measure designed to allocate high protein wheat through the marketing channels are based on the quantitative test for nitrogen. This test is known as the Kjeldahl test and is a fairly accurate measure of the crude protein contained in a sample of wheat. 1/ The relationship of protein content with baking quality has been studied for hard red spring wheat.

> "In studying this phase of the question, Larmour (1930) concluded that correlation coefficients for wheat protein and quality, as measured by the bromate baking method, were in practically all cases sufficiently high to warrant concluding that the relation is significant enough to justify the commercial use of the protein test as a factor in the classification of hard red spring wheat." 2/

In later studies, the same author concluded that it seemed unlikely that a single standard baking procedure which would reveal the true strength of a series of flours can ever be devised. Fisher 3/ concluded that a strong flour which will produce good bread over a long period is less subject to

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1/ C. H. Bailey, Protein Surveys of American Hard Spring and Soft Winter Wheats, University of Minnesota, Agricultural Experiment Station, Tech. Bul. 147, June, 1941, p. 5.

2/ T. R. Aitken and W. F. Geddes, The Behaviour of Strong Flours of Widely Varying Protein Content when Subjected to Normal and Severe Baking Procedures, Board of Grain Commissioners, Grain Research Laboratory, Winnipeg, Canada, Reprinted from Cereal Chemistry, Vol. XI, No. 5, Sept., 1934, p. 487.

3/ Ibid, p. 488.

fermentation tolerances and will withstand more overmixing when combining with other ingredients, and is therefore more suitable to bakers using mass production techniques. Aitken and Geddes studied the correlation between loaf volume and protein content and found the correlation to range between 29.44 and 59.25 depending on the malt and bromate treatment. Analysis of variance showed that the various regressions due to different levels of bromate were not significantly different. 1/ They concluded that when testing a series of flours of similar protein character where gas production was not a limiting factor, the 0.001 per cent bromate formula, in particular, yielded volumes which were essentially a measure of the protein content.

Prior to purchase the miller has only the grade, established by Federal Grade Standard, 2/ which sets the limits of test weight, damaged kernels, moisture, foreign matter, and wheats of other classes, and the additional increment of quality reflected by the protein content expressed as a percentage. There are many other factors which generally bear a relationship to the quality of flour that can be produced from the wheat. Among the more important factors taken into consideration by the miller when he is able to test a sample of the wheat which he has purchased are the following: flour yield, ash content, diastatic activity, gassing

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1/ T. R. Aitken and W. F. Geddes, The Relation Between Protein Content and Strength of Gluten-enriched Flours, Board of Grain Commissioners, Grain Research Laboratory, Winnipeg, Canada, (Reprinted from Cereal Chemistry, Vol. XVI, No. 2, March, 1939, p. 229).

2/ Grain Branch, Handbook of Official Grain Standard of the United States, U.S.D.A., Production and Marketing Administration, U.S. Govt. Printing Office, Washington, 1950.

power, pigment content, vitamin content, mixing tolerance, absorbtion capacity, and baking tests which reveal the crumb structure and texture of the loaf.

Each miller may possibly have a different definition of quality based on the findings of the individual tests and his weighting based on judgment of the relative merits of each test performed. Aitken and Anderson conducted a study in which they hoped to ascertain the suitability of new varieties by tests performed simultaneously by 20 collaborating chemists in Canada, United States and Great Britain. There was a general lack of agreement among the cereal chemists as to the value of the 7 hard red spring wheat varieties submitted with respect to over-all quality. They concluded the results of their findings with the following statement:

> "Several explanations are offered which may account for the variations in opinion found, and among these are: the use the collaborator intends to make of the wheat; the properties given most weight in assessing over-all quality; the volume of testing done; the interpretation of the data; and the principles underlying comparisons. On the other hand, some collaborators have opposite opinions on specific qualities of the same variety that are difficult to understand.
>
> The results of the investigation show that cereal chemists hold different opinions on what constitutes bread-making quality and on how this should be measured. The difficulties of reaching decisions on the merits of new varieties are all too apparent". 1/

The time factor must be taken into consideration in marketing high protein hard red spring wheat, and for this reason it is not appropriate to conduct the various tests employed by millers prior to the time the

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1/ T. R. Aitken and J. Ansel Anderson, Conflicting Opinions on the Quality of Bread Wheats, Grain Research Laboratory, Board of Grain Commissioners for Canada, Winnipeg, Manitoba, April, 1947, p. 18.

wheat reaches the mill. The problem relative to the physical movement through the market channels is that as long as wheat continues to be purchased on the basis of quantative protein tests, and this factor has been made part of the legal institution in Montana, (See page 44) producers have an incentive to produce varieties of hard red spring wheat of high protein content consistent with high bushel yielding capacity. High bushel yielding varieties are not necessarily related to desirable milling quality. In an attempt to educate the producer in regard to the importance of desired qualitative characteristics of specific varieties the millers and other members of the grain trade created the Northwest Crop Improvement Association. They publish material relative to approved spring wheat varieties and discuss the important characteristics of selection utilized by the mill buyer. There are three main questions considered by the buyer; (1) How much flour will the wheat produce?, (2) What will be the baking quality of the flour?, (3) What is the keeping quality of the grain? 1/

While there are no available data for comparing the yield and baking quality of hard red spring varieties, there is evidence to indicate that the majority opinion on baking quality of Rescue wheat is below other recommended varieties. 2/ The choice of this particular variety by pro-

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1/ E. J. Bell, "Program for the Entire Wheat Industry." Oregon Wheat Commission, A paper presented before the Pacific Northwest Baker's Conference, Portland, Oregon, April 20, 1953.

2/ Northwest Crop Improvement Association, Approved Spring Wheat Varieties, (Selected from Dictionary of Spring Wheat Varieties), Minneapolis, Minnesota.

ducers is governed by its resistence to infestation of the sawfly larvae. In this instance the private problem of the producer is in conflict with the private problem of the miller and baker. In the physical handling of hard red spring wheat through commercial trade channels it is virtually impossible to segregate varieties due to the similarity in physical characteristics of the wheat berries of various varieties.

Bakers and Consumers

Quality is a term that is used differently by other segments of the grain trade, such as the baker and the consumer. Bakers desire high protein flour because it is related to the absorbtion capacity, that is the water holding capacity of flour. There are other important considerations related to high protein wheat such as the relation of protein content to loaf size, pigmentation and texture of the loaf. The baker is closer to the consumer with respect to the marketing function and consumer demand creates important considerations other than protein content.

The consumer generally does not think in terms of protein content as an influencing factor in purchasing a loaf of bread. Other factors, some of which are totally unrelated to protein content, include the appearance, flavor, freshness, convenience, cost, habit, and nutrition. With reference to nutrition, protein content plays only a partial role in the nutritive value of the modern loaf of bread. "Wheat flour foods supply 25 per cent of the protein, 30 per cent of the calcium, 40 per cent of thiamin, 35 per cent of niacin, 25 per cent of riboflaven, 45 per cent of iron,

and 33 per cent of the food energy." 1/

1/ E. J. Bell. op. cit.

Part IV -- The Geographic Area

Area of Production

The individual problem of reducing price uncertainty to a risk for individual producers marketing hard red spring wheat is confined to a specific area of production in the United States. Due to the environmental limitations, hard red spring wheat of high protein content is grown primarily in four states of the Northern Great Plains. Bailey summed up his observation of the hard spring wheat area as a producer of high milling and baking quality wheat in the following statement:

> "It seems probable that there is a greater uniformity in gluten properties among the hard wheats of the Great Plains area of North America than in any other major wheat growing region of the world." 1/

Clark and Bayles conducted a study of the distribution of hard red spring wheat by acres and varieties for the crop year 1949. They showed the major producing States to be Montana, North Dakota, South Dakota, and Minnesota. For purposes of the present study it is convenient to confine the production to the four States listed above. Clark and Bayles define the area as follows:

> "The hard red spring varieties are grown principally in the northcentral part of the United States, their production extending into the prairie provinces of Canada....The States leading in the production of hard red spring wheat are North Dakota, South Dakota, Montana, and Minnesota. Varieties of spring wheat also are grown in certain parts of Wisconsin, Iowa, Illinois, and as far east as Maine. In these States, as well as in Nebraska, Colorado, and Wyoming, they are frequently used to replace winter wheat that has failed, due to winterkilling, ...Hard red spring wheat also occupies a

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1/ Bailey, op. cit., p. 4

limited acreage in the Pacific Northwest." 1/

Protein premiums are usually quoted on wheat of 12 or more per cent protein content. It is assumed that all states having hard red spring wheat of less than 12 per cent protein may be excluded for purposes of an economic study of the marketing of high protein hard red spring wheat.

Tariffs and quotas placed on the import of Canadian milling wheat restrict the area of supply of hard red spring wheat of high protein content to the four States previously mentioned. If the tariffs and quotas were eliminated or reduced substantially on the import of milling quality wheat, it would very likely create an immediate surplus supply of high protein wheat on the United States market with a resulting depression in protein premiums. In 1952, the production of hard red spring wheat in the United States was estimated to be 175 million bushels compared with production in the Canadian portion of the Northern Great Plains of 650 million bushels. (See Table II) 2/ The report of the Canadian crop of hard red spring wheat for 1952 contains the following statement:

> "Canada's 1952 wheat crop of 650 million bushels is an all-time record, and it will be mostly dry and high in grade. This is in sharp contrast to last year when more than half the crop was frozen. . . .With high weight and high grade, milling quality is excellent. Protein content is below average, especially in the lower grades. Nevertheless, as the quality of the protein maintains its usual excellence, and as gassing power is satisfactory, the general baking quality of the crop may well prove to be better than the protein level would suggest."

1/ Clark and Bayles, op. cit., p. 44.

2/ Board of Grain Commissioners for Canada, Canadian Wheat, 1952, Grain Research Laboratory, Winnipeg, Manitoba, Crop Bulletin 45, October, 1952.

The Consumers of High Protein Hard Red Spring Wheat.

High protein hard red spring wheat grown in the United States is mainly consumed on the domestic market although there is some special flour export trade. Correspondence with members of the grain trade revealed statements such as the following:

> "The special flour export trade requires a 14.75 per cent to 15 per cent protein wheat which should produce a flour ranging from 13.25 to 13.50 per cent protein. Such flour is used for Cuban bread and others which have no pan support.....
>
> We have made some inquiry regarding exports of 13 per cent protein wheat. Those consulted state that 13 per cent protein wheat is not likely to be exported unless specifically requested and purchased for a special customer....Very little over 12 per cent protein wheat is exported." 1/

A review of the literature relative to the blending capacity of hard red spring wheat indicates that foreign consumers tend to desire high protein wheat from markets other than United States for the following reasons. Canada produces a surplus of high protein hard red spring wheat of acceptable blending qualities. 2/ Canadian foreign trade in wheat has created particular attention to milling and blending quality as an important factor in establishing permanent channels of trade. Foreign purchasers would undoubtedly prefer to buy Canadian high protein wheat of equal milling

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1/ Personal letter from Henry O. Putnam, Executive Secretary, Northwest Crop Improvement Association, 408 Flour Exchange, Minneapolis 15, Minnesota, May 5, 1953.

2/ T. R. Aitken, M. H. Fisher and J. A. Anderson, Blending Value of Canadian Wheat, Grain Research Laboratory, Board of Grain Commissioners for Canada, Winnipeg, Manitoba, Reprinted from Scientific Agriculture, 26:11. November, 1946, p. 583.

quality to United States high protein wheat because importers do not have to compete with domestic millers in Canada and consequently they do not have to pay a protein premium. Protein content, which is not a scarce commodity in Canada, is incorporated into the grain standards of Canadian wheat, as the following statement emphasizes:

> "Assessing the suitability of new varieties of wheat for milling and baking is one of the most important tasks entrusted to cereal chemists. This matter is of special importance to the Board of Grain Commissioners' laboratory because the Canada Grain Act specifies that only varieties that are 'equal to Marquis', the recognized standard variety, shall be admitted to the top grades." 1/

Anderson and Eva conducted a study to show the protein content of cargoes of wheat of Canadian origin moving through Atlantic and Pacific ports to export for four crop years, 1935-36 to 1938-39. The modal group of the frequency distribution of cargoes for four years was 14 to 14.5 per cent protein for No. 1 Northern Spring Wheat for Atlantic cargoes, and 13 to 13.5 per cent for Pacific cargoes. They said:

> "The high degree of uniformity obtained each year in cargoes of each grade of Western Canadian hard red spring wheat and high baking strength and general cleanliness, are the factors chiefly responsible for the reputation which this wheat has achieved on world markets." 2/

1/ Aitken and Anderson, op. cit., p. 6.

2/ Anderson and Eva, op. cit., p. 90.

Part V -- History of Development, Custom, and Laws Pertaining to High Protein Hard Red Spring Wheat.

Research and Technology.

Grain grinding was undoubtedly the first art practiced as the prerequisite of digestion, having its beginning with the grinding of the wild grass which we know as Einkorn. The ruins of Pompeii, destroyed in 79 A.D. have yielded the first indication of the production of bread as it is known today. At that time the grinding of wheat and the baking of bread was conducted as an integrated enterprise and indications are that it was a mass production technique. The attempts to satisfy the demands of consumers of the Roman Empire through production of a differentiated product is evident from the following statement:

> "The higher class of Romans laid great emphasis on the whiteness of their flour. In discussing alica, a special flour made from emmer, Pliny notes 'a most singular fact - chalk is mixed with the meal, which upon becoming well incorporated with it, adds very materially to both the whiteness and the shortness of the mixture'." 1/

Milling and baking were separate enterprises by the time the European movement to the New World began. The milling industry has constantly attempted to provide flours that meet the baker's needs. The introduction of mass baking techniques, using mechanical mixing devices created a need for a uniform quality flour prior to the era of 1900. Millers were aware of the need for research into the qualitative characteristics of the various shipments of wheat they were milling into flour as an aid to competi-

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1/ Storck and Teague, op. cit., p. 88.

tive selling and the first American research department was established by the Washburn Crosby Company in 1898. 1/

Protein tests began to be common practice in American mills after 1900 but it was not until after the first World War that premiums were established as a means of allocating high protein wheats of the hard red spring class. Originally, the premiums were paid only to members of the trade other than producers to provide incentive for allocation, but with the establishment of State Laboratories equipped to conduct chemical tests for protein in wheat, premium payments for high protein wheat have been extended to the producer. The first records show that protein premiums paid to the producer on an extensive scale for hard red spring wheat in the United States market were paid on the Minneapolis Exchange for the crop year 1925.

Legal Institution and Custom.

Federal Grade Standards determine the official grain standards for wheat of all classes. 2/ There are seven such classes of wheat, listed as hard red spring, durum, red durum, hard red winter, soft red winter, white wheat, and mixed wheat. Within the hard red spring wheat class there are three subclasses; dark northern spring, northern spring, and red spring. There are no official federal regulations with respect to marketing on the basis of protein content in the United States; however, gluten quality is a factor in the grade standards established for wheat in Canada.

1/ Ibid, p. 316.

2/ Grain Branch, Handbook of Official Grain Standards of the United States, op. cit., pp. 2-3.

State legislation for each state governs the standards and marketing of wheat produced and sold in the state. 1/ In Montana, the Department of Agriculture, Labor and Industry has a Division of Grain Standards and Marketing entrusted with broad powers to supervise the marketing of grain and protect the interest of owners of stored grain in public warehouses within the State. State legislation in Montana provides for the protein testing of all wheat by public warehousemen:

> "Each public grain warehouseman as defined by the laws of the state shall take a sample from each load of wheat delivered to his warehouse and preserve such sample in an air-tight container with the owner's name thereon. As hauling is completed by each owner the several samples taken from all the loads of any one owner shall be mixed thoroughly together, except that high, medium, or low protein wheat from the same owner or wheat of different types, varieties or grades shall be segregated and separate containers provided for each. A one pint portion of the composite sample shall be submitted to the state grain laboratory at Great Falls, Harlowton, or Bozeman and the balance shall be held in the owner's container. In the event of dissatisfaction on the part of warehousemen or owner either party shall have the right to a final appeal to the state laboratory."

Montana regulations are unique with respect to the purchasing of wheat on the basis of individual protein tests. In the State of North Dakota, the wheat is purchased on the basis of protein tests and premiums are paid, but they are paid on the basis of a station average basis. In North Dakota, the producers, within a specific market area, sell the wheat on the basis of pre-determined average protein content. This method of purchasing, employed by the elevator firms, means that those producers

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1/ Grain Standards and Marketing Laws of the State of Montana, Revised 1950, Montana Department of Agriculture, Labor, and Industry, Helena, Montana, p. 21.

with above average protein content are not able to take advantage of the additional premium above the average for the station. On the other hand, some farmers within the area, who have lower than average protein content, are in a position to gain a gratuity through a higher premium. A somewhat similar method of purchasing is applied in the State of Kansas:

> "A pilot study conducted on the 1950 crop indicated that terminal market price differentials were being applied on an area basis -- that is, in areas where undesirable varieties predominated. This differential varied with protein level and changed considerably throughout the year not only on absolute level but also by protein level." 1/

1/ Private correspondence, John H. McCoy, Assistant Professor, Department of Agricultural Economics, Agricultural Experiment Station, Kansas State College, Manhattan, Kansas, March 24, 1953.

CHAPTER II.

THEORY OF PRICE IN RELATION TO SUPPLY OF AND DEMAND FOR HIGH PROTEIN HARD RED SPRING WHEAT.

The application of economic theory, supported by descriptive models, relates to factors affecting the supply of and demand for high protein hard red spring wheat. Chapter II is divided into three sections; Part I contains physical and economic variables which cause supply changes; Part II relates to the demand factors; and Part III shows premiums as a dependent function of the interaction of supply and demand. The economic problems of production and marketing which result from premium fluctuations, are mainly related to the producers.

Part I. Theory of Supply

Definition of Supply. The traditional theory of supply of agricultural commodities has considered the cost of production for many years, as the basis of entrepreneurial decisions relative to the quantity of a commodity the firm is willing to produce. The marginal analysis assumes that producers adjust inputs of labor, capital, and management until cost of an additional unit of input--the marginal cost--just pays for itself--equals the marginal revenue, or price. At the production level where marginal revenue is equal to marginal cost, under perfect competition, the firm is maximizing net revenue. 1/

1/ Kenneth E. Boulding, Economic Analysis, New York, Revised Edition, Harper and Brothers Publishers, 1948, p. 528.

There are limitations faced by producers in their attempt to make rational economic decisions relative to production of high protein hard red spring wheat. Assume farmers are able to make decisions between the alternatives in the production of wheat and other agriculturally produced commodities through use of marginal analysis. Producers of The Great Plains seed varying acreages from year to year, which is based on cost and price expectations. Acreage is a more appropriate indicator of willingness to produce than yield. The coefficient of variation (the standard deviation divided by the mean), which is a comparative measure expressed in per cent, is much greater for yield of wheat and other field crops than for acreage. Therefore, the effect of an acreage change may be cancelled by the effect of the change in yields. 1/

> "As measured by the coefficient of variation, the yield of wheat is more variable in the Northern Plains than in the United States as a whole. . . The coefficients of variation for the 11-year period 1931-41 are as follows: United States, 21 per cent; Plains, 34 per cent; high yielding area, 12 per cent; medium-yielding area, 50 per cent; and low-yielding area, 66 per cent." 2/

When high protein wheat is considered to be wheat of over 12 per cent protein, there is the additional consideration of the relationship of yield and protein content. It is common knowledge among producers of high protein areas that yield of wheat and protein content are negatively correlated, as the yield increases the protein content decreases; correlations

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1/ Waite and Trelogan, op. cit., pp. 65-67.

2/ Ralph E. Ward, Northern Great Plains as Producer of Wheat. (Reprint from Economic Geography, October 1946, Vol. 22, No. 4, p. 240).

have been shown which vary between -.41 and -.68. 1/

The factors which may be assumed to affect cost of production of high protein wheat are soil, variety, precipitation, and temperature. 2/ Although soil, variety and temperature are important factors, the main influencing factor appears to be precipitation. A multiple regression integral of 7 sets of variables representing the relation of rainfall as a function of time (R = .632) and the protein content, indicated the following:

> "The percentage of the residual variance accounted for by variations in rainfall was calculated and found to be 34 per cent, a high proportion for a single meteorological variant. The remaining 66 per cent is accounted for by environmental factors not associated with rainfall, and by fortuitous experimental errors." 3/

Less moisture creates smaller yields and higher protein content. The environment is mainly gratuitous and the only cost which can be assumed is for land in applying the marginal revenue and marginal cost analysis.

If it is further assumed that protein premiums are segregative and allocative payments, producers can use rational judgment based on cardinal costs. Supply can be increased through segregation and allocation in the process of binning and seeding. If there is price incentive, producers are able to maintain additional bin space for segregating various fields

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1/ Anderson and Eva, op. cit., p. 20.

2/ Ibid, p. 20.

3/ Allen E. Paull and J. Ansel Anderson, The Effects of Amount and Distribution of Rainfall on the Protein Content of Western Canadian Wheat, National Research Council of Canada (Reprinted from the Canadian Journal of Research C20: 212-227, 1942), p. 220.

of the farm unit, depending on protein analysis. Observation indicates that growers do attempt to keep the wheat from fields separate because the bins are small. The extent to which producers sell high protein wheat and save or purchase low protein (under 12%) for feed and seed is unknown, but assumed to represent an insignificant portion of the total seed utilized. It is reasonable to assume that growers are selective between 16 per cent and 13 per cent protein wheat in their seeding practices.

Short Run Supply. The short run is defined as that period of time in which the producer is not capable of making adjustments in his plant and equipment, but of long enough duration to make use of the capacity of the available equipment. 1/ One crop year may be considered the short run in the production of high protein wheat. Having seeded the wheat acreage, the producers have very little effective influence of what the outcome will be, in terms of protein content. Given the product, there are various methods of harvesting, binning, segregating next year's seed, and livestock feeding which will influence the quantity of high protein wheat which the individual places on the market. In addition to the segregation at harvest, producers make choices between marketing periods within the year.

Those factors which may be considered to influence the supply of high protein hard red spring wheat for a given year --- the short run --- are; (1) environment, (2) variety, and (3) the expected premium.

The environment is known to be one of the chief factors affecting the

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1/ Boulding, op. cit., p. 483.

amount of high protein wheat which will be produced. 1/ The climate and weather are not subject to sufficiently accurate prediction to forecast the influence, through utilization of regression analysis, on the amount of protein in hard red spring wheat. A frequency distribution by protein content of the hard red spring wheat crop must necessarily await the harvest season. The principal climatic factors include rainfall, temperature and wind velocity.

There are other environmental factors which govern protein content, and soil is one of the chief ones. Hard red spring wheat of protein contents greater than 12 per cent protein is largely restricted to the area defined in Chapter I because of the environmental characteristics.

The varietal relationship to high protein is used as a factor in determining recommended varieties of particular classes of wheat. The influence of variety is outweighed by the environmental factors. 2/

While environment and variety are probably the most important factors governing the actual supply of high protein wheat which will be produced, once the crop has been seeded the expected premiums will have some influence on producer action. Segregation and allocation practices may be relatively insignificant if producers feel that premiums will be low. By separate harvesting and binning techniques, growers could obtain a larger amount of high protein wheat. Other methods of increasing the amount which enters the market as milling wheat would include saving low protein wheat

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1/ Anderson and Eva, op. cit., p. 21.

2/ Ibid, p. 21.

for next year's seed, and feeding lower protein wheats.

Figure 1 is presented to show the supply curve, on a vertical price axis, and a horizontal quantity axis. If there were no premiums, producers would market quantity OQ_1 because it is produced. The concept of elasticity of supply is introduced to explain the curvature presented in the model. 1/ As the expected value of the premium increases, the producers become more segregative in harvesting, binning and marketing -- it is expected that more high protein wheat would enter the market channels. The ratio of the per cent change in the amount producers are willing to market with a one per cent change in expected premiums is defined as the elasticity of supply. If the ratio of the per cent changes of quantity to price is near zero, or a small fraction, the supply schedule is highly inelastic. An inelastic supply schedule (S_s) is portrayed as almost vertical to the X axis in Figure 1.

Shifts in the short run supply schedules do not occur within years, but rather between years. The supply elasticity may change, but the actual protein quantity produced is a constant for a given year. Various theoretical supply schedules for hard red spring wheat of over 12 per cent protein are shown in Figure 5, page 73; S_1 represents one year, S_2 the next year, and so on. It will be noticed that S_2 may be either to the left or

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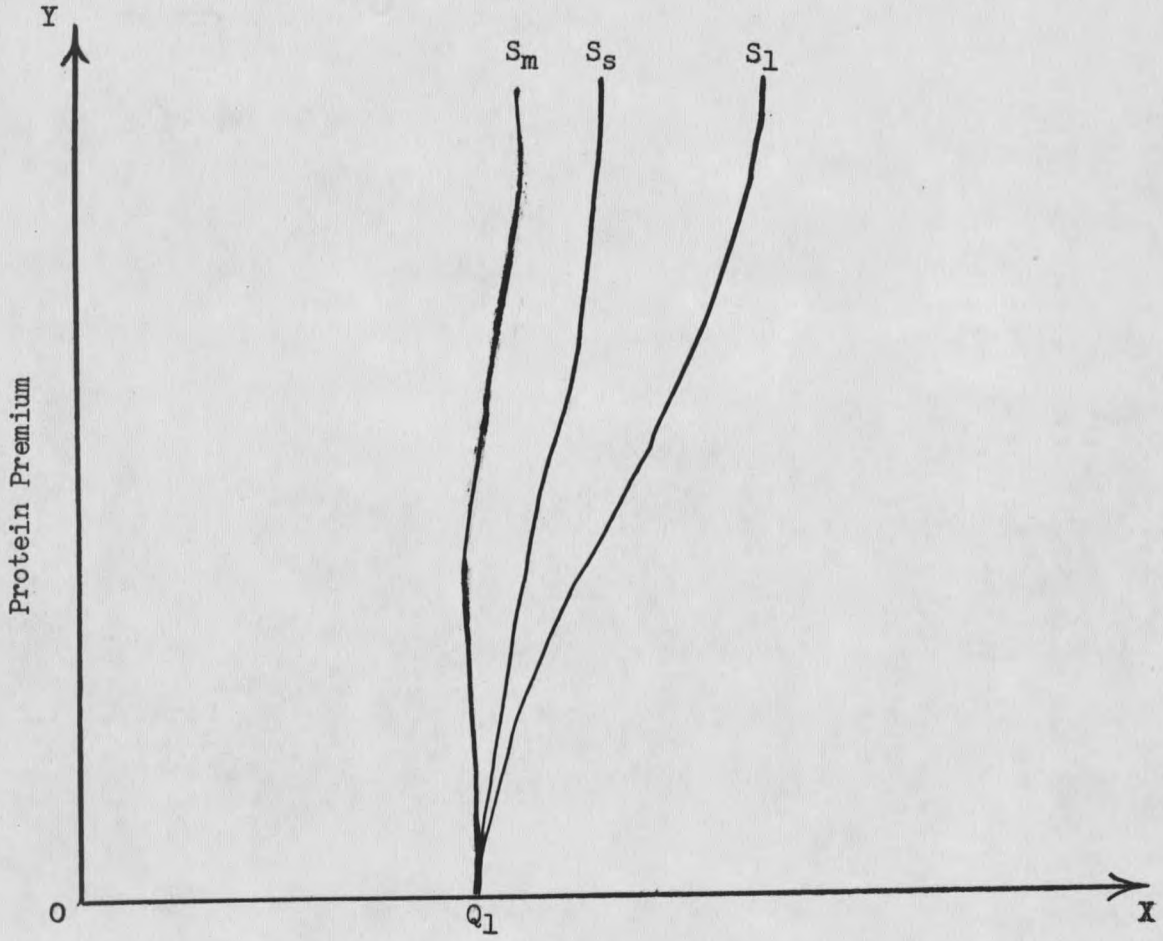
1/ The elasticity of supply expressed in formula notations:

$$E = \frac{\frac{sq}{q}}{\frac{sp}{p}} = \frac{sq}{q} \cdot \frac{p}{p}$$



Quantity of High Protein Hard Red Spring Wheat

Figure 1 -- Theoretical supply schedules comparing elasticity in the market supply S_m, the short run supply, S_s, and the long run supply, S_l, for high protein hard red spring wheat (over 12 per cent protein content).

right of S_l, depending on the environmental characteristics. The fact that predictions of protein content are not significantly valid for periods of longer than a week prior to harvest has been shown by past studies. 1/

1/ Arnold J. King, Dale E. McCarty, Miles McPeek, An Objective Method of Sampling Wheat Fields to Estimate Production and Quality of Wheat, U.S.D.A. Tech. Bul. 814, Feb., 1942.

The Market Supply. The market supply may be defined as a curve (S_m in Figure 1) showing the relationship between the price of a commodity and the quantity which people in the market are willing to sell within one production year.

Within a market year, producers are able to make deliveries of their high protein wheat on the basis of the expected optimum price as reflected by the premium. In addition to premium expectations, producers must take the base price changes into consideration. Among the marketing costs, producers take into consideration cost of storage, which includes risk of deterioration, interest on investment, shrinkage depreciation, insurance, and taxes. 1/

A summary of Table VI indicates that an 8-year monthly average grain movement in Montana from 1940 to 1951, excluding 1941, 1942, and 1943, for July and August, are almost two times the average movement for each of the other months. The figures presented, though not positive proof, indicate the probability that producers market most of their wheat at harvest. The shipments plus the available pre-harvest country elevator storage indicate that at least half the grain moves to country elevators during the harvest months of August and September. January and February are the months in which the average movement was the least in Montana.

Other considerations with respect to the unusually heavy harvest movement are associated with necessity of obtaining cash for loan payments,

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1/ Thomas E. Hall et al, Where and How Much Cash Grain Storage for North Dakota Farmers, Farm Credit Administration, U.S.D.A., Washington, D.C., Bul. 61, May 1951, pp. 6-21.

harvest expenses and credit notes. The extent to which producers segregate the market supply of high protein wheat is an unknown factor. Low protein wheat can be placed under CCC loan, and this may influence producers' decisions relative to selling high protein wheat in the Fall. CCC loans cover only a relatively small portion of the market premium for high protein wheat. Rational producer action would create a greater per cent movement of high protein wheat in the Fall, particularly in years when premiums in the Fall are high. If premiums in the Fall are low, producers may speculate on a higher price during the marketing year --- which may cause a greater per cent of high protein wheat to be held in store. Holding high protein hard red spring wheat for inter-seasonal speculation would not be justified from January to June based on the 20 year average premiums for 15 per cent protein wheat shown in Appendix Table III. July, August and November are the months in which premiums appear to be greatest in Montana.

Due to the transportation shortage in the Fall, and the resultant physical limitation of country elevator facilities, producers are severely restricted in the application of rational judgment relative to the most opportune time period in which they are able to sell wheat. 1/ Adverse weather conditions during winter and spring create an additional limitation to appropriate marketing which would maximize net revenue.

For the aggregate of producers, given the limitations set forth, it

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1/ E. J. Johnson, Markets, G.T.A., "Review of Northwest Grains", Grain Terminal Association Digest, St. Paul 8, Minnesota, August 1951.

appears reasonable to assume an inelastic supply response to premium changes for the market supply. Consequently a one per cent increase in price for protein would result in much less than a one per cent increase in quantity supplied. The elasticity would tend to approach zero for the aggregate supply when premiums are low, response being greater if premiums are high. Figure 1 shows the market supply S_m with a more inelastic slope than the short run supply, S_s.

The Long Run Supply Schedule. The long run is defined as the time period in which all adjustments can be made in production of any commodity. All costs of production, including land, labor and capital may be shifted on the basis of marginal cost analysis. For agricultural production of annual field crops the long run defines any period longer than one production year. Thus producers of high protein hard red spring wheat, within the limits of the geographic area under study, would be able to replace barley or mustard acreage with hard red spring wheat. The resulting change may be described as a long run adjustment.

If hard red spring wheat producers are able to adjust costs of production to expected future premiums the long run supply schedule may be determined by using marginal cost, marginal revenue analysis. A diverse complex of factors require analysis relative to agricultural producers maximizing long run returns through adjustments of marginal cost to marginal revenue. One fact has been clearly brought forth for competitive marketing of agricultural commodities which remains valid for high protein wheat marketing ---costs tend to equal price in the long run. Producers are in a relatively disadvantageous position in predicting future premiums and thus costs of

production frequently are not equated with price in the short run.

Some of the more noticeable factors affecting costs and returns and causing shifts in production in the hard spring wheat area are:

(1) Increased acreage of wheat per farm

(2) Increased area - (new producers)

(3) Fertilizers

(4) More summerfallow

(5) Increasing use of higher protein varieties

(6) Technology in marketing

The alternatives employed by wheat producers in deciding to shift to hard red spring wheat are derived from the postulation that farmers could shift their present barley, oat, and pasture acreage to wheat acreage. Protein premiums are only one factor in the analysis, and likely a relatively insignificant determinant. Other factors of more importance would be the base price of low protein wheat, the cost of making the adjustment, the expected comparative advantage of wheat to other alternate crops.

It is assumed that producers require some basis of judging expected future price to which they adjust input factors of land, labor and capital. Evidence indicates that producers adjust production based on the near past and present prices to a greater extent than on long run average prices. Heady comments on his findings relative to producers' expectations:

> "There is evidence that the planning horizon (for future prices) is not greatly distant for the majority of farmers . . . Perhaps the past more than any other thing serves as

the root of price . . . expectations in agriculture". 1/

If the past premiums are used as a guide to price expectations, high protein hard red spring wheat producers would expect an average premium of 13.9 cents, or 11.4 per cent of the average base price of $1.22, for 16 per cent protein wheat based on the 20-year average, 1933 to 1952. The increased interest in marketing high protein wheat in recent years may be the result of the influence of prices on producers during the current 5 years. The average premium for the past five years, 1948-1952, computed from Table IV is 22.3 cents for 16 per cent protein hard red spring wheat. The average base price for the same 5 years is $1.87. The average premium is 11.9 per cent of the base price. On the basis of the per cent premium to base price there is no more incentive from the premiums of the past 5 years, 1948-1952, for producers to increase production than there was over the past 20 years, 1933-1952.

Regardless of the fact that a given number of farmers could increase wheat acreage on their present cultivated land, there is the continual adjustment of the cost of land to the expected value of the product derived. Schickele and Engelking 2/ states:

> "In technical terms: land prices tend to reflect, more or less depending upon imperfections of the market, the marginal economic productivity of farm real estate (land and permanent improvements) . . . this consideration applies only to long

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1/ Earl O. Heady, Economics of Agricultural Production and Resource Use, New York, Prentice Hall, 1952, pp. 474 and 478.

2/ Rainer Schickele, Reuben Engelking, Land Values and the Land Market in North Dakota, Agric. Exp. Sta., Fargo, N. Dak. Bul. 353, June 1949, pp. 9-10.

run economic developments."

The area in which high protein wheat is grown is limited by present environmental factors previously outlined. More producers could enter the production by expansion of area in the United States by changing environmental influences at exhorbitant costs. There is no evidence that natural changes in environment are occurring which will permit extension of the area. This factor becomes significant only as a cost induced factor through technology and research.

Research in the development of new varieties is constantly underway. Experiment Stations throughout the United States are constantly engaged in attempts to increase the protein content, consistent with such considerations as milling quality and increased per acre yields. If farmers adopt lower yielding varieties to obtain higher protein varieties, the alternative may be measured on the basis of costs and returns analysis.

Experiments are presently being conducted on the effects of chemical fertilizers on protein content. It has been discovered that the artificial addition of plant food nutrients can increase the protein content within varieties of hard red spring wheat, but the milling quality of the gluten has been extremely variable as indicated by torque tests of gluten mixing strength. 1/

High protein in hard red spring wheat is partly a function of tillage practices in the Northern Great Plains. The importance of using summer-

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1/ Unpublished results of protein tests completed by the Agronomy Department of the Agricultural Experiment Station, Montana State College.

fallow land to produce high protein wheat is apparent from a comparison of the data presented by the U.S.D.A. for the 1951 spring wheat crop in Montana and presented in the statement:

> "Spring wheat grown on summer fallowed dry land yielded - highest protein, followed by spring wheat, from continuously cropped dry land. Summer fallowed spring wheat averaged 15.1 per cent protein with nearly half of the production yielding 16 per cent or more protein. Continuously cropped dry land spring wheat averaged 14.9 per cent protein and about one-third of the production was 16 per cent and over in protein content. The irrigated spring wheat averaged 12.7 per cent protein." 1/

The supply schedules in the long run time period might be considered more elastic than that of the short run for the following reason. Producers may become more segregative of the given supply in the future. Through less feeding and seeding of high protein wheat it would be possible to place more on the market than at present. Increased technology in sampling for high protein wheat at harvest time may increase the amount of segregation possible.

All the considerations presented relative to producer action must be thought of in terms of the derived supply of high protein wheat. Actually, producers consider the production of wheat in general and high protein wheat as a factor contributing to the general consideration. For example, to add nitrogen fertilizer, producers would generally consider the increased yield of the product more important than the increased protein content. Nevertheless, the factors all have an influence on supply elas-

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1/ Montana Department of Agriculture, Labor and Industry, Montana Agricultural Statistics, U.S.D.A., B.A.E., Helena, Montana, December 1952, Vol. IV, p. 43.

ticity in the long run. Many of the long run factors are reduced to insignificance in the short run because the amount of high protein wheat in a given crop year is dependent on the acreage planted. So the long run supply curve is presented somewhat more elastic in the economic model, Figure 1.

Part II. Theory of Demand in Relation to High Protein Hard Red Spring Wheat

Introduction:

Producer demand for high protein may be assumed, for empirical purposes, to originate with the miller and, as such, is regarded as a derived demand. Actually, the demand for any commodity stems from the consumer, which includes all segments of society. Effective demand is defined as desire backed by the ability to pay. The higher the price, the less will be purchased of a commodity. If consumers of bread desire a particular quality in the bread that is produced, they are willing to pay a price for it. If the price rises for that product, the consumer will change in part to the consumption of an alternative commodity under typical conditions. Consumers' desire is expressed through the analysis of indifference curves and consumer satisfaction. 1/

An example of an indifference curve approach to the derivation of consumers demand curve for bread is presented in figure 2 as an explanation of the increasing importance of commercial bakeries in supplying bread to consumers.

Prior to 1940, housewives with limited incomes were purchasing a larger amount of flour for baking purposes. As incomes increase, there is a greater demand for purchased services. Mass baking techniques and increasing disposable income create shifts in consumption from family type

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1/ George J. Stigler, The Theory of Price, New York, The MacMillan Co., Revised Edition 1952, Chapter 5, pp. 68-95.

flours to high grade baker's flour. Stated another way, the housewife, given a certain amount of money and leisure, will substitute leisure for money according to an indifference curve pattern as is shown in Figure 2. If baking bread takes time that must be derived from leisure hours, the price of bread relative to the price of leisure will determine the rate of substitution between the two. With larger amounts of disposable income and assuming the price of other goods does not change, the consumer will be on a higher indifference curve. In Figure 2, three indifference curves, I_1, I_2, and I_3 are shown which depict ordinal preference patterns of consumers (housewives) for income and leisure at 3 levels of satisfaction. The curves, I_1, I_2, and I_3 may also be expressed as the marginal rate of substitution or the ratio of marginal utilities of disposable income and leisure. Given an income of OM and leisure time of OL, the line ML represents the marginal rate at which consumers can substitute income and leisure. Where ML is tangent to the indifference curve I_1 at S, the consumer will spend OT of the income for commodities and OR of leisure.

Assuming that incomes increase, and a greater amount of leisure is available, consumers can substitute income and leisure on the line GK. The optimum substitution of leisure for income is where the line GK is tangent to an indifference curve. The point of tangency of line GK and an indifference curve is shown at V on indifference curve I_2. At this point, consumers expend ON of leisure and OH of disposable income. HG then represents the amount of disposable income remaining for consumers and NK represents the amount of leisure they have as a residual.

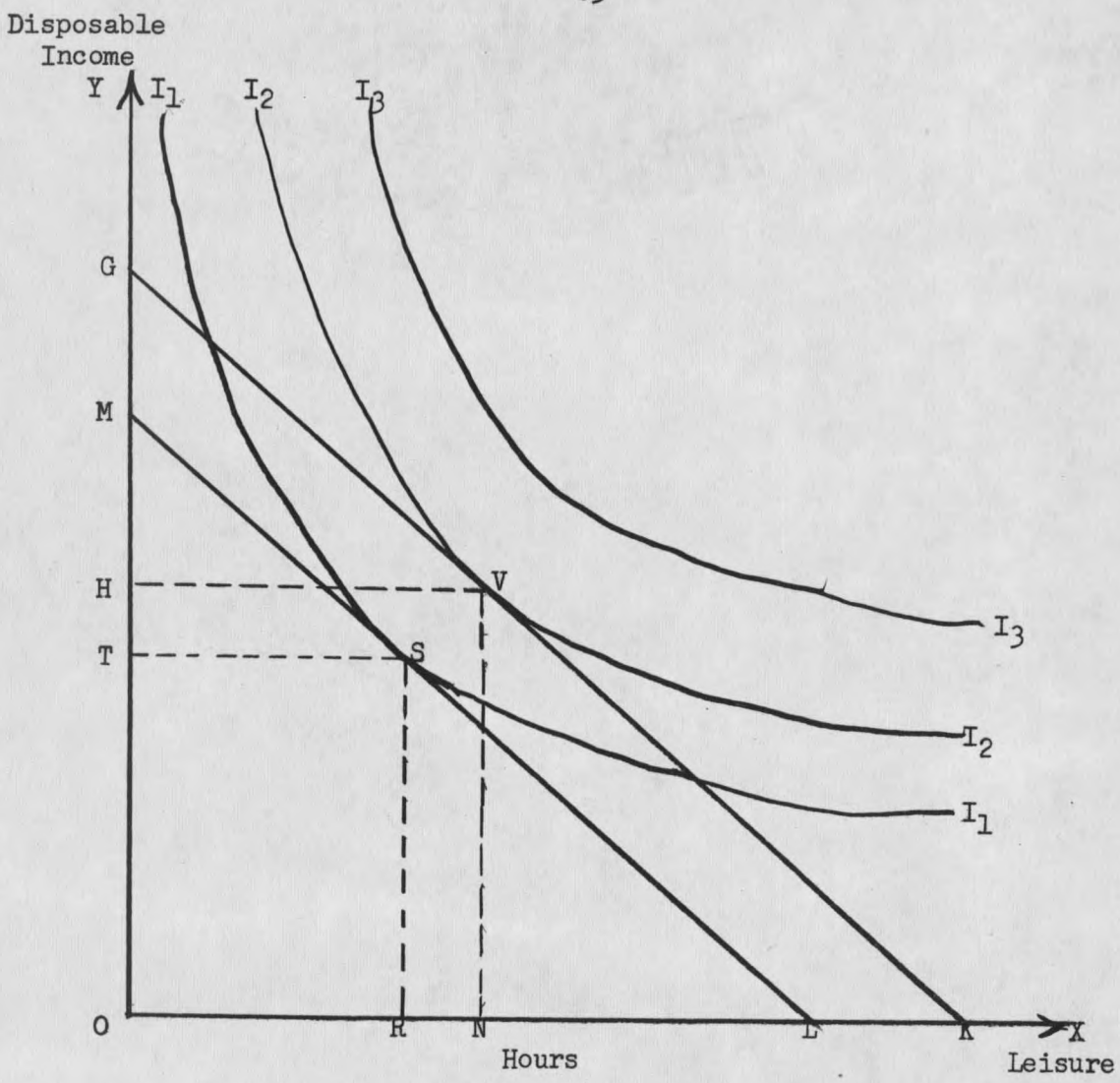

Figure 2 -- Indifference curves showing consumer preference between leisure and disposable income.

This illustration shows how demand is partly a function of, or dependent on, incomes. As incomes rise, consumers desire to purchase more services to increase their time available for leisure or other uses, providing the ratio of prices to income for other commodities remains the same. Increases in the amount of baker's bread purchased increases the derived demand for the high protein wheat required to mill the desired

flour for mass bread baking techniques. Family flour ranges from 10 per cent minimum protein to 11½ per cent protein, depending upon protein supply. The miller expects 13 per cent protein wheat to produce a flour of about 11½ per cent protein. Bakers desire flour protein content ranging from 11½ per cent protein to 12½ per cent protein depending upon their trade. Thus, if consumers purchase bread rather than bake it at home, they increase the demand for high protein wheat.

Some of the factors which are important in long run consideration become insignificant in determining short run and market demand. It is useful to subdivide the periods of time into three distinct periods, similar to the supply periods, in order to present the relative importance of factors and the interrelationships causing varying elasticities.

The factors which are considered important in empirical calculations of the demand curve may only be held constant in the short run time period. The two common approaches to the derivation of the demand curve for high protein wheat -- the budget and time series -- may not be reliably applied to the long run analysis because tastes cannot be held constant and the quantity demanded changes because of shifts of the demand for high protein wheat. The time series approach has limited applicability to classes of commodities and the family budget approach is not applicable to measure the rate of shift of the supply or demand curves of intermediate goods, or goods that are commonly not consumed directly by human beings, such as hay, corn or wheat. The family-budget approach does not measure the rate of shift of the demand curve because the data relate to a single point in

time. 1/

Long Run Demand. The long run may be defined as that period of time in which changes in consumers' tastes would vary in an amount sufficient to have a significant influence on the amount of a commodity which will be purchased at various prices. For purposes of relating supply and demand to premiums for high protein wheat, it is convenient to express the long run demand as any period longer than one production year.

In the long run, a complex of variable factors have an effect on the tastes of consumers. The purchasing power of money is continually changing; consumer habit changes as well as do the fashions persistent of a particular period. Changing technology and research create dynamic demand conditions; population changes also have an important bearing on demand.

Estimates of what future population will be show considerable variation. The Western United States population growth in the future is projected by some individuals to be as low as a 14 per cent increase over 1950 population by 1960, while others with a medium series of forecasts predict a 26 per cent increase, and a third group predict a high increase of 34 per cent. The fact that high protein hard red spring wheat is utilized for blending with low protein white wheat grown in Washington State requires a prediction of what the population of the Western States will be in the future. This example is not intended to imply that high protein hard red spring wheat is solely dependent on the population of the

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1/ Henry Schultz, The Theory and Measurement of Demand, Chicago, University of Chicago Press, 1938, p. 129.

Western States; the Eastern States also utilize the wheat to blend with low protein soft red winter wheat. Therefore, the population of Eastern States may be equally or more important as a variable determining future demand for high protein hard red spring wheat.

Other long run factors include the level incomes and effect on the elasticity of demand. In addition, alternative uses for high protein wheat may be found through the medium of research. Foreign customers may be influential in increasing the elasticity in the long run. Quality of soft winter wheats may decline, creating greater necessity for more high protein hard red spring wheat. A similar situation may arise with respect to soft and hard red winter wheats, which are blended with hard red spring wheats.

Historically, it appears that the amount of high protein wheat demanded will increase. Reduced tariffs and quotas on imports may eliminate the scarcity and thus the premium. The producer's guess may be as accurate as an empirical investigation in long run forecasting.

The elasticity of demand increases with time for the following reasons: Technological factors limit the ability of consumers to make effective readjustments in their consumption habit. A change in price of bread relative to other products would cause consumers to make substitutions. Imperfect knowledge of the change in price relative to changes in price of other commodities would prevent immediate response by consumers.

The demand for high protein wheat may be considered highly inelastic for the long run, short run, and market period because it is a derived demand from the consumers' demand for bread and represents a relatively small proportion of the total cost of the final product. One other reason

is the lack of substitution among uses for high protein hard red spring wheat.

Short Run Demand. Within one production year many variables which have an effect on the elasticity of demand may be controlled by assuming a constant rate of change or by holding them fixed. Among important factors which are generally held fixed for a production year are: the price of related commodities, the consumer's income, the per capita consumption of flour, or consumers' tastes, technology, and population. The empirical derivation of the demand curve then may be computed.

For high protein wheat, the location and elasticity of short run demand may be considered to be mainly due to the protein contents of classes of milling wheats with which hard red spring wheats are blended. If the demand is held highly inelastic (Figure 3) in the short run, shifts in the demand schedule become relatively more important than elasticity.

An illustrative model is presented to show the theorized relation of elasticity and changes of demand (Figure 4). It is assumed that the demand schedule is highly inelastic over a relevant range (perhaps between 10 cents and 25 cents premium per bushel), represented by a large per cent change in price from P_1 to P_2 which is associated with a small per cent change in quantity purchased. The quantity desired at a given price will change from year to year depending on the protein contents of other milling classes with which high protein hard red spring wheat is blended. The change in premium from P_1 to P_2 in Figure 4 is associated with a decline in the amount millers are willing to purchase, from Q_1 to Q_2. Assuming the elasticity of demand remains constant between year one and year two

(D_1 and D_2) the change in quantity millers will purchase at P_2 changes from Q_2 to Q_3. The change in amount which would be taken, Q_2Q_3, is greater because of shifts in the demand schedule than the change in the amount taken, Q_2Q_1, due to a premium change.

For a given year, the average protein content of soft white wheat grown in Washington State will partly govern the westward movement of hard red spring wheat required for blending. Similarly, the average protein content of hard red spring wheat will influence west coast millers because they can and do make substitutions between hard spring and hard winter wheat in blends. If price increased too much, California, Oregon and Washington millers could utilize all hard winter wheat rather than blending hard spring with soft white; this is the substitution effect which increases the elasticity of demand as premiums increase. (Note: The greater the number of substitutes, the greater the elasticity in the long run as well as the short run.)

Because of the importance of knowing the supplies, millers have representatives surveying the wheat crops by following the harvest and sampling the various classes of wheat. 1/ If the normal protein content of white wheat is 9%, and in a particular year the average falls to 8% protein content, more hard red spring wheat will be utilized for blending, shifting demand to the right. Actually, both supply and demand may be estimated for a given crop year by the millers because so many long run variables do not have to be taken into account.

1/ Storck and Teague, op. cit., p. 316.

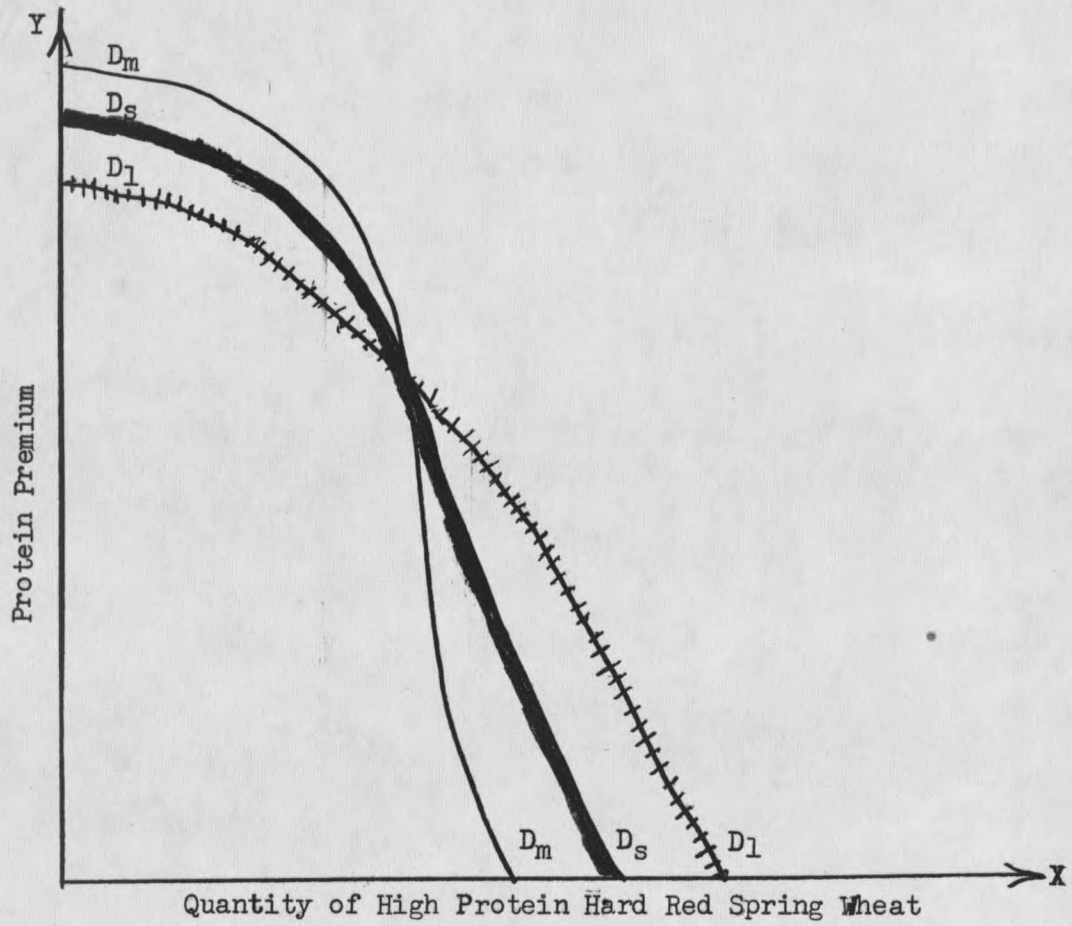

Figure 3 -- Theoretical demand schedules comparing elasticity in the market demand, D_m, the short run demand, D_s, and the long run demand, D_l, for high protein hard red spring wheat (over 12 per cent protein content).

Demand is relatively elastic at high prices (Figure 4). At some extraordinary high price, millers would cease to purchase high protein hard red spring wheat. As the price declines, the demand schedules become more inelastic. The inference of this assumption is that at high prices a small per cent change in the price creates a large per cent change in the amount utilized by millers.

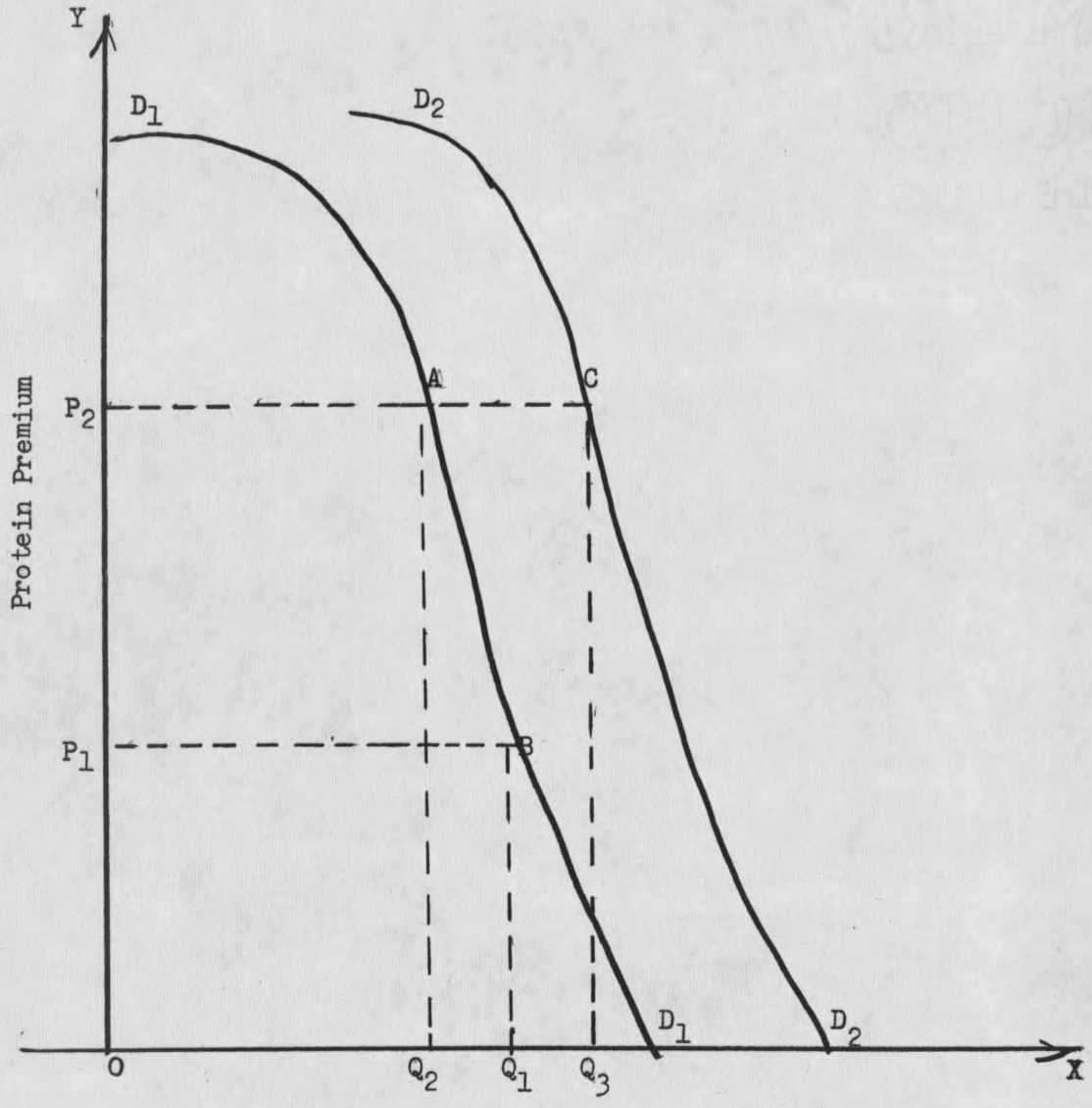

Figure 4 -- Theoretical short run demand schedules for two crop years showing elasticity and shifts or changes of demand.

Market Demand. The market demand is assumed to be highly inelastic within the crop year. Demand changes in the market place because of unforeseeable influencing factors. One or more mill buyers may have difficulty obtaining the necessary high protein wheat to blend for a specific flour order or

orders. Rather than lose the contracts or reduce operations of the mill, it may be a saving to the firm to absorb a small loss through overbidding protein than to lose the customer (baker) contract through default.

The higher premium in July and August of 1951 and 1952 (Appendix Table V) may be due partly to a shortage in the market supply of the previous crop, and partly due to the assumption that millers are anxious to obtain large quantities of the new crop for storage purposes. It is reasonable to assume that millers store substantial quantities of the high protein wheat of the new crop, from the beginning of the crop year, to ensure adequate supplies for blending. Purchasing for storage would create higher prices when millers anticipate a shortage throughout the marketing year. Physical limitations of being able to adjust supplies in rapid response to market shortages is possibly creative of most of the high price which may prevail at harvest and until the millers' demand is satisfied for the contracts he has, or anticipates having.

As a result of the physical limitations of adjustment the elasticity of demand in the market period is shown to be less than for the short run or the long run time period (Figure 3). The demand aspect of the problem of adjustment is that millers are not able to substitute any other kind of wheat and still keep their mill running at full production. It would take time and be costly in the market time period to bring in hard winter wheat which could produce the desired flour without blending. Rather than change the blending technique, the miller will pay more for the high protein hard red spring wheat he has been using in his blends.

Part III. Protein Premiums as a Function of Supply and Demand

Premium Fluctuations. Parts I and II have introduced the factors affecting supply and demand in the formulation of equilibrium market prices. Figure 5 shows the relationship of supply and demand in the short run -- one crop year.

Price is the equilibrium position established by the interaction of supply and demand functions. Years are presented in the model as subscripts to supply and demand curves, S_1 implying a calculable function for supply in Year 1. Demand in Year 1 is represented by D_1. Where D_1 and S_1 intersect, it is assumed, given pure competition, that P_1 will be the equilibrium price about which prices will have a tendency to fluctuate in the market place for that year.

The mathematical computation of the short run demand schedules is well known for linear functions, when the quantities of the relevant variables are known. 1/ Very little research of a quantitative mathematical nature has been conducted on the supply schedules. Bailey's attempt to show the relation of price of protein as the dependent variable of supply holding the demand function fixed, shows a close relationship. 2/ There is no way of knowing whether the price in 1925, for example, was 4.2 cents with a 20% supply over 13 per cent protein, or whether it was the inter-

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1/ Mordecai Ezekiel, Methods of Correlation Analysis, New York, John Wiley & Sons, Inc., Second Edition, Seventh Printing, 1950, p. 248.

2/ Bailey, op. cit., pp. 38-40.

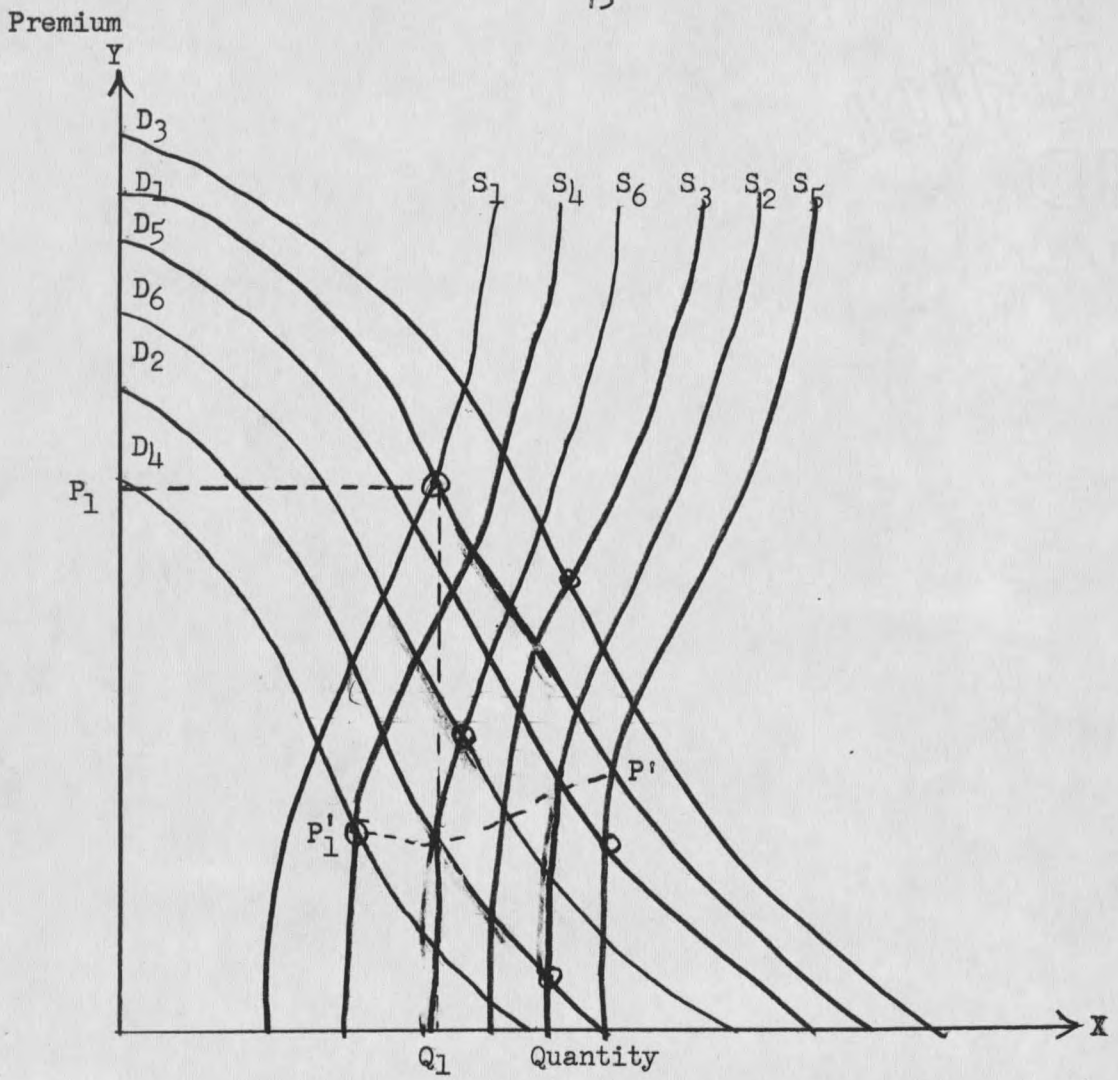

Figure 5 -- Interaction of supply and demand schedules in establishing premiums for high protein (over 12 per cent) hard red spring wheat, by crop years.

action of a number of shifts of supply and demand represented as P'_1 P'_1 in Figure 5. Ezekiel refers to an early study of high premiums as a function of scarce supply of high protein wheat. 1/ He found that when the supply

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1/ Ezekiel, op. cit., p. 426, and
Kuhrt, W. J., Preliminary Report, Analysis of the Variation in the Quality Factors of the 1925 Crop of Spring Wheat, and the Relation of Such Variation to Prices Received and Premiums Paid in 1925-26, U.S.D.A., Bur. Agr. Econ., Oct., 1927.

is large, the premium is low, and vice versa.

Premiums paid by country elevators to farmers in Montana are quoted daily in the Great Falls Tribune; usually the premium is quoted from 12 per cent protein and is expressed on the basis of ½ per cent increases up to 17 per cent protein. The historical nature of the premiums is presented in the Appendix section. The average premium for 20 years by months for 16 per cent hard red spring wheat averaged 11.4 per cent of the base price, with a maximum range of variation of 1.6% for each month. (See Appendix Table III). This average variation by months indicates a close relationship of premiums to base price, and is suggestive of a need for more adequate research for its explanation.

Protein premiums averaged for each calendar year averaged 19.5 per cent of the base price, and the maximum range of variation was 14.1 per cent. (See Appendix Table IV). Premium averages based on the calendar year lack the significance of averages based on a crop year. In 1938, protein premiums were highest (24.1 per cent), expressed as a percentage of base price. The year 1952 showed the lowest premium as a per cent of base price.

Premiums and base prices are compared between hard winter and hard red spring wheat classes in Appendix Table IV and Table VII. The twenty year average base price of hard spring wheat is $1.22 compared to $1.18 for dark hard winter wheat. The premium on dark hard winter is two cents greater for 14 per cent winter wheat compared to 14 per cent spring wheat. (7.7 cents compared to 5.7 cents). There appears to be a close relationship between the base prices and the protein premiums for hard winter and

spring classes of wheat purchased in Montana.

Blending Wheat. A preliminary attempt was made to determine whether or not there would be sufficient price incentive for producers to attempt segregating of hard red spring wheat of varying protein contents. Appendix Table VIII shows average premiums by months for a twenty year period, 1933 to 1952. The cost of blending 12 per cent protein and 14 per cent protein on a 1:1 ratio shows an average loss of -0.6 cents compared to selling each lot individually. Similarly deducted, the average loss for a 13 per cent and 15 per cent blend was -0.4 cents, and for 14 per cent plus 16 per cent blend, the average loss was -0.2 cents.

Based on this evidence, there is substantiation of the feeling among other members of the grain trade that producers would not gain from blending different protein content wheats. 1/

Blending data were compiled for the year 1951 to determine fluctuations based on monthly premiums for one year (Appendix Table IX). Farmers would have lost one cent on the 12 per cent and 14 per cent blends; three cents on the 13 and 15 per cent blends; and 0 cents on the 14 and 16 per cent blends. In July 1951, they would have lost 9 cents by blending 13 per cent and 15 per cent wheat to get 14 per cent wheat. Over a twenty year period, the maximum loss was found to be 3.1 cents from selling a blend of 12 per cent and 14 per cent in April.

Averaging the data by months indicates that a producer could not blend continuously and increase income. The data covers up one important

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1/ Personal observations among grain buyers and millers at Great Falls, Shelby and Havre, Montana.

phase of blending possibilities available to producers. Those producers having their crop binned on a segregative basis of protein content could, and possibly do, take advantage of changing premium margins from day to day. If they had a 14 per cent protein wheat in one bin and a 16 per cent protein wheat in another bin, and the price was such that it would be more profitable to blend the two bins at the time of sale, they could alternate loads between the two bins and the net result at the elevator would be the average protein obtained by the combination. More complete data would be required with respect to daily premium margins before the probability of producer success is known.

Exchange Prices and Elevator Prices. Appendix Table X shows the Minneapolis Exchange monthly average bid premiums for 15 per cent protein. There is considerable variation between the Grain Exchange (millers, speculators bids) and the elevator price. For example, in January 1951, the Exchange bid was 20 cents, whereas the elevator bid to farmers was 16 cents (See Appendix Table XIII). Base prices plus premiums are compared for the same period in Appendix Tables XII and XIII---Minneapolis $2.61, elevator $2.07. The difference, $.54, constitutes freight (about 42 cents); risk and handling charges (about 12 cents). The data infers that elevator operators receive a portion of the premium offered by mill buyers as legitimate charges for handling the supplementary commodity, protein. Further analysis with more reliable data would be necessary before reliable results are obtained relative to the distribution of premiums between elevator operators and producers.

Storage Loan Program. The cash base price quoted at the country elevator

has been below the storage loan rates established on the parity price formula. For this reason, producers do not gain as much from cash sales in some periods as the premium quotations would indicate. Storage loan rates are established on the basis of the base price, and only a fraction of the premium is loaned to producers. For example, the storage loan rate may be $1.98 for the base price on Number 1 heavy dark northern spring, plus 3 cents for 15 per cent protein; total loan is $2.01. The base cash price at the same time may be $1.89 and the premium 13 cents for 15 per cent protein; a total value of $2.02. The additional one cent would be sufficient to induce producers of the wheat to divert it out of storage channels, barring producer speculative action.

Protein Premiums in Imperfect Markets. The distribution of premiums may be analyzed through construction of economic models representing supply, demand and price with the assumptions of imperfect competition. In figure 6 the supply schedule has been presented with an inelastic slope, characteristic of the short run period. The demand schedule is derived from multiplying the marginal physical product by the price to obtain the value of the marginal product or demand cruve, (VMP). 1/

With imperfect competition, assuming there are few buyers relative to sellers of high protein wheat, and the buyers have knowledge of supply, producers know that quantity OQ_1 will be available in the market regardless of whether a premium is paid or not. Instead of paying OP_4 they could obtain the quantity OQ_1 at any price between O and OP_4.

1/ Maurice C. Taylor, "A Review of Economic Principles", Mimeograph Summary, Agric. Econ. Dept., Montana State College, Bozeman, Montana.

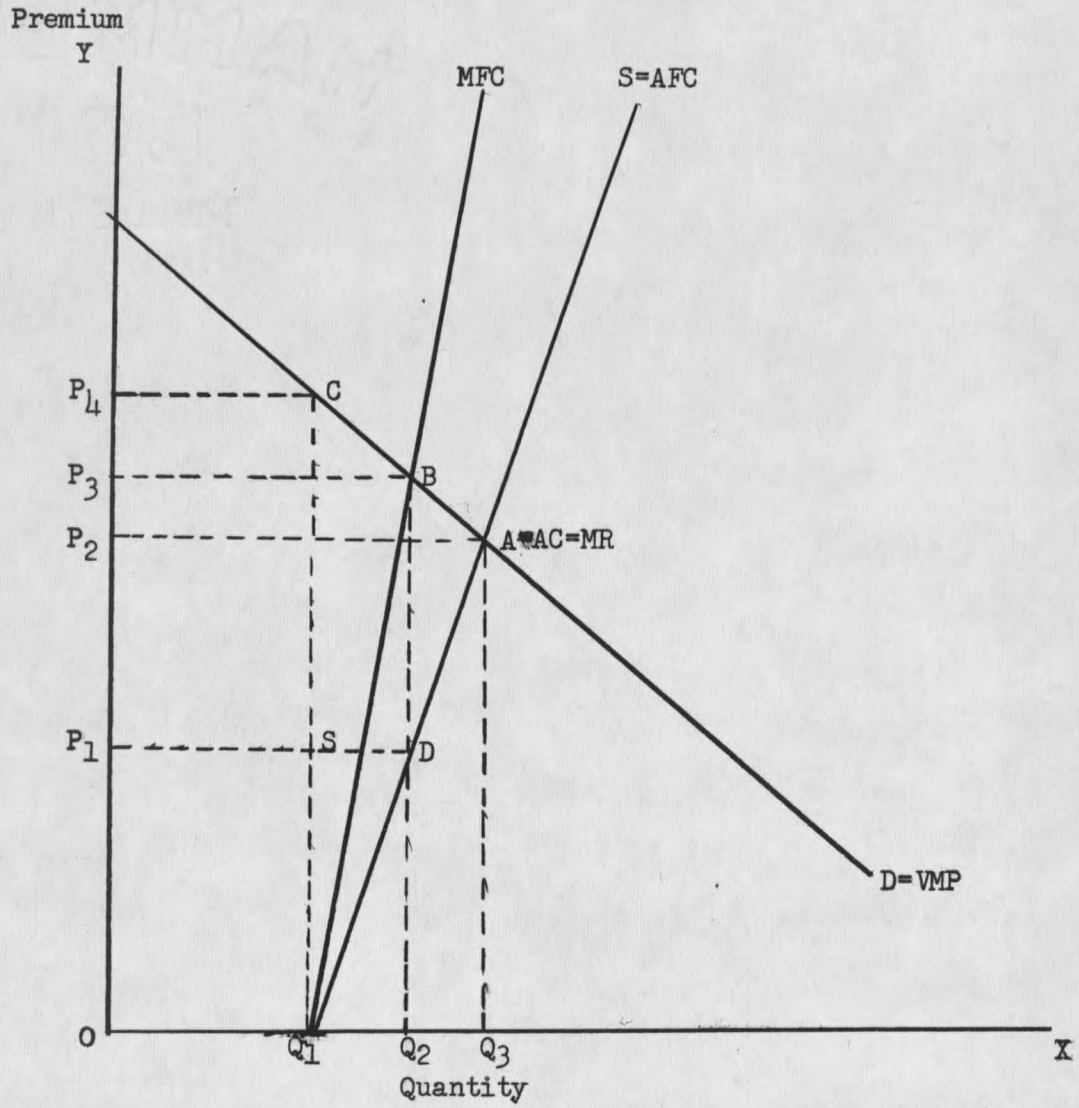

Figure 6 -- Imperfect competition and distribution of economic surplus, assuming the supply schedule is (1) perfectly inelastic (Q_1C) and (2) highly inelastic (Q_1S).

Additional increments of quantity supplied are based on the marginal factor cost, MFC, and the average factor cost, AFC in figure 6. The purchasing firm is theoretically able to purchase on the basis of the intersection of marginal factor cost and marginal value product curves, represented by the point B in the diagram. The purchasing firm may pay only

OP_1 for quantity OQ_2, because OP_1 is the price which is required to induce the additional amount, Q_1Q_2 of high protein wheat on the market even though the marginal value product of OQ_2 amount of high protein wheat is OP_3. The amount of gain in price to the purchasing firm is represented by P_1P_3 in figure 4.

The problem for producers is an attempt to obtain the maximum premium which is obtained by the purchaser. Instead of obtaining OP_1 for quantity OQ_2, they desire to obtain a premium of OP_3. The attempts by State legislators to obtain a greater portion of the premium for producers has been emphasized by legislation requiring protein tests of the producer's wheat.

If OP_3 is the price that purchasers could pay, and still equate marginal factor cost and value of marginal product, and OP_1 is the price they do pay to attract quantity OQ_2 to their firms, there is a social loss of high protein wheat entering the market. At price OP_1, producers will place only OQ_2 on the market, but if they were paid OP_2, the producers' supply would be OQ_3. The loss of product to society is represented by quantity Q_2Q_3.

The difference in price paid to producers, represented by OP_1, as compared to OP_3, represents loss to producers and an equal gain to purchasers. The social interest in attempting to obtain a greater portion of the premium that theoretically could be paid would be reflected in the increased quantity available to society, shown as Q_2Q_3 in the diagram, figure 6. Under the assumptions of imperfectly competitive purchasing, millers would be interested in paying OP_1 to obtain OQ_2 of high protein wheat. The premium and quantity lines are shown intersecting the supply curve at D in

figure 6. Producers are interested in obtaining premium OP_3 for quantity OQ_2; where the purchaser equates marginal factor cost and the value of the marginal product at B. Society would like to have the purchaser equate supply and demand schedules AFC and VMP at A, which would give the producer OP_2 of premium and increase the total product to society from OQ_2 to OQ_3.

If it is assumed that the supply curve is perfectly inelastic, that is, there would be no more product placed on the market whether the premium was high or low, then in the absence of competition among buyers, the purchasing firm would not be required to pay a premium to obtain the quantity desired. The attempts to reflect premiums to producers would require setting a minimum price to producers through social action. The price established would be based on the judgment of the legislators in this instance, and the social product would be no more and no less. The social factor required to establish premiums where supply is perfectly inelastic would of necessity be based on a conviction that it is better for the producer to gain the benefit of the economic surplus than for the purchaser to receive it. 1/

The theoretical analysis applied to economic surplus (or monopsonistic profit) is presented diagramatically in figure 6. The supply coming on the market in the given year is expected to be OQ_1. If the supply curve is perfectly inelastic, it could be represented as a vertical straight line, projecting from Q_1 to C and parallel to the price axis.

1/ Earl O. Heady, op. cit., p. 827.

The demand curve of purchasers is represented by the value of the marginal product curve, VMP, in figure 5. The premium which purchasers could theoretically pay is OP_4, but they are not required to pay any premium to obtain OQ_1. Society may decide that producers should receive a portion of the economic surplus and may arbitrarily establish a minimum level, which would be represented by OP_1. If the price was established at OP_1, producers would receive economic rent of $OP_1 \times OQ_1$ represented by rectangle $OP_1 SQ_1$, and purchasing firms would receive $P_1P_4 \times OQ_1$, represented by the area P_1P_4CS in figure 6.

Chapter III.

CRITICAL ANALYSIS OF METHODS OF DETERMINING THE SUPPLY OF HIGH PROTEIN HARD RED SPRING WHEAT.

Part I. Sampling Considerations

Reasons for Determining Supply.

The theory of supply relative to the elasticity and shifts in the supply schedule points up the importance of determining the quantity of high protein wheat for each year. The average protein content of the supply of other classes of wheat was determined to be significant in creating shifts in the demand schedule. Thus; a knowledge of protein content of the supply of all classes of wheat is regarded as necessary in estimating the expected equilibrium price within a crop year.

The Statistical Population of Wheat. The ultimate determination of frequency distributions of quantities of various classes of wheat is the individual kernel. Each kernel in a given quantity of wheat varies in protein content from the next.

> "Protein contents of individual kernels of wheat, representing random samples taken from two plots of 0.1 acre and two plots of 0.23 acre, were found to be distributed within samples in an approximately normal manner over a range of at least 6 percentage units with a standard deviation of 1.4 units. . . Within plants, the average range for single heads was 1.7%. . . Mean values for individual spikelets were normally distributed over a range of 5.1%; . . .the top two spikelets of each head generally had decidedly lower protein contents than the remaining spikelets.
>
> Within spikelets containing three kernels, the top kernel tended to be decidedly lower in protein content (mean, 14.7%) than the remaining two; the middle kernel (15.9%) tended to be slightly higher than the lowestone (15.7%) . . .Within plants, the protein contents of individual kernels were normally distributed over a range of about 6% with a standard deviation of

1.2%". 1/

On a given field, the protein content may vary in relation to soil areas and because of the influence of showers which were not uniformly distributed. 2/

Description of the Marketing Process Relative to Sampling Possibilities.

Samples of wheat may be taken from fields at harvest time by producers as a guide to segregative binning. The next stage of sampling is at the country elevator, where the information is utilized for the establishment of the price of the wheat and as a guide to segregative binning. Up to this stage in marketing, the State protein testing laboratories play an important role in the process of determining the protein content. While the premium established in the fall may be an indication of how much segregation will occur, it is expected that very little differential segregative binning occurs on farms because of limitations resulting from the delayed results of protein tests.

The time required to obtain the results of protein tests, a minimum of from 48 to 72 hours, places severe restrictions on country elevator operators also. Elevator bins are limited and experienced country elevator operators bin on the basis of judgment. Within a few days after harvest, these operators are in a position to know in what localities within their market area the high and low protein wheats are being harvested. They

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1/ L. Levi and J. A. Anderson, Variations in Protein Contents of Plants, Heads, Spikelets, and Individual Kernels, of Wheat, Can. Journ. Res. F, 28:71-81, Mar. 1950.

2/ Bell, op. cit., p. 14.

utilize this knowledge of the area, plus the relation of hard dark vitreous kernels to protein content, as their guide to binning practices. Bailey summarized the empirical findings of several investigators and found a wide range of relationship of kernel appearance and protein content depending on the area, the year and the factors affecting the appearance. 1/ Elevator operators are severely restricted in attempting to bin on the basis of visual guides.

As the elevator operators load boxcars with wheat, they practice blending techniques which may be effected to reduce or increase the average protein content of the carlot. Other considerations which influence operators in loading cars on track are the bushel weight, dockage, and moisture content. Once the car has been loaded, the sample is forwarded to the State laboratory for an official grade. State grading labs are established for the purpose of grading each carlot of wheat according to Federal grade standards.

As the wheat moves from one state to another, it is subjected to further protein tests. Most hard red spring wheat moves east from Montana and is marketed through the Minneapolis and Duluth wheat exchanges. Purchasers at the commodity exchange, bid the base price and premium on the basis of the established grade and protein tests for each carlot. A sample of each carlot is maintained on tables to allow visual inspection by the bidders, who may be mill buyers, exporters, speculators, or terminal elevator operators.

1/ Bailey, op. cit., pp. 9-10.

When the mill buyer obtains a carlot of high protein wheat, the carlot is diverted to the mill. Further analysis, including protein tests, determines the milling and blending quality of the carload of wheat. If the wheat purchase does not meet the requirements assumed to be associated with the federal grade and protein content, the miller offers the carload back on the commodity exchange where it is offered to some other prospective purchaser, or uses it in a blend that will recompense the deficiencies.

In the process of testing and moving wheat through marketing channels, considerable data is compiled by State organizations and private industry which is useful as a basis for analyzing the protein content of the various classes of wheat. The purpose of analyzing the methods of determining the supply is to gain some knowledge relative to which method is most likely to give the desired results. Factors which require consideration in obtaining frequency distributions of various protein contents include timeliness, accuracy, and cost. Most samples are based on a relatively large number of individual protein tests. An average of 4,660 shipments constituted the sample from which the protein tests of 161 stations were computed in Bailey's analysis of the coefficient of variation for shipping points. 1/ He found that 13 per cent average protein wheat for a station may vary an average of 0.42 per cent of protein in individual carlots.

Sampling Theory. The past work that has been done by Bailey, Anderson and Eva, the Bureau of Agricultural Economics in Montana, and many other agencies is useful in establishing the size of sample according to theory of

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1/ Ibid, p. 38.

sampling. If the population has a mean μ, and a finite variance σ^2, then the distribution of the sample mean approaches the normal distribution with variance $\frac{\sigma^2}{n}$ and mean μ as the sample size increases. If it is desired to find the probability that the sample mean will fall within a small interval containing the population mean, it is appropriate to utilize Tchbysheff's inequality to determine the size of the sample. 1/ For a probability of .95 that the sample mean will lie within .5 of the population mean when the standard deviation σ equals 1,

The size of sample n is computed from the formula:

$$1 - \frac{\sigma^2}{nb^2} = .95$$

$$n = \frac{\sigma^2}{.05\, b^2} = \frac{1}{.05(.5)^2} = 80$$

$\overline{X}$ = sample mean
μ = population mean
σ = standard deviation of population
n = size of sample
b = distance from the $(\overline{X} - \mu)$

Therefore, the size of sample should be 80 individual records.

Estimating a Cumulative Frequency Distribution.

It is desirable to predict the goodness of fit of the sample distribution of a frequency distribution to the frequency distribution of the population. The following technique provides a means of determining the various confidence intervals for samples of any size. The cumulative frequency distribution of the sample is shown in figure 7. 2/ For the sample of size 280, assuming random sampling techniques were employed in drawing the sample, it would probably be desirable to obtain a 95 per cent confidence interval.

1/ Alexander M. Mood, Introduction to Theory of Statistics, New York, McGraw-Hill Book Company, Inc., 1950, p. 135.

2/ Cumulative frequency distribution drawn from distribution of 280 individual samples for Manitoba, 1935, Table B-XI, Anderson and Eva, op. cit., p. 134.

The size of the band in percentage points would be computed from the formula: 1/

$$d\alpha = \frac{1.36}{\sqrt{n}} = \frac{1.36}{\sqrt{280}} = 0.08$$

n = Sample size

α is the chance that the maximum deviation between the cumulative distributions of the population and of the sample exceeds $d\alpha$. 2/

$d\alpha$ is the percentile of the frequency distribution of the maximum deviation of a sample cumulative distribution from the population cumulative distribution. 3/

$200\ d\alpha$ = 0.08 X 200 = 16 = the band in which the cumulative frequency of the population is contained within a 95% confidence limit when N = 280. 3/

Therefore, lines may be drawn 8 per cent units on either side of the frequency distribution of the sample of 280 units, and assuming random sampling and a homogenous area, 4/ the cumulative distribution of the population will be within 16 units of the cumulative distribution of the sample. (figure 7).

The limitations of obtaining a completely random sample may impair the significance of the results obtained. Examination of the methods presently employed with respect to homogeneity of the population and random

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1/ Wilfrid J. Dixon and Frank J. Massey, Jr., Introduction to Statistical Analysis, New York, McGraw-Hill Book Co., Inc., 1951, pp. 256-258.

2/ Ibid, pg. 348

3/ Ibid, pg. 256

4/ Crop reporting districts, as used by the Agr. Mktg. Service of U.S.D.A. were considered homogenous areas for stratified random sampling by King, McCarty, and McPeek, op. cit., (footnote), p. 16.

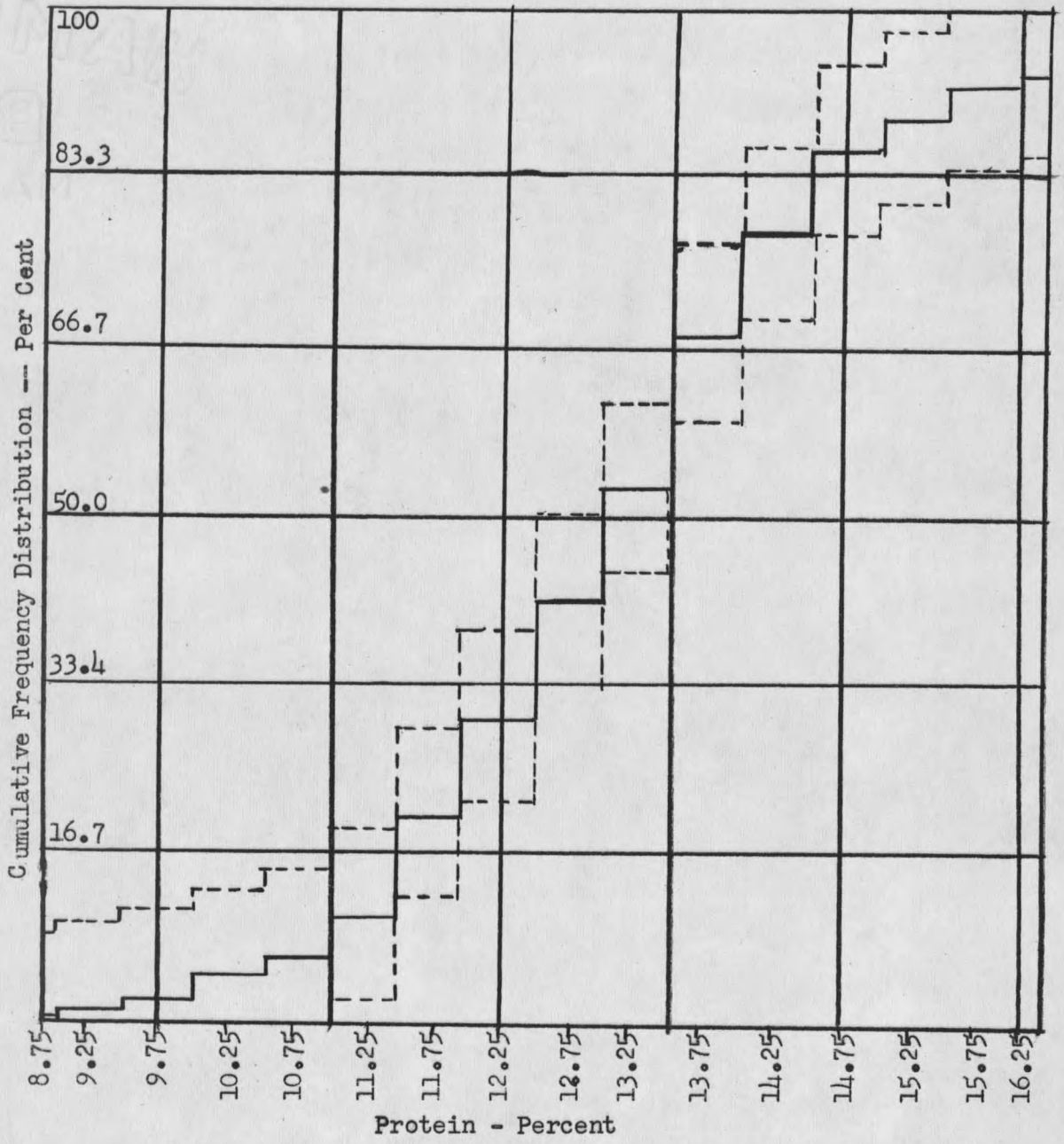

Figure 7 -- Confidence interval (assuming stratified random sampling) for probability = .95 that the distribution of the cumulative frequency of a population is within a band of 16 percentage units wide, 8 units above and below, the cumulative frequency distribution of a sample, size 280 units.

collection of samples may be useful in a determination of the relative merits of the sampling techniques.

Premiums in Relation to Historical Data.

Preliminary analysis of factors expected to create an influence in the establishment of a price equilibrium for protein for 5 market years, 1947-1951, is presented in Table I. The average protein premium for 15 per cent protein wheat was abnormally high in 1947. In attempting to relate the high premium to causative factors, a number of variables were computed. First, the base price of No. 1 hard red spring wheat and the average premium for the crop year were compared. 1/ The average premium was expressed as a per cent of the average base price for the five years. A comparison of the 5-year averages shows that in 1947 the protein premium, 12.2 per cent, represented the greatest per cent of the base price. The average premium in 1951, expressed as a per cent of base price, was 4.5 per cent of the base price. Some factors, other than the level of price of ordinary protein wheat, are thereby postulated to cause changes in the level of premiums for high protein hard red spring wheat.

The production estimates indicate no significant relationship to the premium. The production is 210 million bushels for 1947 in the four high protein hard spring wheat producing States of Montana, North Dakota, South Dakota and Minnesota. During the twenty years, 1933 to 1952 2/ this production estimate was only exceeded five times, the highest production being 246 million bushels in 1951. In 1947 the production of spring wheat was

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1/ "Base price" refers to ordinary wheat of less than 12 per cent protein.

2/ Appendix Table II

Table I. Relation of Average Protein Premium for Hard Red Spring Wheat to Average Protein Content and Loaf Volume of 4 Classes of Milling Wheat, 1947-1951.

Ave. 1/ Premium, 15% Protein at Minneapolis		Ave. 1/ Base Price (Ordinary Protein) Minneapolis	Average Premium, 15% Protein, as a Percent of Base Price, Minneapolis	Production 2/ Hard Red Spring Wheat in Mont., N. Dak., S.Dak., Minn.	Average Protein Content 3/ by Wheat Classes				Average Loaf Volume by Wheat Classes			
					Hard Red Spring	White Wheat 5/	Hard Red Winter	Soft Red Winter 5/	Hard Red Spring 4/	White 3/	Hard Red Winter 3/	Soft Red Winter 3/
Yr.	Cents	Cents	Percent	1,000,000Bu.	Per Cent				Milliliters			
1947	33	270	12.2	210	14.0	8.8	11.4	9.9	824	551	716	616
1948	12	226	5.3	216	12.4	8.2	11.5	9.3	769	498	687	583
1949	14	224	6.2	158	13.5	9.0	11.9	9.4	865	579	780	622
1950	22	234	9.4	199	13.0	8.7	11.8	9.8	821	533	733	626
1951	11	242	4.5	246	13.8	9.4	12.1	9.9	833	534	733	582

1/ Premiums computed from Table IX and X for crop year, July through June.

2/ See Table II - Appendix.

3/ Mimeographed Annual Reports to Field Offices, G.S.R. Project No. 47, U.S.D.A., P.M.A., Grain Branch 1949-1953.

4/ Mim. Reports, Milling, Baking, and chemical experiments with Hard Red Spring Wheat, U.S.D.A. Agr. Research Adm., Bur. of Plant Industry, Soils, and Agr. Eng. and P.M.A.

5/ Data on Protein content of White Wheat and Soft Red Winter Wheat is not available prior to 1947.

high and the premium was also high, whereas in 1951 the production was high but the premium was low, probably because protein content of hard red winter wheat was high in 1951. Production is not the sole criterion for the determination of protein premiums.

The average protein contents derived as samples of inspected carlots is not a random sample. It is therefore impossible to determine the probability of error. However, it is the only available source of compiled statistics from which comparisons could be made of yearly average protein contents of the total crop of various classes of wheat. Hard red spring wheat averages range between 13.0 and 14.0 per cent in the five years; white wheat varies between an average protein content of 8.2 per cent and 9.4 per cent; hard red winter wheat varies between an average protein content of 11.4 per cent and 12.1 per cent; and the range in variation of averages between years for soft red winter wheat is from 9.3 per cent to 9.9 per cent protein. In 1947, the average protein content of the four wheat classes appears to be fairly high, corresponding to a high premium and a high production of hard red spring wheat. In 1951 the premium was low, while production and average protein appear to be high for hard red spring wheat. The average protein content of the other three classes of wheat was also high, according to the data in Table I.

There is a high relationship between protein content and loaf volume. 1/ According to the data presented, the size of loaves made from the white

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1/ John A. Johnson, R. O. Pence, and J. A. Shellenberger, Milling and Baking Characteristics of Hard Red Winter Wheat Varieties Grown in Kansas, Agric. Exp. Sta., Kansas State College, Manhattan, Kansas Circ. 238, Feb. 1947, p. 14.

wheat and hard red winter wheat classes was smallest in 1948, while the average size of loaves of soft red winter wheat was also low. Adding high protein wheat to increase loaf volume is the purpose of blending hard red spring wheat with the other three classes. It is apparent from the data that more hard red spring wheat of high protein content would be required in 1948 than in the four other years; providing that the sample is sufficiently representative of the actual average loaf volume that existed in that year. If the sample, from which the data is drawn, is representative in terms of probability theory, it is apparent that some factor or factors influence protein premiums other than the factors indicated in Table I. 1/

Two other factors that could create premium fluctuations are; incomplete knowledge among purchasers and the frequency distribution of the protein per cent about the mean. Purchasers, (millers, speculators) may make an unreliable forecast of the average protein content of the four classes of wheat, and estimate the average protein content of hard red spring wheat as 13.0 per cent in 1947, when actually the average was 14.0 per cent. Thus, bidders would feel that there would be a shortage of high protein wheat for the market year. On the other hand, purchasers may underestimate the protein content of the classes of wheat with which hard red spring wheat is required for blending. If they underestimate, they would expect more bidders on the Exchange and also each bidder would require more high protein hard red spring wheat. Thus, shifts in demand would create higher

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1/ $P\left(\mu - \frac{a\sigma}{\sqrt{n}} < \bar{X} < \mu + \frac{a\sigma}{\sqrt{n}}\right) > 1 - \frac{\sigma^2}{n\,b^2}$, assuming a normal distribution, and variance is known.

premiums.

The other consideration, the frequency distribution of the quantity of wheat by various protein contents may be abnormal in a given year. The frequency distribution of protein content may vary relative to the standard deviation from the mean from year to year. The standard deviation of the sample is unknown, from which the data for the five crop years in Table I is computed. 1/ Very little reliance may be placed on the table as a guide to determination of causative factors in relation to premiums. However, an indication is presented that further statistical refinement is necessary in selecting samples before conclusions are valid.

Prerequisites of Sampling.

(a) Factors of Supply and Demand. Part of the solution of determining the equilibrium price within a production year is to determine the frequency distribution of the hard red spring wheat crop by protein per cent. The other determining factor, after supply has been determined, is to derive the demand schedule. It became evident in Chapter II that shifts in the demand schedule occurred because of the average protein content of the soft red winter wheat, hard red winter wheat, and white wheat classes. It is therefore necessary to establish the protein content of the supply of all classes of wheat with which hard red spring wheat is blended. In addi-

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1/ Standard deviation, $\sigma = \sqrt{\frac{\Sigma x^2}{n}}$

where X = individual differences from the mean = $(X-\bar{X})$

Σ = summation sign

n = number of observations

tion, there is a specific market for a given quantity of 16 per cent protein wheat for the production of high protein flour.

(b) Timeliness. If producers desire to have knowledge of the estimation of supply which would guide them in establishing their marketing policy, it is essential that the information be available at an early date. For this reason, it would be necessary to sample the harvesting of the crop similar to the techniques employed by millers. To date, none of the results of surveys conducted by United States governmental agencies, with respect to protein content, are made available to producers within a month of harvest.

A stratified random sampling technique has been empirically tested by King, McCarty and McPeek for determining the protein content of homogenous stratums in the population of wheat acreage. 1/ The sample was stratified by crop reporting districts on the basis of acreage, and an attempt made to follow the actual harvest. The number of samples 2/ required to estimate the state average protein content within $\frac{1}{4}$ per cent at fiducial probability of 95 per cent was found to be 857 in Kansas in 1939 compared to 1,320, the actual number taken. Two samples were taken from each field and acreage was calculated on the basis of route sampling with the aid of a crop meter. The average protein content was not adjusted for bias due

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1/ King, McCarty and McPeek, op. cit., pp. 15-36.

2/ Number of samples needed = $n^1 = n\ 4\ V\ (X-M)^2$

where (x-m) = one-half the range of accuracy of 1/8 per cent; V = estimated variance of the mean; and n = number of samples actually taken.

to unripened grain. The survey samples were taken about five days prior to harvest, and a check showed that samples taken eight days prior to harvest would yield a test about .50 per cent of the mature protein content. Further research would be necessary to establish an adequate basis for correction of bias. The data presented by King, McCarty and McPeek merely indicates that bias exists in preharvest sampling for protein content, and that the bias decreases with the proximity to the harvest date.

Part II. Appraisal of Techniques in Use

Applied Sampling Techniques. Comparisons of three separate estimates showed a wide range in the average protein content of the Montana crop in 1951. The variation in averages is assumed to be dependent on the method employed in drawing the sample. Average protein contents, as presented for each method, were 15.3 per cent, 14.9 per cent and 13.9 per cent. Frequency distributions are unavailable for computing the standard deviation for one of the samples.

Cereal chemists of the Pacific Northwest Section, American Association of Cereal Chemists, collaborate with the Pacific Northwest Crop Improvement Association in determining protein contents of classes of wheat. (Appendix Table XIV) They have determined the average protein content and the frequency distribution by per cent protein of Montana hard red spring wheat through 1945-1952. The method employed by cereal chemists in 1951 consisted of analyzing 917 individual samples from the first thirty days' receipts of new wheat in the Fall. Their results of the 1951 hard red spring wheat in Montana show the average protein content to be 15.3 per cent. The results of the survey were available to members of the Northwest Crop Improvement Association during the marketing year. The 15.3 per cent (weighted average) is probably biased by not being representative of the total area of spring wheat in the State of Montana. There is also the possibility that a bias is present because it represents wheat purchased by mill buyers and tested in the mill laboratory.

The second source of information on protein percentages was collected by farm survey questionnaires and may be assumed to be more representative

of the actual average protein of the crop. 1/ The average (weighted) protein content was determined by stratified random samples from approximately 4,000 farms. Average protein by acreage and cropping practice (summerfallow, irrigated, or other dry land) was obtained for the crop year 1951. The results of the survey were published by December, 1952, which is one year too late to be of practical assistance to producers in marketing their crop.

The United States Department of Agriculture, Grain Branch, was the third source of information on average (unweighted) protein content (13.9 per cent) of the 1951 spring wheat crop. 2/ Weighted averages may not be representative because each of the field offices participating in the work was instructed to composite approximately equal quantities of the largest possible number of carlots of wheat that fall within each of the straight numerical grades. 3/ The material available to the field offices of the Grain Branch consisted of samples used for the purpose of appeal inspection; therefore, the proportions of such samples falling within the various grades do not necessarily agree with the corresponding proportions for the entire crop.

The three sources of available data have serious limitations for use as guides to producers in attempting to allocate their high protein wheat in such a way as to maximize net income. The farm questionnaire survey

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1/ "Montana Agricultural Statistics", op. cit., pp. 43-45.

2/ Grain Branch, G.S.R. Project No. 47, United States Department of Agriculture, P.M.A., March 18, 1953.

3/ Weighted mean for Great Falls inspection point is 14.3 per cent protein.

is most representative in terms of distribution of sample by crop districts, (stratified random sampling), but lacks timeliness as well as being limited to one State in the high protein hard red spring wheat producing area of the Northern Great Plains.

It is of interest, with respect to regional sampling, to observe the practical application of stratified random sampling employed in determining the protein content of Canadian hard red spring wheat. 1/ The area is divided into crop reporting districts (stratum) for homogeneity, and samples are collected in proportion to production in each district. Samples were obtained by collection of envelope samples from country elevators and farmers in such numbers that they represent as closely as possible the volume of different grades of wheat produced in different areas. A total of 4,600 samples was obtained for a preliminary map published September 26, 1952. On November 3, 1952, a final map was compiled from 6,419 samples. Average protein content for the expansion of the preliminary survey was the same for the total region. One Province showed an average protein content of one-tenth of one per cent protein higher on the expanded survey. A further check was obtained by sampling every twentieth carlot of hard red spring wheat passing through inspection points during the full crop year. Based on carlot testing, the average protein content was 13.6 per cent protein for the 1951 crop. The results of the 1951 Fall survey map, dated October 27, 1951, was 13.8 per cent protein content; a

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1/ Board of Grain Commissioners for Canada, Protein Survey of Wheat, 1951 and 1952, Grain Research Laboratory, Winnipeg, Manitoba. Crop Bulletins Nos. 41 and 46, Nov. 1951 and Nov. 1952.

difference of two-tenths of one per cent protein between the two determinations.

Regional planning will be required to determine the average protein content and the distribution of wheats of higher and lower protein around the mean. Early surveys are a prerequisite to information which could be used by producers. The techniques and cost of gaining the information are known. The benefit of increased knowledge accrues to all members of the grain trade as a reduction of uncertainty.

Chapter IV

SUMMARY AND CONCLUSIONS

Part I. Reasons for and Purpose of the Study

The primary objective of the foregoing research has been to reveal the economic problems of marketing high protein hard red spring wheat produced in the Northern Great Plains area of the United States. The methodological approach to defining the problems was confined to initial stages of inquiry. As such, the study developed into a process of observation, description, classification, analysis and definition of economic problems associated with marketing high protein hard red spring wheat. The justification for proceeding with this stage of inquiry developed from a feeling among wheat producers that more adequate knowledge of protein premiums was essential as an aid to producer marketing. Producers have been aware of constant fluctuations in premiums paid to them for their high protein wheat for the past thirty years.

Observation and Classification.

In the observational stage of inquiry the fact became apparent that marketing problems were not confined to the producer segment of society. Other marketing agencies such as elevator operators, commission firms, millers and bakers have individual economic problems, in attempting to maximize net income, that were associated with the marketing of high protein hard red spring wheat. Observation created the assumption that producers and millers were the main segments of society confronted with marketing problems of economic significance relative to this commodity.

The research was confined primarily to the economic problems confront-

ing producers in attempting to maximize net income through timely marketing of a supplementary crop-protein in hard red spring wheat. Economic problems of the remaining marketing segments were introduced in relation to their significance in creating an understanding of the producer problem.

The producer's problem in attempting to market high protein hard red spring wheat is mainly a problem of uncertainty, created by unpredictable variation in protein premiums. Another important problem is that producers feel they do not receive an adequate share of the payment for the quality inherent in hard red spring wheat.

Conflicting opinions are apparent between producers, millers and bakers as to what constitutes quality in high protein hard red spring wheat. Millers feel that protein content is not always an adequate guide to the blending and milling and baking characteristics of the wheat. To maintain good customer relations with bakers, and thus solve the miller's individual problem of maximizing profit, the miller attempts to be consistent in the quality of flour produced. Millers are also individually concerned with paying only the portion of the premium that is necessary to induce sellers to allocate sufficient high protein wheat to the mills for blending to baker specifications. Society is concerned with the optimum allocation of premiums between marketing segments that will create the greatest social net gain in terms of the quantity of the product that will be produced as well as in terms of the satisfactions of the aggregate of marketing segments.

United States mills are the main source of demand for high protein hard red spring wheat. High protein wheat of this class is mainly desired

for its ability to increase the quality of other milling classes of wheat. Proportionately small quantities of high protein hard red spring wheat or wheat flour are exported from the United States. Particular types of bread are made from high protein wheat flour and the production of this bread creates some additional demand for high protein hard red spring wheat.

Part II. -- Solution of the Problem

Factors Affecting Premiums.

The problem of determining the cause of fluctuations of protein premiums requires knowledge of the supply of and the demand for high protein hard red spring wheat. Analysis of price in the preceeding Chapter II was limited mainly to the application of economic theory. Economic theory assumes that changes in supply of and demand for high protein hard red spring wheat creates price fluctuations from year to year and within the crop year.

To determine the supply a sampling technique is required which would give the average protein content of the total crop as well as the frequency distribution by per cent protein of the entire crop of hard red spring wheat for the crop year.

Empirical determination of the demand for high protein hard red spring wheat is assumed to be dependent on the supply, average protein content, as well as the frequency distribution, by per cent protein of all other milling classes of wheat grown in the United States. Hard red spring wheat is required to blend with hard red winter, soft red winter and white classes of wheat.

In the period of time exceeding one production year the supply will change because of the influence of price on production plans. Producers will tend to equate marginal cost to marginal revenue among alternative crops. Millers will seek alternatives to the use of high protein hard red spring wheat if premiums are high, based on their marginal cost-marginal revenue analysis. Population increases, changes in consumer tastes and

changes in incomes will alter the amount demanded at specific premiums in the future.

Theoretical Implications.

Supply is highly inelastic within the production year for high protein hard red spring wheat. A given per cent increase in premiums will place a proportionately smaller per cent increase in quantity of high protein wheat on the market. A large per cent decrease in premiums would cause a proportionately smaller per cent decrease in quantity supplied by producers.

Demand is elastic when premiums are high, and the time period is long, therefore a small per cent increase in premiums would result in a large per cent decrease in the amount of high protein wheat millers are willing to purchase. Demand is more inelastic as the time period decreases and as premiums decrease within a given time period.

Within one production year, supply and demand are assumed to be highly inelastic over the relevant range, supply being less elastic than demand. Changes in supply and demand from year to year are assumed to create greater variations in premiums than elasticity of supply and demand. Changes in supply are considered as variable as changes in demand. Premiums are not as easily correlated to supply and demand between years as within years. The supply and demand functions must be computed for each year. Premium fluctuations are created by large shifts in supply and demand schedules between years.

Requirements for Determining Supply and Demand Schedules.

To perform empirical investigations relating to supply and demand for high protein hard red spring wheat requires coordination of research

between regional stratum. To determine the frequency distribution and average protein content of hard red spring wheat for Montana alone is not sufficient coverage of the supply of high protein hard red spring wheat. Similarly, the total production, frequency distribution and average per cent protein of other milling classes of wheat must be determined on a regional basis. Stratified random sampling techniques are adaptable to determining the necessary influencing factors of supply and demand in the short run time period of one crop production year.

Part III. Economic Implications of the Problem

Producers

Given a more adequate knowledge of factors affecting supply and demand and their interaction with respect to fluctuating premiums may allow producers to:

(1) perform the blending function now mainly restricted to the elevator operators and millers.

(2) increase net income through intra-seasonal and inter-seasonal storage.

(3) perform more effective individual bargaining in the market place to obtain a larger share of the protein premium.

Millers

Millers could possibly be more efficient in reducing flour production costs if they had more adequate knowledge of the supply of and the demand for high protein hard red spring wheat for each production and marketing year. Increased knowledge has a tendency to narrow the range of fluctuations of prices from established equilibrium positions for most agricultural commodities. Thus the risk cost associated with milling high protein wheat would be reduced. Duplication of surveys conducted by millers to determine supply and quality of the crop at harvest may be avoided if a coordinated agency could perform the service for all firms and all segments performing the marketing function. The elimination of duplicate surveys would have a tendency to reduce the cost of the product to consumers, if the cost to each firm were reduced.

Society

If high protein wheat marketing costs are reduced, society is better off in terms of reduced costs being reflected to consumers of bread. Society may be concerned with the welfare of producers versus the welfare of other marketing segments as a primary function of the dissemination of knowledge of supply. Increased knowledge to producers with a resultant increase in bargaining ability, would tend to apportion a greater share of economic surplus presently gained by purchasers in a monopsonistic market and result in a greater amount of high protein wheat being produced in the long run or a greater amount placed on the market in the short run.

Society may feel that producers could not increase the supply in the short run (one production year) because they assume that supply is perfectly inelastic. Therefore, establishing a minimum premium to producers would have to be based on the assumption that satisfactions of producers are increased in greater proportion than the loss of satisfaction to the other marketing segments. Satisfactions are intangible values which do not lend themselves to economic evaluation or empirical investigation. Social judgement is limited to economic evaluation and the influence of the desires of the majority in setting limits on social segments in a democratic nation.

A P P E N D I X

Statistical Tables

Table II. Spring Wheat Yield and Production in Montana, North Dakota, South Dakota, and Minnesota, 1933-1952 1/

	YIELD				PRODUCTION				
Year	Mont.	N.Dak.	S.Dak.	Minn.	Mont.	N.Dak.	S.Dak.	Minn.	Total
	--1,000--Bushels--								
1933	7.0	7.0	4.0	9.7	19,390	56,035	3,556	13,076	92,057
34	10.0	5.8	4.8	10.6	17,544	15,370	480	11,501	44,895
35	8.5	6.0	7.5	9.5	22,151	36,570	19,725	14,839	93,285
36	5.0	5.2	4.9	9.0	8,960	12,678	2,705	13,347	37,690
37	7.0	6.9	5.2	16.0	14,301	31,961	10,676	27,520	84,458
1938	13.0	7.8	8.5	15.0	42,757	42,635	18,674	33,030	137,096
39	12.0	10.3	7.4	13.2	28,812	49,358	12,032	17,582	107,784
40	12.5	12.0	9.5	19.5	34,212	67,860	19,152	25,974	147,198
41	17.0	18.0	12.0	13.5	40,477	110,952	27,096	16,362	194,887
42	19.5	20.0	17.0	20.5	37,148	112,180	35,700	18,388	203,416
1943	21.5	19.0	11.0	16.0	55,706	124,697	27,027	15,072	222,502
44	17.6	16.1	12.4	16.8	49,245	129,444	32,910	17,875	229,474
45	11.5	15.5	15.5	19.0	27,669	124,620	43,198	18,392	213,879
46	12.5	13.5	14.5	19.5	30,075	107,460	44,863	24,726	207,124
47	14.0	14.0	14.0	17.5	43,120	105,868	44,184	17,745	210,917
1948	17.0	14.5	13.0	17.5	56,542	99,774	43,485	15,978	215,779
49	9.5	10.5	7.5	15.0	36,964	78,026	26,092	16,710	157,792
50	18.0	14.0	9.5	17.0	68,634	91,546	25,783	13,260	199,223
51	14.5	14.0	14.5	18.5	66,352	117,180	45,254	18,038	246,824
52	13.0	10.0	7.5	14.5	54,730	81,190	23,408	15,414	174,742

1/ Source: Bureau of Agricultural Economics, Helena, Montana.

Table III. Seasonal Trend of Wheat Prices and Protein Premiums, 20 Year Average, 1933-52, by Months - Dark Northern and Northern Spring Wheat. 1/

MONTH	BASE PRICE NO. 1 HVY.	Per cent Protein -- PREMIUM -- 12%	13%	14%	15%	16%	PER CENT 16% PROTEIN PREMIUM IS OF BASE PRICE
	Dollars	Cts.	Cts.	Cts.	Cts.	Cts.	Per cent
JAN.	1.21	0.8	3.3	6.1	9.8	13.7	11.3
FEB.	1.19	0.6	2.6	5.5	9.2	13.3	11.2
MAR.	1.21	0.3	1.8	4.4	8.2	12.2	10.0
APRIL	1.22	0.4	2.2	4.8	8.4	12.3	10.0
MAY	1.21	0.5	2.2	4.6	8.4	12.2	10.1
JUNE	1.20	0.4	2.2	5.4	9.6	13.7	11.4
JULY	1.24	0.9	3.0	6.8	10.8	15.4	12.4
AUG.	1.17	1.2	3.2	6.6	10.8	15.2	13.0
SEPT.	1.21	0.6	2.3	5.8	9.8	14.2	11.7
OCT.	1.21	0.6	2.5	6.0	10.0	14.4	11.9
NOV.	1.25	0.6	3.0	6.4	10.8	16.0	12.8
DEC.	1.28	0.6	2.8	5.8	9.6	14.2	11.1
AVE.	1.22	0.6	2.6	5.7	9.6	13.9	11.4

1/ Premiums from Mid-month price quotations of Great Falls Tribune, Great Falls, Montana, 1933-1952.

Table IV. Distribution by Per Cent Protein of Yearly Average of Mid-Month Premiums For Number 1 Dark Northern and Northern Spring Wheat For 20 Years, 1933-1952. 1/

YEAR	BASE PRICE NO. 1 HVY.	PROTEIN PREMIUM						PER CENT 16% IS OF BASE PRICE
		12%	13%	14%	15%	16%	17%	
	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Per Cent
1933	45.5	0.3	1.2	2.6	5.1	7.1	0.0	15.6
1934	72.2	0.0	0.1	1.0	3.1	5.4	0.0	7.4
1935	86.2	0.0	0.9	2.2	4.2	7.0	0.0	8.1
1936	107.3	0.0	0.1	2.5	4.4	6.3	0.0	5.9
1937	112.2	0.0	1.5	4.9	7.7	10.7	0.0	9.5
1938	57.3	0.2	1.8	4.6	8.9	13.8	0.0	24.1
1939	48.1	0.0	0.2	1.8	4.8	8.7	0.0	18.1
1940	56.5	0.0	0.3	1.7	3.4	5.2	7.0	9.2
1941	68.3	0.0	0.4	2.1	3.3	5.2	7.4	7.6
1942	83.7	0.5	2.3	7.0	10.7	12.7	15.0	15.2
1943	109.2	0.0	1.0	3.8	7.1	10.6	14.0	9.7
1944	134.2	0.1	2.3	5.8	9.8	13.7	17.5	10.2
1945	135.2	1.8	4.8	6.8	11.2	15.2	19.2	11.2
1946	161.7	1.1	3.8	6.9	11.2	15.6	19.9	9.6
1947	227.6	1.5	6.5	12.8	21.2	29.0	37.0	12.7
1948	198.8	3.2	10.2	17.7	25.5	33.7	41.3	17.0
1949	175.5	1.8	5.5	9.8	14.9	23.7	32.4	13.5
1950	179.1	1.2	4.8	9.8	16.0	22.8	29.6	12.7
1951	190.2	0.8	2.8	6.2	13.5	20.8	27.6	10.9
1952	192.0	0.2	1.5	3.4	6.4	10.4	14.4	5.4
Ave.	122.0	0.6	2.6	5.7	9.6	13.9	14.1	11.4

1/ Unweighted means based on mid-month premiums from Great Falls Tribune, 1933-1952 (Calendar year).

Table V. Mid-month Base Price and Protein Premium of No. 1 Heavy Dark Northern and Northern Red Spring Wheat, by Months, 1933-1952. 1/

1933

MONTH	BASE PRICE NO. 1 HVY.	PROTEIN PREMIUM IN CENTS						
	Dollar	Under 12%	12%	13%	14%	15%	16%	Over 16%
JAN.	.18	0	2	4	6	8	10	
FEB.	.21	0	0	2	4	6	8	
MAR.	.24	0	0	2	4	6	8	
APR.	.38	0	0	2	4	6	8	
MAY	.45	0	2	3	5	9	12	
JUNE	.44	0	0	2	4	8	10	
JULY	.88	0	0	0	2	6	8	
AUG.	.59	0	0	0	2	4	6	
SEPT.	.60	0	0	0	0	2	4	
OCT.	.39	0	0	0	0	2	4	
NOV.	.58	0	0	0	0	1	2	
DEC.	.52	0	0	0	0	3	5	
TOTAL	5.46	0	4	15	31	61	85	
AVE.	.455	0	.3	1.2	2.6	5.1	7.1	

1934

MONTH	BASE PRICE NO. 1 HVY.	PROTEIN PREMIUM IN CENTS						
	Dollar	Under 12%	12%	13%	14%	15%	16%	Over 16%
JAN.	.62	0	0	0	0	3	5	
FEB.	.61	0	0	0	0	3	5	
MAR.	.59	0	0	0	1	4	6	
APR.	.53	0	0	0	1	4	6	
MAY	.62	0	0	0	1	4	6	
JUNE	.72	0	0	0	1	2	4	
JULY	.77	0	0	0	1	3	5	
AUG.	.87	0	0	0	0	2	4	
SEPT.	.87	0	0	0	1	2	4	
OCT.	.83	0	0	0	0	2	4	
NOV.	.81	0	0	0	2	3	6	
DEC.	.82	0	0	1	4	5	10	
TOTAL	8.66	0	0	1	12	37	65	
AVE.	.722	0	0	.1	1.0	3.1	5.4	

1/ Price quotations from Great Falls Tribune.

Table V (Cont.).

1935

MONTH	BASE PRICE NO. 1 HVY.	PROTEIN PREMIUM IN CENTS						
	Dollar	Under 12%	12%	13%	14%	15%	16%	Over 16%
JAN.	.79	0	0	2	4	6	10	
FEB.	.80	0	0	2	5	10	14	
MAR.	.77	0	0	1	3	4	8	
APR.	.87	0	0	1	3	6	10	
MAY	.86	0	0	1	2	4	8	
JUNE	.66	0	0	1.5	4	6	10	
JULY	.77	0	0	2	4	8	12	
AUG.	.91	0	0	0	2	4	6	
SEPT.	1.03	0	0	0	0	0	0	
OCT.	.97	0	0	0	0	0	0	
NOV.	.96	0	0	0	0	1	3	
DEC.	.95	0	0	0	0	1	3	
TOTAL	10.34	0	0	10.5	27	50	84	
AVE.	.862	0	0	.9	2.2	4.2	7.0	

1936

MONTH	BASE PRICE NO. 1 HVY.	PROTEIN PREMIUM IN CENTS						
	Dollar	Under 12%	12%	13%	14%	15%	16%	Over 16%
JAN.	1.00	0	0	0	2	4	6	
FEB.	1.00	0	0	0	2	4	6	
MAR.	.96	0	0	0	2	4	6	
APR.	.89	0	0	0	2	4	6	
MAY	.83	0	0	0	2	4	5	
JUNE	.98	0	0	0	2	4	6	
JULY	1.15	0	0	1	8	9	11	
AUG.	1.22	0	0	0	2	4	6	
SEPT.	1.10	0	0	0	2	4	6	
OCT.	1.14	0	0	0	2	4	6	
NOV.	1.22	0	0	0	2	4	6	
DEC.	1.39	0	0	0	2	4	6	
TOTAL	12.88	0	0	1	30	53	76	
AVE.	1.073	0	0	.1	2.5	4.4	6.3	

Table V (Cont.).

1937

MONTH	BASE PRICE NO. 1 HVY.	PROTEIN PREMIUM IN CENTS						
	Dollar	Under 12%	12%	13%	14%	15%	16%	Over 16%
JAN.	1.42	0	0	2	6	8	10	
FEB.	1.46	0	0	2	6	8	10	
MAR.	1.32	0	0	2	6	8	10	
APR.	1.31	0	0	2	6	8	10	
MAY	1.22	0	0	2	6	8	10	
JUNE	1.18	0	0	2	6	8	10	
JULY	1.23	0	0	2	6	8	10	
AUG.	1.05	0	0	0	2	4	6	
SEPT.	.90	0	0	0	2	6	10	
OCT.	.85	0	0	0	2	6	10	
NOV.	.75	0	0	2	6	11	17	
DEC.	.78	0	0	2	4	9	15	
TOTAL	13.47	0	0	18	59	92	128	
AVE.	1.122	0	0	1.5	4.9	7.7	10.7	

1938

MONTH	BASE PRICE NO. 1 HVY.	PROTEIN PREMIUM IN CENTS						
	Dollar	Under 12%	12%	13%	14%	15%	16%	Over 16%
JAN.	.87	0	0	2	4	9	15	
FEB.	.78	0	0	2	4	9	15	
MAR.	.71	0	0	1	3	9	15	
APR.	.69	0	0	5	7	13	19	
MAY	.61	0	0	3	5	11	17	
JUNE	.73	0	0	1	3	9	15	
JULY	.54	0	0	3	8	16	22	
AUG.	.37	0	2	4	6	8	10	
SEPT.	.41	0	0	1	9	7	12	
OCT.	.38	0	0	0	2	6	10	
NOV.	.39	0	0	0	2	5	8	
DEC.	.40	0	0	0	2	5	8	
TOTAL	6.88	0	2	22	55	107	166	
AVE.	.573	0	.2	1.8	4.6	8.9	13.8	

Table V (Cont.).

1939

MONTH	BASE PRICE NO. 1 HVY.	PROTEIN PREMIUM IN CENTS						
	Dollar	Under 12%	12%	13%	14%	15%	16%	Over 16%
JAN.	.43	0	0	0	1	5	8	
FEB.	.42	0	0	0	2	5	8	
MAR.	.40	0	0	0	2	7	10	
APR.	.41	0	0	0	2	6	11	
MAY	.51	0	0	0	0	4	9	
JUNE	.47	0	0	0	3	6	11	
JULY	.40	0	0	0	3	6	12	
AUG.	.39	0	0	2	6	10	14	
SEPT.	.58	0	0	0	2	4	8	12
OCT.	.51	0	0	0	1	2	5	7
NOV.	.55	0	0	0	0	1	4	6
DEC.	.70	0	0	0	0	1	4	6
TOTAL	5.77	0	0	2	22	57	104	
AVE.	.481	0	0	.2	1.8	4.8	8.7	

1940

MONTH	BASE PRICE NO. 1 HVY.	PROTEIN PREMIUM IN CENTS						
	Dollar	Under 12%	12%	13%	14%	15%	16%	Over 16%
JAN.	.70	0	0	0	0	1	2	4
FEB.	.67	0	0	0	2	3	4	6
MAR.	.68	0	0	0	0	1	2	3
APR.	.76	0	0	0	0	1	2	3
MAY	.55	0	0	0	0	1	2	3
JUNE	.51	0	0	0	2	4	7	9
JULY	.46	0	0	2	5	7	10	12
AUG.	.40	0	0	2	6	8	10	12
SEPT.	.43	0	0	0	4	6	8	10
OCT.	.53	0	0	0	2	4	6	8
NOV.	.55	0	0	0	0	3	5	7
DEC.	.52	0	0	0	0	3	5	7
TOTAL	6.78	0	0	4	20	41	63	84
AVE.	.565	0	0	.3	1.7	3.4	5.2	7.0