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An Economic Analysis of the Domestic Demand for Wheat by Class in the United States

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HIGHLIGHTS

Wheat has been treated as a homogeneous product in most previous studies analyzing the demand for wheat. Actually, there are considerable differences among the different classes of wheat with respect to quality, growing season, and other characteristics which determine use in the manufacturing of various wheat products.

The per capita disappearances of the various classes of wheat declined over time with the exception of slight increases for hard red winter wheat, white wheat, and durum wheat in 1964 and 1965. The per capita disappearances of soft red winter wheat and white wheat were closely related as indicated by a correlation coefficient of .9027. The per capita disappearances for all classes of wheat were positively correlated.

The demand for hard red spring wheat was inversely related to the price of hard red spring wheat and the price of hard red winter wheat. The demand for hard red winter wheat was directly related to the price of hard red spring wheat. The high substitutability of the hard wheats was indicated.

The demand for soft red winter wheat was inversely related to time and the price of white wheat positively related to the per capita production of soft red winter wheat. These relationships indicate that soft wheats are complementary products.

The demand for white wheat was inversely related to the price of white wheat. No relationship was evident between white wheat and the other classes of wheat.

The demand for durum wheat was inversely related to the price of durum wheat and directly related to the production of durum wheat, hard red spring wheat, and hard red winter wheat. These relationships indicate that the demand for durum is closely related to production of hard wheats.

The demand for hard red spring wheat was projected for 1970 by use of regression analysis and percentage change. The regression technique, applied to data representing 15 years, indicated a decline in the domestic demand for hard red spring wheat on the basis of a 15-year trend. When using percentage change over the last five years, it was found that the domestic demand for hard red spring wheat will increase.

The consumption of white flour by households in the United States declined as household incomes increased; whereas, the consumption of prepared flour mixes increased with household incomes. The consumption of cold wheat cereals increased with household income; however, the consumption of hot wheat cereals was not significantly affected by household income. The consumption of macaroni, spaghetti, and noodles by households increased as their incomes increased. The consumption of bread and other bakery products also increased as household incomes increased.

Generally, the household consumption of wheat products within regions of the United States was similar to the average household consumptions for the United States. The household consumption of macaroni, spaghetti, and noodles was inversely related to income changes in the Northeast region. The household consumption of hot wheat cereals was inversely related to income changes in the Western region.

The average incomes of households in the United States have increased over time. Households consumed less white flour and more prepared mixes and bakery goods as their incomes increased. The net result was a 10 percent decline in the average household consumption of wheat products; however, the number of households has increased 14.4 percent. Thus, the consumption of wheat products has increased slightly from 1955 through 1965.

Soft red winter wheat was purchased in the East North Central and East South Central regions of the United States and was projected to increase by 10 million bushels from 1970 to 1975. Hard red winter wheat and hard red spring wheat were purchased in nearly every region. Projections from a 15-year trend for the hard wheats indicated little change in wheat purchases. White wheat was purchased in the Western and East North Central regions of the United States and was projected to increase in the East North Central region. Durum wheat was purchased in the West and North Central regions in the United States and was projected to increase slightly. Increases in wheat purchases generally followed population trends.

AN ECONOMIC ANALYSIS OF THE DOMESTIC DEMAND FOR WHEAT BY CLASS IN THE UNITED STATES

David C. Nelson and Robert G. Thompson*

Wheat is divided into five major classes which are produced in five regions in the United States. There are important differences with respect to quality, growing season, and other characteristics among the different classes of wheat. Each class of wheat has certain characteristics which determine its use in the making of various wheat products.

Hard red spring wheat and hard red winter wheat are used primarily in the manufacture of bread flour because of the high gluten content found in these two classes.[1] Soft red winter wheat and soft white wheat are both generally low in protein, and, because of this characteristic, are especially suitable in the manufacture of pastries, crackers, biscuits, and cakes.[2] Durum wheat is processed into semolina, which is used in making macaroni, spaghetti, and other pasta products.[3]

The production of wheat in the United States averaged 1,286.5 million bushels per year over the years 1958 through 1967. The total domestic disappearance of wheat averaged 596.8 million bushels per year for 1957 to 1963 and 684.9 million bushels per year for 1964 to 1966.[4]

The annual per capita demand for wheat in the United States has been declining during the last 20 years. This is indicated by a near constant annual total domestic demand for wheat and an increasing population of the United States.

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[1]Kahlon, Avtar Singh, The Domestic Demand and Price Structure for Different Classes of Wheat in the United States, Unpublished Ph. D. Dissertation, Department of Agricultural Economics, Kansas State University, 1961, p. 1.

[2]Ibid., p. 1.

[3]Ibid.

[4]U. S. Department of Agriculture, Handbook of Agricultural Charts 1967, Washington, D. C., October 1967, p. 87.

There are certain factors that cause this per capita domestic demand to decline, such as consumer incomes and consumer tastes and preferences. It is important to know what factors have caused the decline in the per capita domestic demand for wheat and evaluate the impact this decline will have on the wheat producer of the United States. Identification and the knowledge of the relative importance of these variables will enable society to make the necessary adjustments when determining the future location and level of resources employed in the production of wheat.

Purpose of the Study

The purpose of this study is to determine the total and regional domestic demands for the five basic classes of wheat and to determine the most important factors that affect these demands. Projection of identified trends will be made for the demand for wheat by class.

Several factors, such as quality, substitutability, consumer income and population have been associated with the domestic demand for wheat by class. The effect of these factors on the demand for each class of wheat indicates how the demand for that particular class of wheat would react to future changes in these factors.

The various classes of wheat are produced in five major areas. Flour millers blend different classes of wheat in order to produce a uniform finished product. Thus, wheat produced domestically is transported from one region for consumption in another.[5] The regional demand for wheat by class will be important when determining an optimum least-cost distribution pattern for the various classes of wheat produced in the United States.

The consumption of wheat for human use in the form of wheat products is considered more extensively in this study than consumption for seed, feed, and industrial uses. In 1966, 526.3 million bushels or 71.9 percent of the total wheat consumed domestically were used for food.[6] Location and changes in the consumption of wheat products will have a large effect on the demand for wheat.

Objectives

The major objective of this study is to identify and analyze the demand for the five major classes of wheat. The specific objectives of this study are:

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[5]Consumption in this case is defined as the amount of wheat used by millers to manufacture wheat products.

[6]U. S. Department of Agriculture, Agricultural Statistics 1966, Washington, D. C., 1966.

1. To review the past and present total domestic demand for the several classes of wheat.

2. To determine what variables have affected the demand for the several classes of wheat.

3. To determine trends in the consumption of a variety of wheat products by households.

4. To project future changes in the consumption of these products.

5. To review the past and present total demand for the several classes of wheat in 17 subregions of the United States by wheat processors.

6. To make projections of the trends in the consumption of the various classes of wheat in each of the 17 subregions by wheat processors.

Method of Study

The demand for wheat was studied with respect to the total United States' demand, the household demand, and the wheat processor demand. Each of these demands was analyzed separately.

The total domestic demand for wheat was analyzed by the use of regression techniques.[7] The per capita disappearance of each of the various classes of wheat for 1947 through 1966 is employed as dependent variables. Independent variables for 1947 through 1966 consisted of yearly average price, per capita production, protein, deflated per capita disposable income, and time (1947 = 1). The data for the previously listed variables were developed from various publications of the U. S. Department of Agriculture.

The qualities of the various classes of wheat were compared in determining the effect of quality on the consumption of different wheat products. The per capita consumption of many wheat products by households is affected by income either directly or inversely. Because of this, regression analysis was applied to consumption and income figures found in Food Consumption of Households in the United States,[8] to

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[7]Regression techniques are statistical methods employed to test the relationship between the quantities of one variable called the dependent variable in response to changes in quantities of one or more variables called independent variables where variable symbolizes a set of values of specific activities.

[8]Agricultural Research Service, Food Consumption of Households in the United States, U. S. Department of Agriculture, Washington, D. C., 1956 and 1967.

determine trends in household consumption of wheat products in response to varying levels of income.

The consumption of each class of wheat by wheat processors in 17 regions of the United States was determined through mailed questionnaires. The amount of each class of wheat processed in each region, as reported by the questionnaires returned, was expanded to estimate the total amount of wheat processed in that region by use of a multiplier. This multiplier is the ratio of the total wheat processed in that region divided by the amount of wheat reported by the questionnaires returned. Each class of wheat was examined with respect to the past and present consumption of that class in each region and with respect to the past and present consumption of that class in proportion to the total wheat processed in each region.

Domestic Demand for Different Classes of Wheat

The demand for wheat is defined as the various quantities of wheat that consumers will take off the market at all possible alternative prices in a given period of time. Each class of wheat has a separate demand with substitution possible with certain other classes. Within each class of wheat there are several demand alternatives:

1. Domestic demand for wheat as a human food.
2. Demand for wheat as livestock feed.
3. Export demand for wheat.
4. Demand for wheat in industrial uses.
5. Demand for wheat for seed.
6. Demand for wheat for storage.

The purpose of this analysis is to determine what factors affect the domestic demand for each class of wheat and to determine how these factors have changed from 1947 to 1966 and are expected to change in the future. The domestic demand for hard red spring wheat will be projected into the future.

Domestic Demand Analysis

The following analysis of the domestic disappearance of wheat assumes that wheat carryover is dependent upon the domestic disappearance of wheat and the export demand for wheat. Wheat not used domestically or exported is considered carryover. The domestic disappearance of wheat was composed of wheat used for food, feed, seed, and industrial purposes in the United States. The amount of wheat used for seed was related to the total domestic disappearance and varied only slightly from year to year. The amount of wheat used for industrial purposes amounts to less than one million bushels of wheat per year with little variation between years. Thus, most changes in domestic disappearance were a

response to changes in the demand for human food and animal feed which in turn varied with respect to each class of wheat.

Per Capita Disappearance of Different Classes of Wheat

The dependent variables used in this analysis are the per capita domestic disappearances of each class of wheat (Table 1). Hard red winter wheat accounts for a large proportion of the total per capita disappearance of all classes of wheat with 1.49 bushels in 1966. The per capita disappearance of hard red spring wheat and soft red winter wheat comprised about the same amount of the total with .71 and .73 bushels, respectively, in 1966. The per capita disappearance of white wheat and durum wheat, respectively, was proportionately less than all other classes of wheat with .33 and .23 bushels, respectively, in 1966.

The per capita disappearance of hard red spring wheat declined from 1947 to 1961 and remained relatively constant from 1961 to 1966. The per capita disappearance of hard red winter wheat indicated a declining trend with the exception of 1965. The per capita disappearance of soft red winter wheat was declining from 1947 to 1959 and remained relatively constant from 1959 to 1966. The per capita disappearance of white wheat has been constantly declining with the exception of 1964 through 1966. The per capita disappearance of durum was .05 bushels in 1954 and .25 bushels in 1965.

The relationships among the dependent variables were determined by use of correlation coefficients. The correlation coefficients between the dependent variables indicate the similarity of fluctuation between classes. The per capita disappearances of all the classes of wheat were positively correlated (Table 2). The correlation coefficient between white wheat and soft red winter wheat was very high at .90, while the correlation coefficients between white wheat and hard red winter wheat and hard red spring wheat were fairly high. On the other hand, the correlation coefficients between durum and hard red spring wheat and soft red winter wheat were low.

Factors Affecting Demand

The quantity demanded of a normal product is inversely related to its price.[9] The demand for that product is affected by various factors, such as:

1. Tastes and preferences of consumers.
2. Money incomes of consumers.
3. Prices of related goods.
4. Consumer expectations with respect to future prices and incomes.
5. Number of consumers in the market.

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[9]A change in demand must not be confused with a change in quantity demanded. A change in the quantity demanded is a direct result of a change in price. A change in demand is a direct result of a change in other factors called determinants.

TABLE 1. PER CAPITA DISAPPEARANCE FIGURES ON WHEAT, BY CLASSES, UNITED STATES, 1947-1966[a]

Year Beginning July	Hard Red Winter	Hard Red Spring	Soft Red Winter	White	Durum
			(bushels)		
1947	2.2480	1.0685	1.0893	.6522	.2012
1948	1.6299	.9343	1.1526	.6752	.2319
1949	1.8500	.9451	1.0390	.5228	.2011
1950	1.9646	.9889	.8900	.4944	.1912
1951	1.6074	1.2250	.8750	.5315	.2009
1952	1.5355	1.1150	.8346	.5224	.1784
1953	1.6357	.9087	.8962	.4136	.1003
1954	1.5272	.8867	.8806	.4403	.0493
1955	1.4400	.9197	.8289	.3449	.0847
1956	1.3970	.8322	.7966	.3091	.1308
1957	1.4013	.7765	.7765	.2919	.1576
1958	1.4471	.8441	.7867	.2584	.1608
1959	1.5191	.7624	.7455	.2541	.1412
1960	1.4390	.8025	.7416	.2269	.1439
1961	1.5564	.7075	.7292	.2177	.1088
1962	1.3340	.7125	.7286	.2197	.1339
1963	1.3146	.6969	.7180	.1953	.1425
1964	1.4262	.7131	.7443	.3383	.1614
1965	1.7628	.7195	.7144	.3186	.2518
1966	1.4936	.7112	.7316	.3302	.2286

[a]Total domestic disappearance divided by total U. S. population.

Source: U. S. Department of Agriculture, Agricultural Marketing Service, Wheat Situation, Washington, D. C., 1948-1967. Economic Report of the President, Washington, D. C., January 1967, p. 32.

TABLE 2. CORRELATION COEFFICIENTS OF PER CAPITA DISAPPEARANCE FOR WHEAT BETWEEN CLASSES IN THE UNITED STATES, 1947-1966

Class	HRW	HRS	SRW	White	Durum
HRW	1				
HRS	.5111	1			
SRW	.6595	.6447	1		
White	.7075	.7926	.9027	1	
Durum	.4398	.1723	.2625	.4373	1

Analysis of the factors affecting the demand for each class of wheat must include each of these determinants to the extent possible. Tastes and preferences were difficult to measure. The consumer indirectly expresses demand for the various classes of wheat through the purchase of various wheat products. The proportions of each class of wheat used in the various wheat products are determined by the wheat processor who attempts to satisfy the tastes and preferences of the consumer.

The processor considers the quality and price of each class of wheat when determining which class of wheat he will purchase. Quality was expressed through protein content of hard red winter wheat and hard red spring wheat for the years 1947-1966 (Table 3). The protein content of hard red spring wheat and hard red winter wheat fluctuated widely from year to year.[10] The general trend of the protein content of hard red spring is gradually increasing. On the other hand, the protein content of hard red winter declined during the period from 1947 to 1966. The price of wheat reflects some effects of government programs. Thus, it was necessary to include per capita production in this analysis. Production was used in per capita form to maintain consistency of measurement with the dependent variables.

The proportions of wheat produced by class remained fairly stable for the years 1962 through 1966 (Table 4). The production of hard red winter wheat was 51 percent of the total production in 1966; whereas, soft red winter wheat, hard red spring wheat, and white wheat each accounted for 16, 14, and 14 percent, respectively, of the total production of wheat in 1966. The production of durum was 5 percent of the total production of wheat in 1966.

The per capita production of hard red winter wheat varied considerably between years (Table 5). The per capita production of hard red spring wheat fluctuated much less than hard red winter wheat. The per capita production of soft red winter wheat averaged slightly greater than the per capita production of white wheat. The per capita domestic consumption of soft red winter wheat was approximately two times greater than the per capita consumption of white wheat. The difference between the two consumptions is because of the export demand for white wheat. White wheat is produced near export points and averaged two times the exports of soft red winter wheats for the years 1962 through 1966.

The per capita production of durum wheat has fluctuated considerably with a low of .03 bushels in 1954. The 1962 per capita production of durum wheat was 3.28 times that of 1961 when it was .11 bushel.

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[10]The protein content of hard red spring wheat was for North Dakota from 1963 to 1966. Earlier years were for all hard red spring wheat.

TABLE 3. PROTEIN CONTENT OF HARD RED SPRING WHEAT AND HARD RED WINTER WHEAT, UNITED STATES, 1947-1966

Year Beginning July	Hard Red Spring[a]	Hard Red Winter[b]
	(percent)	
1947	14.037	11.8
1948	13.387	12.4
1949	13.600	12.8
1950	13.087	12.4
1951	13.878	11.9
1952	13.748	11.1
1953	13.160	13.5
1954	14.005	12.3
1955	13.908	12.5
1956	13.943	14.1
1957	14.520	12.0
1958	13.877	11.8
1959	14.747	12.5
1960	14.855	11.5
1961	14.979	10.7
1962	13.300	11.7
1963	14.400	12.1
1964	14.700	12.2
1965	14.400	11.3
1966	15.200	12.2

[a]Weighted averages, 1947-1961. Average protein of North Dakota hard red spring wheat, 1962-1966.

[b]Average protein content of Kansas hard red winter wheat, 1947-1966.

Source: Physical, Chemical, and Baking Properties of Carlot Receipts of Wheat, Report 356, Agricultural Marketing Service, U. S. Department of Agriculture, 1947-1963. Sibbitt, L. D., and Gilles, K. A., The Quality of North Dakota's 1966 Hard Red Spring Wheat, Department of Cereal Technology, North Dakota State University, p. 10. Kansas Wheat Quality in 1967, Kansas Wheat Commission, p. 24.

TABLE 4. PROPORTIONS OF TOTAL WHEAT PRODUCED BY CLASS, UNITED STATES, 1962-1966[a]

Year Beginning July 1 Ending June 30	Class of Wheat				
	Soft Red Winter	Hard Red Winter	Hard Red Spring	White	Durum
			(percent)		
1962	.1435	.4909	.1600	.1417	.0640
1963	.1918	.4772	.1410	.1453	.0447
1964	.1751	.4926	.1402	.1402	.0519
1965	.1380	.5124	.1590	.1387	.0520
1966	.1636	.5123	.1389	.1381	.0471

[a]Calculated from production figures.

Source: Yearbook Statistical Committee, Agricultural Statistics, U. S. Department of Agriculture, Washington, D. C., 1963-1967.

The exports of each class of wheat have not been proportionate to the production of each class. The exports of hard red winter wheat far exceeded the production of this class as a percent of the total produced. On the other hand, the exports of hard red spring wheat, soft red winter wheat, and durum wheat have accounted for much less than the proportionate share of production. Hard red winter wheat accounted for an average of 65.4 percent of the exports compared to a production of 49.7 percent (Table 6). This amounts to about 16 percent more exports than the proportionate share of the production of wheat. The exports of hard red spring wheat accounted for 6.5 percent of the total exported compared to 14.8 percent of the total production. Soft red winter wheat accounted for 8.2 percent of the exports compared to 16.2 percent of the total production. Durum wheat exports were 2.7 percent compared to 5.2 percent of the total production.

The money income of consumers is another important factor affecting the consumption of many wheat products. The type of product will determine the manner in which changes in income affect consumption. In most cases, increasing incomes cause increased consumption of the product. Some products considered "inferior" will be consumed without change or will decrease as income increased. This means that the good was either a necessity or that it could be substituted for as the consumers' purchasing power increased.

The demand for wheat used to produce all-purpose flour was higher with lower household incomes in the United States for 1955 and 1965. The demand for wheat used to produce prepared mixes and other convenience

TABLE 5. PER CAPITA PRODUCTION FIGURES ON WHEAT BY CLASSES, UNITED STATES, 1947-1966[a]

Year Beginning July	Soft Red Winter	Hard Red Winter	Hard Red Spring	White	Durum
			(bushels)		
1947	1.4560	5.1628	1.5286	.9696	.3116
1948	1.4420	4.4205	1.5388	1.1173	.3125
1949	1.3588	3.6297	1.1344	.9748	.2648
1950	1.0715	3.0254	1.3647	1.0084	.2502
1951	.9598	2.4777	1.6593	1.0781	.2299
1952	1.2323	4.6061	1.1556	1.1829	.1469
1953	1.4492	3.1611	1.3587	1.2961	.0866
1954	1.1363	3.0104	.8945	.9869	.0307
1955	1.0588	2.5110	1.1133	.8652	.1210
1956	1.1116	2.6513	1.0581	.9214	.2318
1957	.9050	2.5048	.9867	.9517	.2335
1958	1.1026	4.8007	1.3380	.9992	.1263
1959	.8810	3.5014	.8528	.9826	.1129
1960	1.0516	4.3944	1.0405	.8357	.1882
1961	1.0993	4.1033	.6313	.7728	.1143
1962	.8411	2.8770	.9376	.8304	.3750
1963	1.1562	2.8772	.8500	.8764	.2692
1964	1.1763	3.3104	.9421	.9421	.3487
1965	.9405	3.4949	1.0844	.9457	.3546
1966	1.0770	3.3733	.9144	.9094	.3099

[a]Total production divided by total U. S. population.

Source: U. S. Department of Agriculture, Agricultural Statistics, Washington, D. C., 1957-1966. Economic Report of the President, Washington, D. C., January 1967, p. 232.

TABLE 6. AVERAGE PROPORTION OF TOTAL WHEAT PRODUCTION AND TOTAL WHEAT EXPORTS BY CLASS, UNITED STATES, 1962-1966

Proportion of All Wheat	Class				
	Soft Red Winter	Hard Red Winter	Hard Red Spring	White	Durum
			(percent)		
Produced[a]	16.2	49.7	14.8	14.1	5.2
Exported	8.2	65.4	6.5	16.5	2.7

[a]Calculated from Table 3.

Source: Anderson, Donald E. and Clair W. Cudworth, Trends in the Flow of Wheat Exports in the World Market, Agricultural Economics Report No. 56, Department of Agricultural Economics, North Dakota State University, 1967, p. 22.

foods increased with higher household incomes. The deflated per capita disposable income has increased steadily during the years 1947 through 1966 (Table 7). Because of this steady increase with small fluctuations, this factor affects the consumption of wheat in nearly the same manner as introducing a time variable with 1947 = 1 and 1966 = 20. Thus, the use of deflated disposable income was a significant variable when used in conjunction with the time variable.

The prices of each class of wheat have had some effect on the per capita disappearance of wheat (Table 8). The price trends of hard red spring wheat and hard red winter wheat have had a tendency to fluctuate similarly. The difference between the prices for the two classes of wheat was partly due to premiums for hard red spring and partly to the difference in grades.[11] The prices of soft red winter wheat and white wheat also followed approximately the same trend fluctuations. The difference in grades accounts for a large part of the difference in price. There were large fluctuations in the price of durum. The per capita disappearance and the per capita production of durum also indicated large fluctuations. The price of No. 2 durum at Minneapolis was $3.92 in 1954 and $1.68 in 1965.

[11]Prices of No. 1 Hard Red Winter at Kansas City are not available in published form prior to 1961. Therefore, it is not possible to determine how much of the difference in price is due to premiums and how much is due to difference in grades.

TABLE 7. DEFLATED PER CAPITA DISPOSABLE INCOME, UNITED STATES, 1947-1966[a]

Year	Deflated Per Capita Disposable Income
	(dollars)
1947	1,514.14
1948	1,539.38
1949	1,522.89
1950	1,627.68
1951	1,623.20
1952	1,641.08
1953	1,698.50
1954	1,693.38
1955	1,785.64
1956	1,840.55
1957	1,837.76
1958	1,818.27
1959	1,876.85
1960	1,878.76
1961	1,903.07
1962	1,958.25
1963	2,001.87
1964	2,101.76
1965	2,193.81
1966	2,269.67

[a]Per capita disposable income was deflated through dividing by consumer price index (1957-1959 = 100).

Source: Economic Report of the President, Washington, D. C., January 1967, pp. 232 and 262.

Consumer expectations with respect to future prices and incomes were a difficult variable to measure. It was assumed that consumer expectations would not have a significant effect on the demand for wheat and, therefore, were not considered in this analysis. The wheat processor must purchase a certain amount of wheat each year. The volume of purchases is dependent upon the demand for that processor's product and the storage capacity for wheat available.

The number of consumers in the market will affect the demand for wheat. The summation of the per capita consumption of each consumer comprises the total demand for wheat for human consumption. Because the analysis employs per capita data, the number of consumers in the market was not used as an independent variable.

TABLE 8. AVERAGE PRICES OF THE DIFFERENT CLASSES OF WHEAT, UNITED STATES, 1947-1966

Year	Dark Northern Spring No. 1 Minneapolis	Hard Red Winter No. 2 Kansas City	Soft Red Winter No. 2 St. Louis	White No. 1 Portland	Durum No. 2 Minneapolis
			(dollars)		
1947	2.88	2.52	2.45	2.50	2.89
1948	2.37	2.19	2.19	2.20	2.35
1949	2.37	2.16	1.91	2.19	2.30
1950	2.46	2.28	2.20	2.23	2.40
1951	2.50	2.43	2.23	2.42	2.51
1952	2.50	2.32	2.16	2.39	2.92
1953	2.57	2.27	1.92	2.31	3.49
1954	2.68	2.37	2.05	2.36	3.92
1955	2.48	2.18	2.00	2.19	2.79
1956	2.42	2.21	2.11	2.41	2.59
1957	2.40	2.15	2.20	2.26	2.41
1958	2.24	1.94	1.95	2.02	2.36
1959	2.26	2.00	1.87	2.00	2.46
1960	2.16	1.94	1.84	2.04	2.32
1961	2.40	2.05	1.95	2.10	3.20
1962	2.47	2.25	1.95	2.17	2.56
1963	2.34	1.94	1.73	3.08	2.35
1964	1.79	1.57	1.43	1.51	1.69
1965	1.80	1.60	1.50	1.53	1.68
1966	1.95[a]	1.79[a]	1.57[a]	1.76	2.05[a]

[a]Estimated from figures in Grain Marketing News, July 7, 1967, pp. 8-12.

Source: Commodity Research Bureau, Inc., Commodity Year Book, 1958-1967. U. S. Department of Agriculture, Agricultural Statistics, Washington, D. C., 1966, p. 15.

Relationship of Price to Quantity

The degree to which variation and trend in per capita disappearance is related to change in price can be used to generate insight into a specific demand function. In order to determine this relationship, statistical methods were used. In the case of each class several variables, including price, were regressed on the per capita disappearance to determine the most relevant variables in explaining variation or trend in per capita disappearance. (See appendix for list of dependent and independent variables and the mathematical equations developed for regression by class).

Hard Red Spring Wheat

It was felt that the period 1952 through 1966 was a more reliable time period to use to develop a specific demand function. Analysis of the period 1947 through 1966 did not produce a statistically significant relationship between price variation and per capita disappearance variation. Analysis of the shorter time period did produce a significant relationship between these variables.

The relationship between these variables indicated what was expected; that is, the consumer reacts rather indifferently to wide changes in price (Figure 1). In other words, the demand is very inelastic relative to price.

Hard Red Winter Wheat

The relationship between per capita disappearance of hard red winter wheat and price of hard red winter wheat was statistically insignificant. However, a statistically significant relationship did develop between per capita disappearance of hard red winter wheat and the price of hard red spring wheat. The regression coefficient (+.9587) indicates that nearly the same kind of relationship exists between per capita consumption of hard red winter wheat and price of hard red winter wheat as between per capita consumption of hard red spring wheat and the price of hard red spring wheat. That is, the consumer reacts very indifferently to changes in price of hard red winter wheat; and therefore, the demand for hard red winter wheat is highly inelastic. However, the positive relationship between these two variables also indicates that as the price of hard red spring wheat increases, substitution of hard red winter for hard red spring occurs at nearly a one-for-one ratio (Figure 2).[12]

Soft Red Winter Wheat

As in the case with hard red winter wheat, the analysis of this class of wheat indicates no statistically significant relationship between per capita disappearance and price. The dependent variable was statistically related to the price of white wheat which indicates that soft red winter and white wheat have acted as complementary products.

White Wheat

The per capita disappearance of white wheat was statistically significantly inversely affected by the price of white wheat. This indicates that consumers react directly to price changes in this class of wheat. The nature of the demand function derived from the analysis indicates a highly inelastic relationship between price and quantity demanded per capita (Figure 3).

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[12]This is a most interesting conclusion and since it is based upon data relationships, it deserves a good deal of further research.

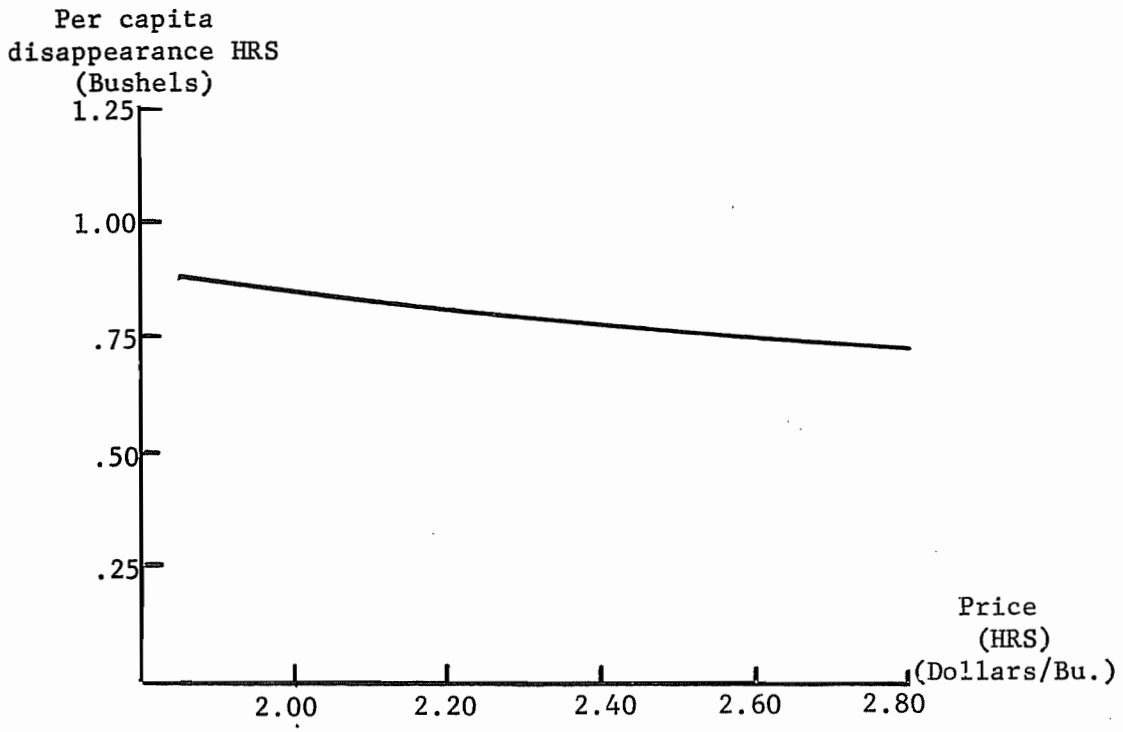

Figure 1. The Relationship Between Per Capita Disappearance of Hard Red Spring Wheat and the Price of Hard Red Spring Wheat, United States, 1952-1966.

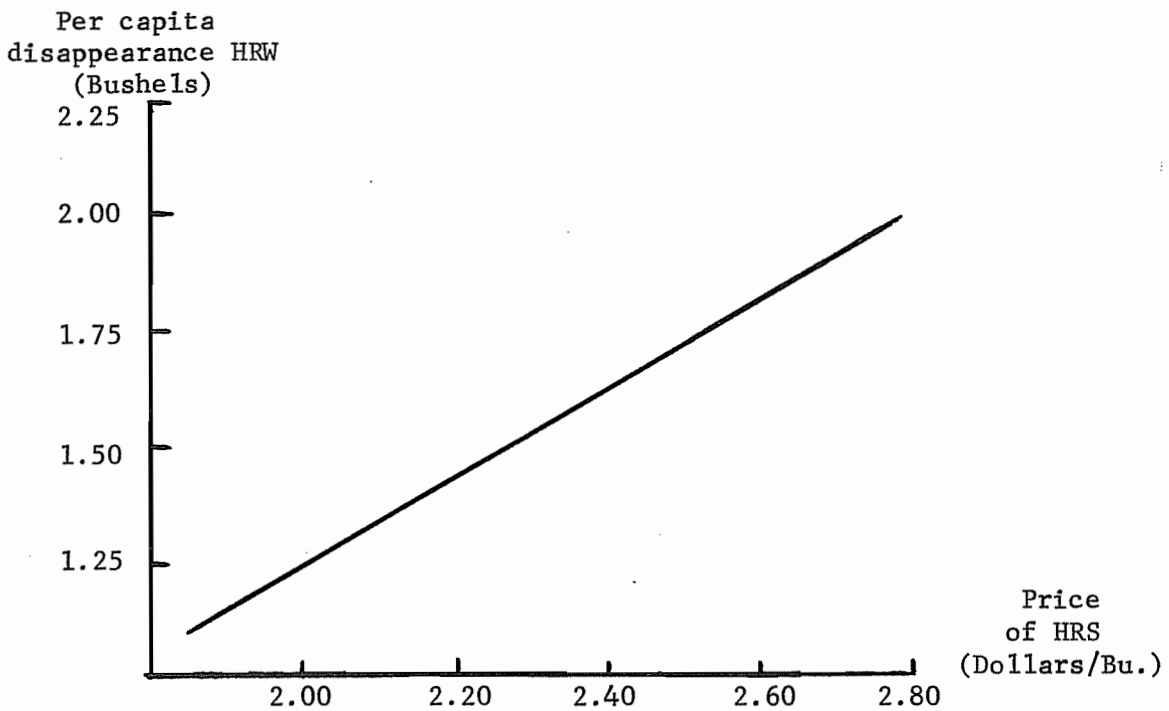

Figure 2. The Relationship Between Per Capita Disappearance of Hard Red Winter Wheat and the Price of Hard Red Spring Wheat, United States, 1947-1966.

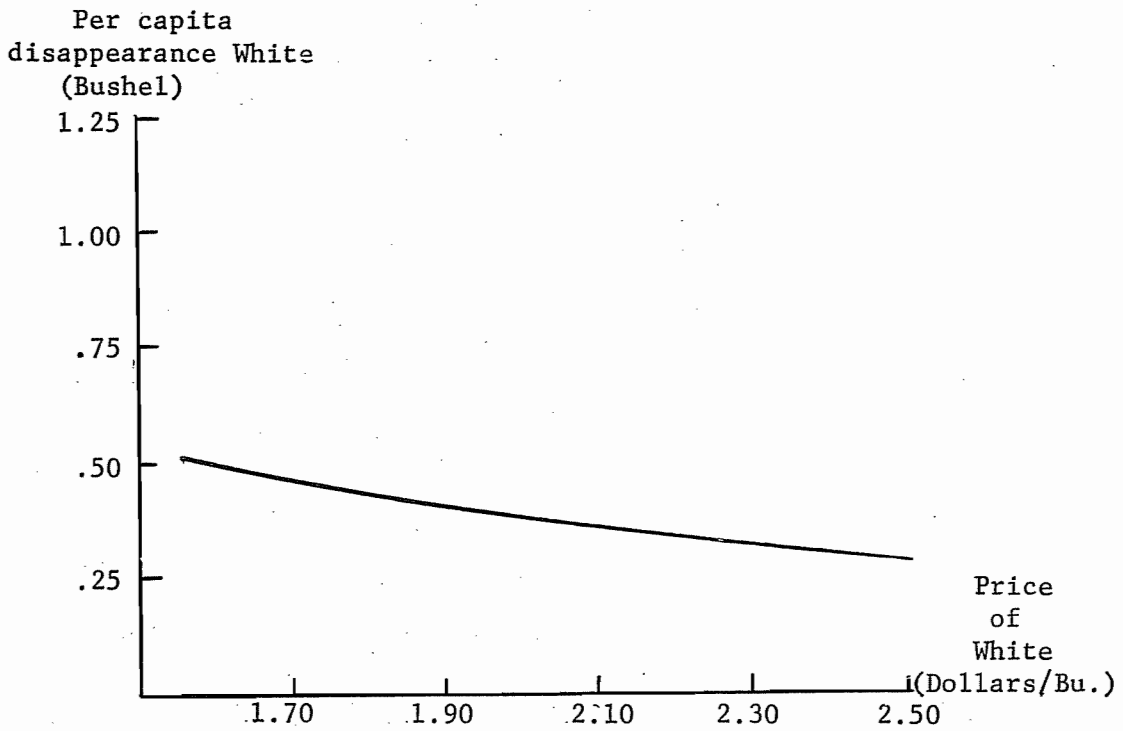

Figure 3. The Relationship Between Per Capita Disappearance of White Wheat and the Price of White Wheat, United States, 1947-1966.

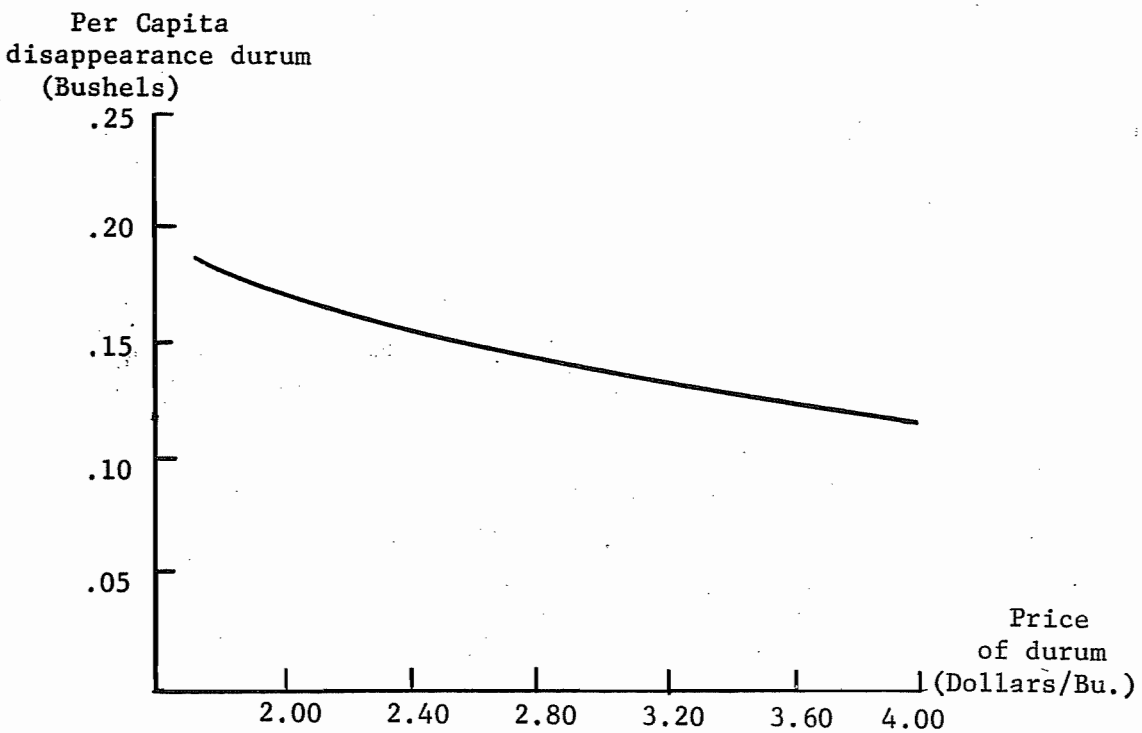

Figure 4. The Relationship Between Per Capita Disappearance of Durum Wheat and the Price of Durum Wheat, United States, 1947-1966.

Durum Wheat

The per capita disappearance of durum wheat was statistically significantly inversely affected by the price of durum wheat. This indicates that consumers react directly to price changes in this class of wheat. The nature of the demand function indicates a highly inelastic relationship between price and quantity demanded per capita (Figure 4).

Projected Demand for Hard Red Spring

In order to estimate future demand for hard red spring wheat, the statistical equation was reduced to two independent variables; price and time. The total explained variation (.91) employing these two variables was great enough to assume that the variation in price and changes in tastes due to time would explain nearly all the variation in per capita disappearance. Pursuing this hypothesis further indicates that the variation in price (holding time constant) only explains about 34 percent of the variation in per capita disappearance while the variation (change) in time (holding price constant) explains about 87 percent of the variation in per capita disappearance of hard red spring wheat. Thus the statistical equation appears logical. Since the per capita quantity demanded of hard red spring responds only slightly to wide changes in price, other variables must explain any wide variations in per capita demanded and that variable is likely associated with change in time; that is, tastes, income, and substitute product prices.

Projection of demand for hard red spring through 1970 then could be accomplished by assuming the 1970 demand function would resemble the 1966 demand function. The aggregate demand for each year could then be determined by merely multiplying demand by the 1966 population and by the projected population for 1970 (Table 9).

The data representing 1970 indicate a decrease in demand for hard red spring wheat caused by net changes in the determinants of demand as expressed by the time variable.

The projection on the following page was developed from data representing the per capita disappearance of hard red spring wheat for the period 1952 through 1966. Earlier years showed a downward trend in the per capita disappearance of hard red spring wheat; however, during the last five years of this period, the per capita disappearance of hard red spring wheat has been relatively stable.

Thus, a better method of projecting the per capita disappearance of hard red spring wheat would be the percentage changes over the most recent years. Since 1960, the per capita disappearance of hard red spring wheat has remained pretty constant at .71 bushels. Therefore, assuming prices do not change radically through 1970, the total domestic disappearance of hard red spring wheat in 1970 will be greater than in 1966 (Table 10).

TABLE 9. PER CAPITA AND TOTAL DISAPPEARANCE OF HARD RED SPRING WHEAT WITH RESPECT TO DIFFERENT PRICES FOR 1966 AND PROJECT TO 1970

	Disappearance			
	Per Capita		Total	
Price	1966	1970	1966	1970
	(bushels)		(000 bushels)	
1.50	.7574	.7016	149,442	146,282
1.60	.7399	.6854	145,644	142,564
1.70	.7239	.6706	142,487	139,475
1.80	.7091	.6568	139,573	136,623
1.90	.6953	.6441	136,872	133,979
2.00	.6828	.6323	134,358	131,518
2.10	.6706	.6212	132,010	129,219
2.20	.6595	.6109	129,809	127,064
2.30	.6490	.6012	127,740	125,039
2.40	.6390	.5920	125,790	123,130
2.50	.6297	.5833	123,947	121,327

TABLE 10. PER CAPITA AND TOTAL DISAPPEARANCE OF HARD RED SPRING WITH RESPECT TO DIFFERENT PRICES FOR 1966 AND 1970, FOR THE UNITED STATES, PROJECTED BY PERCENTAGE CHANGES

	Disappearance			
	Per Capita		Total	
Price	1966	1970	1966	1970
	(bushels)		(000 bushels)	
1.50	.7574	.7574	149,442	157,282
1.60	.7399	.7399	145,644	153,899
1.70	.7239	.7239	142,487	150,563
1.80	.7091	.7091	139,573	147,484
1.90	.6953	.6953	136,872	144,631
2.00	.6828	.6828	134,358	141,975
2.10	.6706	.6706	132,010	139,493
2.20	.6595	.6595	129,809	137,168
2.30	.6490	.6490	127,740	134,982
2.40	.6390	.6390	125,790	132,920
2.50	.6297	.6297	123,947	130,973

An interesting observation from this analysis is that it appears that the average price elasticity over the years 1952 through 1966 was about -.36. This means that one percent change in the price of hard red spring wheat will, on the average, result in a .36 percent change in the opposite direction in per capita disappearance. Thus, if price were lowered for the sake of increasing quantity demanded, the total revenue would decline.

Consumption of Wheat Products for Food

There are several variables which affect the consumption of commercially processed wheat foods. These variables are subdivided according to whether they primarily affect supply or demand. Those variables which affect supply include technological changes, cost relationships, and marketing institutions and facilities; variables which affect demand include income, United States urbanization, home-food production, and employment and education of homemakers.[13]

The influence of demand variables on changes in the quantity consumed of processed foods cannot be studied directly with time-series data because such data concurrently reflect the effects of changes in supply. Sets of cross-sectional data derived from household food surveys provide indicators of the possible effects of changes in major demand variables.[14]

The demand for various wheat products with respect to income and urbanizations is indicated in a household food consumption survey during 1955 and 1965.[15] All urbanizations were used to show the effects of different levels of household income on the consumption of wheat products. The wheat products analyzed were:

1. Flour and other cereals (includes some corn products).

    a. Flour other than mixes.
    b. Prepared flour mixes.
    c. Cold wheat cereals.
    d. Hot wheat cereals.
    e. Macaroni, spaghetti, noodles.

2. Bakery products.

    a. Bread.
    b. Baked goods other than bread.

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[13]Agricultural Marketing Service, Consumption of Processed Farm Foods, Report No. 409, U. S. Department of Agriculture, Washington, D. C., June 1960, p. 29.

[14]Ibid.

[15]Agricultural Research Service, Food Consumption of Households in the United States, Report No. 1, U. S. Department of Agriculture, Washington, D. C., December 1956.

The Effect of Household Income on the Consumption of Wheat Products

The next two sections will be concerned with the relationship between income and the consumption of several wheat products in the United States and four subregions of the nation: the Northeast, the North Central, the South, and the West (Figure 5).

Consumption of Wheat Products in the United States

The "Household Food Consumption Surveys of 1955 and 1965" provide wheat product consumption data for the United States (Tables 11 and 12). All urbanizations or urban and rural were used with various incomes of individuals and households in the United States. The consumption of various wheat products was analyzed with respect to changes in income.

The relationship between income and consumption varied with respect to each particular wheat product. The correlation coefficients between income and consumption were good indicators of the average relationship but did not provide insight into the significance of income as a factor affecting consumption.

The following discussion presents the results of an analysis determining the effect of income on the consumption of each of the several wheat products.

A negative correlation was found between income and the consumption of flour and other cereal products (Table 13). When differentiating as to type of flour, a positive correlation was found between incomes and prepared flour mixes and a negative correlation was found between incomes and flour other than mixes. As incomes increased, households consumed more convenience foods, while home baking decreased. Other wheat products were positively correlated with income with the exception of hot wheat cereals in 1965. The consumption of baked goods other than bread was highly positively correlated with income.

Regression techniques were applied to determine the effects of average household income on the household consumption of the various wheat products (Appendix Table 1). Income was a significant variable affecting the per household consumption of all wheat products. This was not true for hot cereals where the per household consumption was very small in comparison to other wheat products and did not follow any consistent pattern.

The per household consumption of flour and other cereal products decreased as income increased (Figures 6 and 7). In 1965, the per household consumption of these products reached a minimum at an income of $20,191. The consumption of prepared flour mixes increased with higher income up to $10,812 in 1955 (Figure 8). Beyond this income consumption declined.

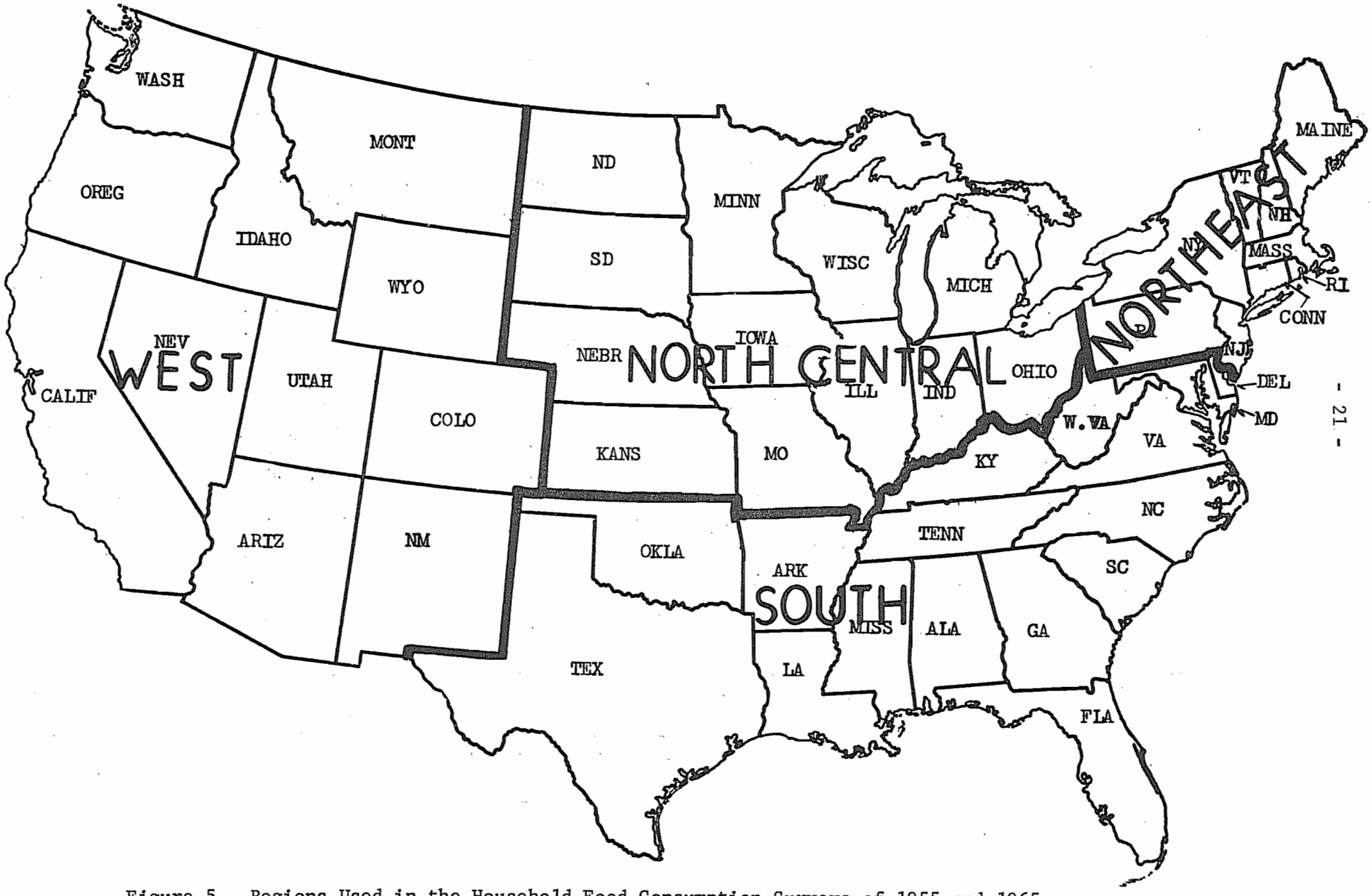

Figure 5. Regions Used in the Household Food Consumption Surveys of 1955 and 1965.

TABLE 11. PER HOUSEHOLD CONSUMPTION OF WHEAT PRODUCTS IN THE UNITED STATES FOR 1955

Income Range	Aver. Income	Proportion of Households	Quantity Per Household: Flour and Other Cereal Products	White Flour	Prepared Flour Mixes	Cold Wheat Cereals	Hot Wheat Cereals	Macaroni Spaghetti Noodles	Bakery Products	White and Whole Wheat Bread	Baked Goods Other Than Bread
	($)	(%)	(pounds per week)								
Households of 1	1,663	8.1	1.86	.73	.14	.09	.04	.11	2.55	1.46	.87
Households of 2 or more	4,544	100.0	6.22	2.79	.65	.22	.06	.44	7.07	4.54	2.09
Under 1,000	371	6.6	12.41	6.50	.25	.11	.04	.23	3.46	2.39	.96
1,000-1,999	1,491	10.3	9.03	4.70	.37	.15	.07	.34	4.84	3.38	1.28
2,000-2,999	2,510	13.0	7.71	3.88	.52	.21	.05	.46	6.18	4.25	1.62
3,000-3,999	3,506	18.5	6.26	2.77	.68	.23	.07	.48	7.58	5.04	2.18
4,000-4,999	4,496	19.3	5.20	2.09	.79	.24	.06	.50	7.78	4.99	2.28
5,000-5,999	5,448	11.6	5.07	1.93	.78	.28	.07	.51	8.44	5.29	2.53
6,000-7,999	6,755	12.1	4.25	1.50	.78	.30	.05	.44	8.61	5.28	2.74
8,000-9,999	8,814	4.0	4.21	1.56	.82	.23	.05	.54	7.89	4.58	2.63
10,000 & over	15,652	4.6	3.74	1.01	.81	.23	.06	.46	8.32	4.56	3.04

Source: Food Consumption of Households in the United States, Report No. 1, Agricultural Research Service, U. S. Department of Agriculture, Washington, D. C., December 1956.

TABLE 12. PER HOUSEHOLD CONSUMPTION OF WHEAT PRODUCTS IN THE UNITED STATES FOR 1965

Income Range	Aver. Income[a]	Proportion of Households	Quantity Per Household: Flour and Other Cereal Products	White Flour	Prepared Flour Mixes	Cold Wheat Cereals	Hot Wheat Cereals	Macaroni Spaghetti Noodles	Bakery Products	White and Whole Wheat Bread	Baked Goods Other Than Bread
	($)	(%)	(pounds per week)								
All households	---	100.0	4.69	1.55	.48	.22	.08	.42	7.64	4.05	3.28
Under 1,000	375	4.8	5.31	2.28	.14	.07	.10	.14	4.23	2.48	1.64
1,000-1,999	1,500	8.5	5.33	2.20	.22	.16	.07	.25	4.23	2.39	1.71
2,000-2,999	2,500	8.9	5.85	2.33	.36	.15	.07	.38	6.22	3.57	2.50
3,000-3,999	3,500	9.7	5.89	2.18	.42	.18	.08	.40	7.08	4.10	2.78
4,000-4,999	4,500	10.1	5.25	1.87	.49	.22	.10	.47	7.86	4.42	3.18
5,000-5,999	5,500	14.5	4.58	1.34	.57	.23	.09	.52	8.22	4.49	3.41
6,000-6,999	6,500	10.9	4.65	1.35	.58	.27	.08	.55	8.95	4.81	3.80
7,000-7,999	7,500	9.4	4.35	1.32	.58	.26	.07	.48	9.32	4.93	4.01
8,000-8,999	8,500	6.6	4.21	1.22	.57	.25	.07	.43	9.30	4.73	4.25
9,000-9,999	9,500	4.9	3.65	.82	.60	.28	.06	.45	8.97	4.42	4.02
10,000-15,000	12,500	8.8	3.70	.82	.59	.27	.09	.46	9.00	4.10	4.40
15,000 & over	20,000	2.9	3.50	.70	.70	.27	.06	.40	9.69	4.05	5.00

[a]Estimated from 1955 data.

Source: Food Consumption of Households in the United States, Report No. 1, Agricultural Research Service, U. S. Department of Agriculture, Washington, D. C., 1968.

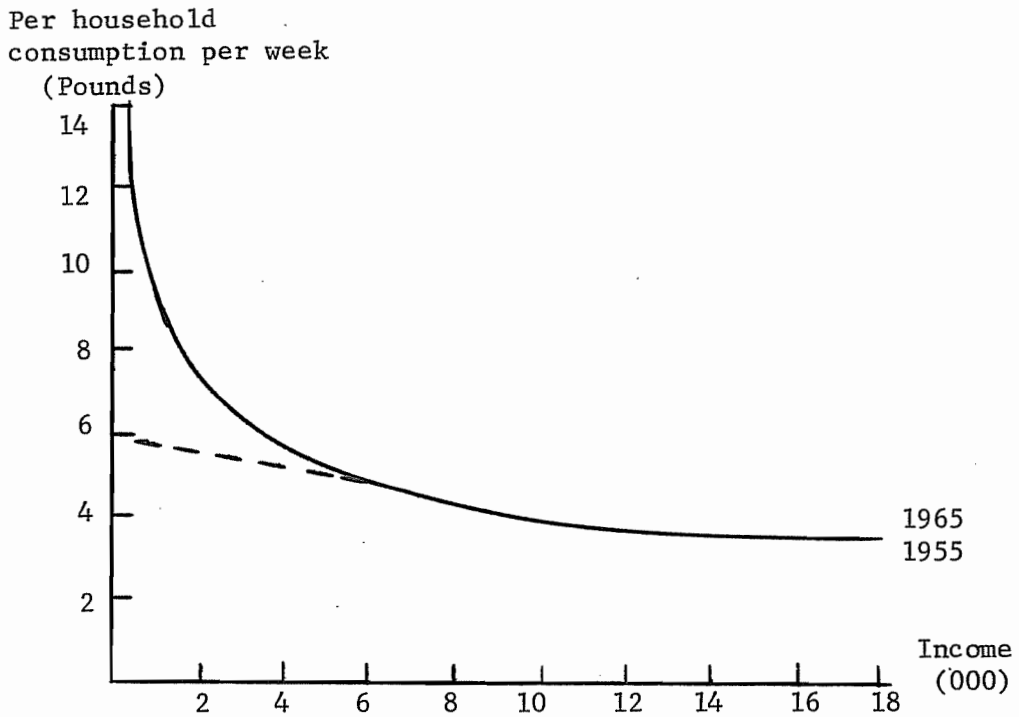

Figure 6. Consumption of Flour and Other Cereal Products With Respect to Household Income in the United States for 1955 and 1965.

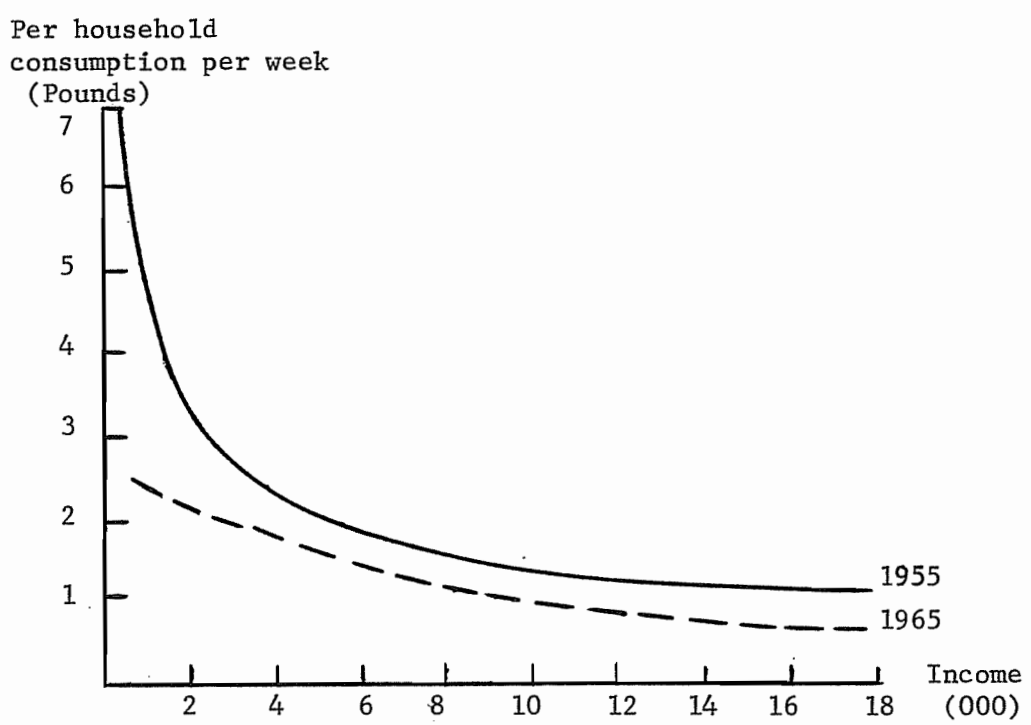

Figure 7. Consumption of White Flour With Respect to Household Income in the United States for 1955 and 1965.

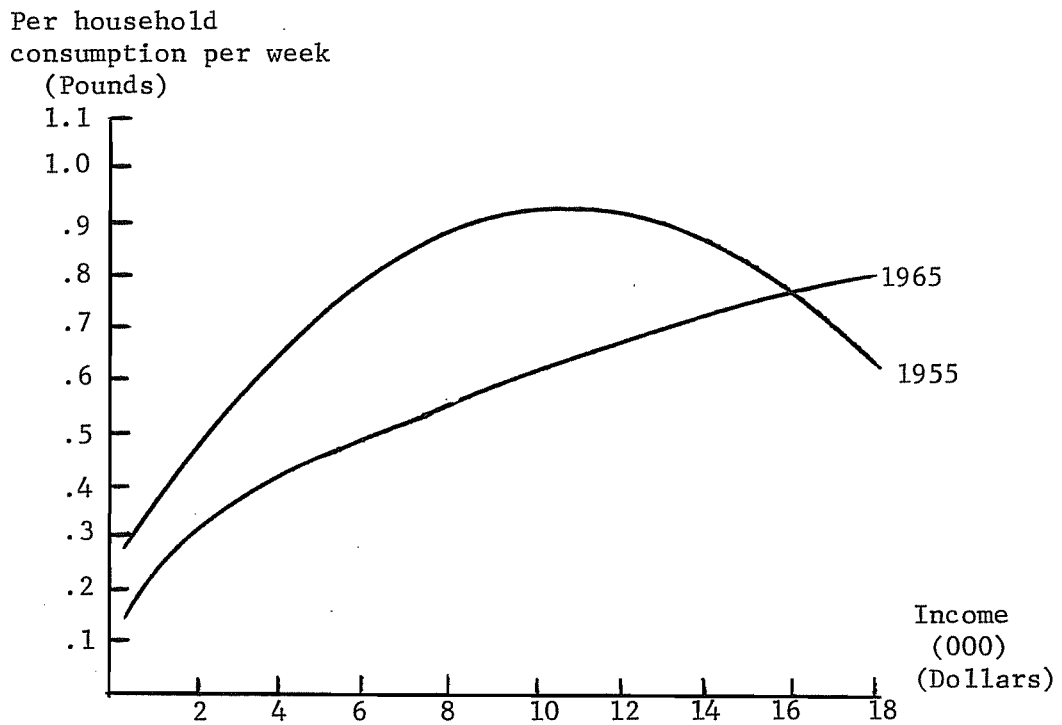

Figure 8. Consumption of Prepared Flour Mixes With Respect to Household Income in the United States for 1955 and 1965.

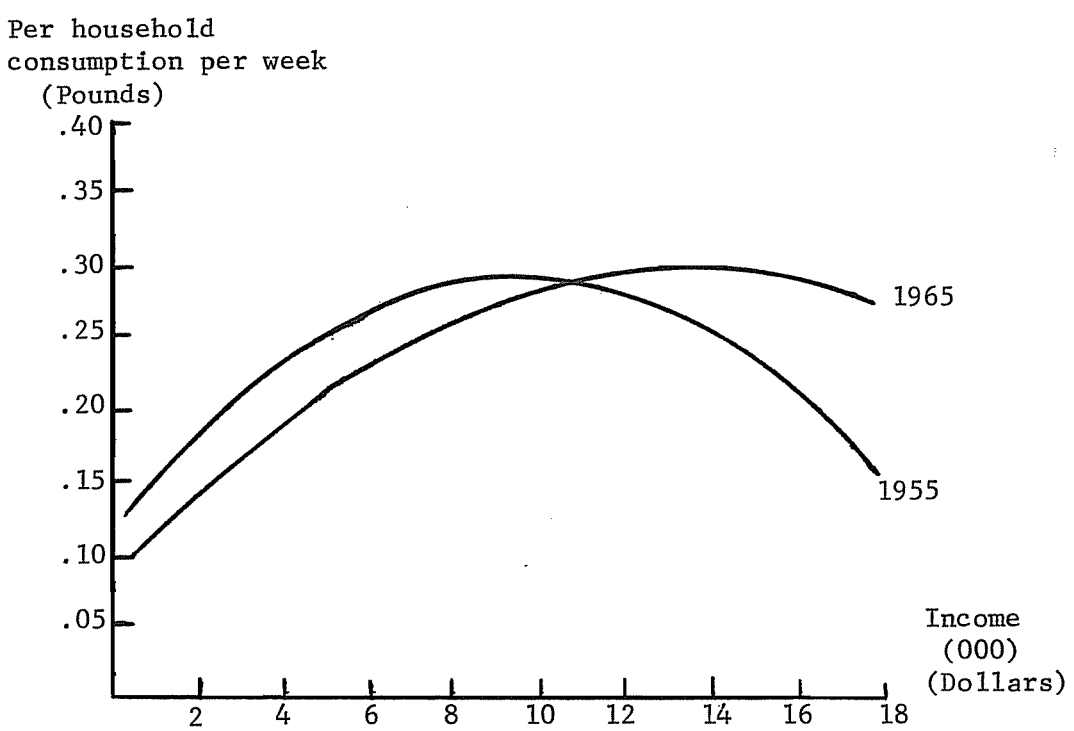

Figure 9. Consumption of Cold Wheat Cereals With Respect to Household Income in the United States for 1955 and 1965.

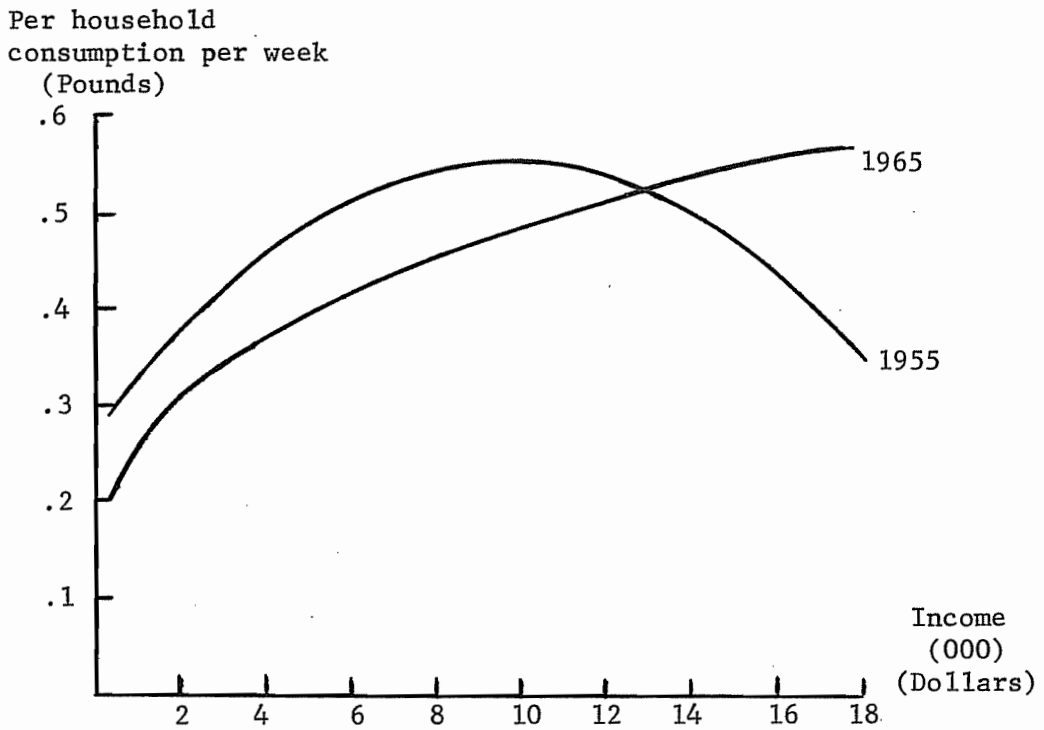

Figure 10. Consumption of Macaroni, Spaghetti, and Noodles, With Respect to Household Income in the United States for 1955 and 1965.

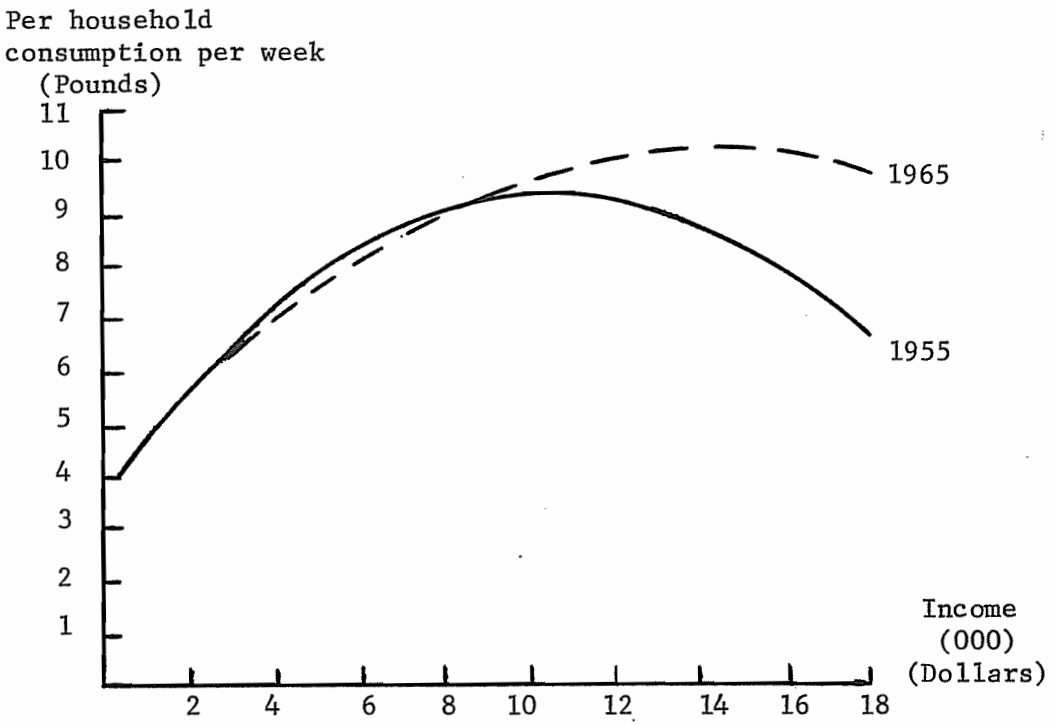

Figure 11. Consumption of Bakery Products With Respect to Household Income in the United States for 1955 and 1965.

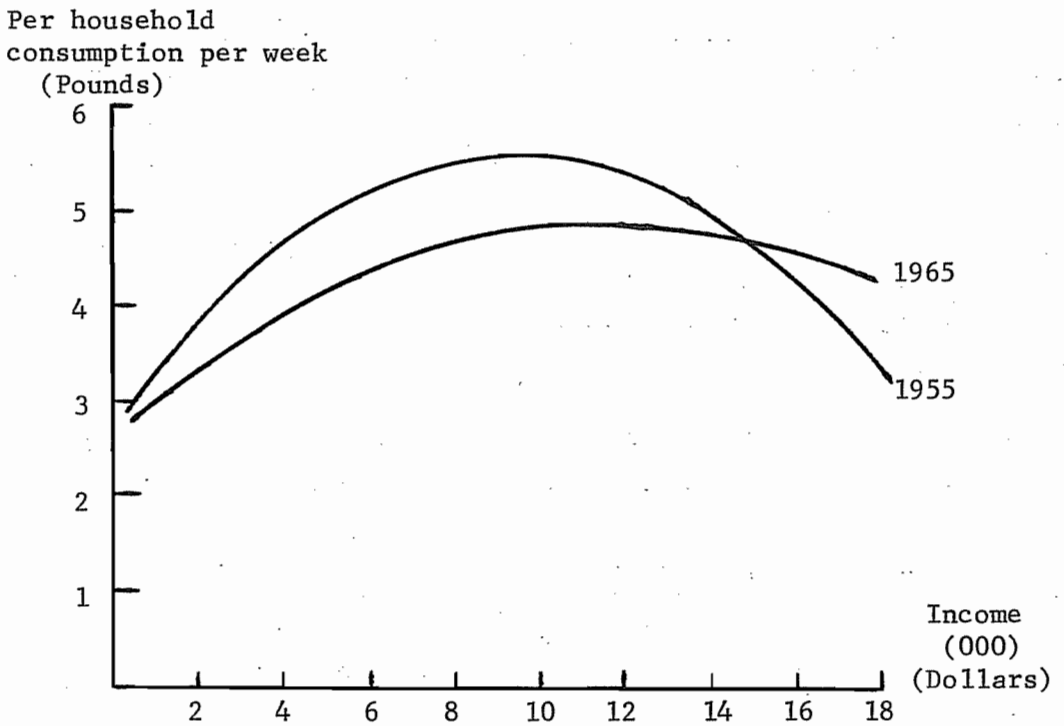

Figure 12. Consumption of White and Whole Wheat Bread With Respect to Household Income in the United States for 1955 and 1965.

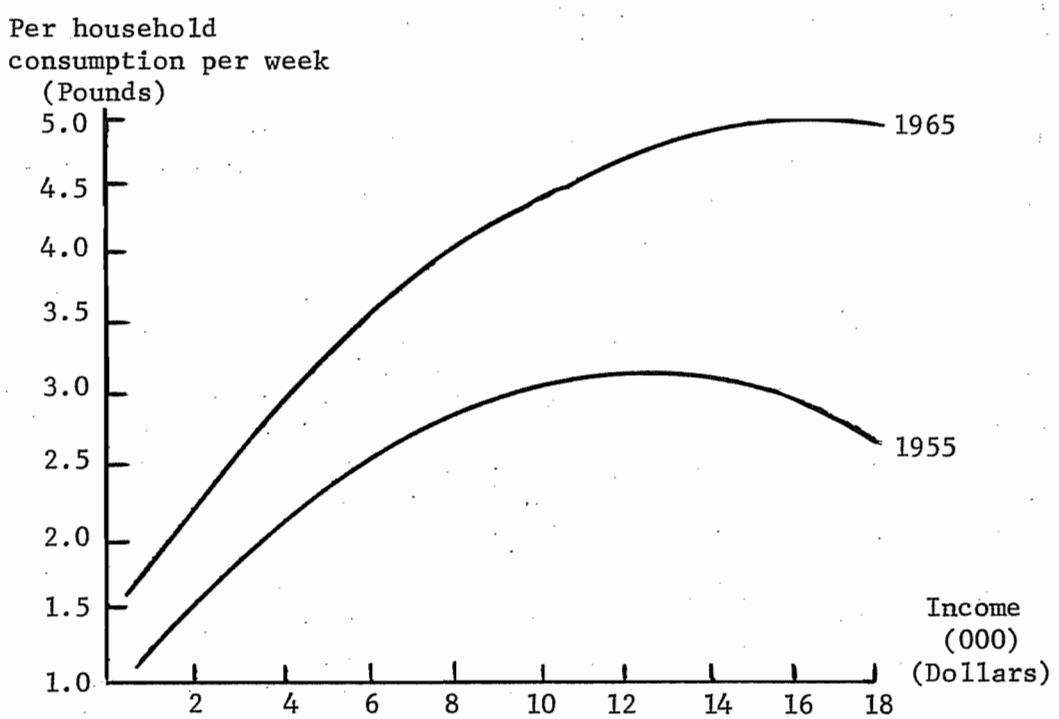

Figure 13. Consumption of Bakery Products Other Than Bread With Respect to Household Income in the United States for 1955 and 1965.

TABLE 13. CORRELATION COEFFICIENTS BETWEEN INCOME AND THE CONSUMPTION OF DIFFERENT WHEAT PRODUCTS IN THE UNITED STATES FOR 1955 AND 1965.

	Consumption of								
Income For Year	Flour and Other Cereal Products	Flour Other Than Mixes	Pre-pared Flour Mixes	Cold Wheat Cereals	Hot Wheat Cereals	Macaroni Spaghetti Noodles	Bakery Prod-ucts	White and Whole Wheat Bread	Baked Goods Other Than Bread
1955	-.7664	-.7895	.7213	.4879	.0622	.5038	.6823	.4535	.8530
1965	-.8537	-.8806	.8146	.7438	-.4484	.4049	.7704	.4439	.8995

The per household consumption of cold cereals increased with higher incomes up to $9,614 in 1955 and $13,919 in 1965 (Figure 9). Income had no effect on the per household consumption of hot cereals. Higher incomes indicated an increased per consumption of macaroni, spaghetti, and noodles (Figure 10). Beyond an income of $9,757 in 1955 the per household consumption declined.

The per household consumption of bakery products and its sub-products increased with higher incomes until a certain income was reached (Figures 11 through 13). Beyond this income the per household consumption declined.

The per household consumption of flour and other cereal products in 1965 was lower than in 1955. This was expected because of a declining household consumption of these products with an increase in household income.

The per household consumption of bakery products increased slightly from 1955 to 1965. This was caused by a decrease in the consumption of bakery bread by households and an increase in the consumption of other bakery products by households.

The per capita consumption of wheat flour has been declining each year. This was caused by different urbanization characteristics, increase in real income, and several other factors; however, time series data showing these factors were not available. An increase in real income would reduce the consumption of flour sold to households and increase the consumption of convenience wheat products. Increased population may offset a decline in per capita consumption of wheat flour such that total consumption may actually increase or remain constant.

The consumption of hard wheats will probably be increased in proportion to all wheat by an increase in real incomes in the future because a large proportion of the hard wheats is used in making bread and rolls. The total consumption of soft wheats will change only slightly because approximately half of the soft wheats were used for all purpose flour and the other half was used for convenience foods.

Consumption of Wheat Products by Region

The consumption of the different wheat products varied between the regions delineated in the food consumption surveys of 1955 and 1965. The negative correlation between the consumption of flour other than mixes and income was evident in all regions in 1955 (Table 14). The consumption of prepared flour mixes was positively correlated with income. The consumption of cold wheat cereals was positively correlated with income in all regions except the North Central. The consumption of hot cereals was negatively correlated with income in all regions except the South. The consumption of macaroni, spaghetti, and noodles was negatively correlated with income in the Northeast and West regions with correlation coefficients of -.82 and -.48, respectively. In the North Central region the reverse was evident with a correlation coefficient of .77. Households in the North Central region consumed more of these products with higher incomes. The production of durum in the North Central region may have some effect on the consumption of durum products.

TABLE 14. CORRELATION COEFFICIENTS BETWEEN INCOME AND CONSUMPTION OF DIFFERENT WHEAT PRODUCTS IN FOUR REGIONS OF THE UNITED STATES IN 1955

	Consumption of								
Region of Income	Flour and Other Cereal Products	Flour Other Than Mixes	Prepared Flour Mixes	Cold Wheat Cereals	Hot Wheat Cereals	Macaroni Spaghetti Noodles	Bakery Products	White and Whole Wheat Bread	Baked Goods Other Than Bread
Northeast	-.7420	-.7028	.4031	.1437	-.4680	-.8229	.4082	-.0831	.6215
North Central	-.8141	-.8907	.5610	-.4392	-.1692	.7690	.6202	.3012	.8728
South	-.7818	-.8340	.3472	.6446	.4312	.1015	.7206	.3805	.9048
West	-.7710	-.8138	.5804	.2411	-.5442	-.4792	.5797	-.2380	.9418

The consumption of bakery products was positively correlated with income. The correlations between income and the consumption of white and whole wheat bread were low. The consumption of baked goods other than bread was positively correlated with income in all regions. This was expected because of an increase in demand for convenience foods.

Regression analysis was used with all four regions for 1955 (Appendix Table 2). The major function of this analysis was to determine the kind and degree of relationship between consumption of various products and income in each region.

The per household consumption of cold wheat cereals, hot wheat cereals, and bread was not affected by income in most cases. The per household consumption of flour and other cereal products was inversely related to income in all regions. The per household consumption of flour other than mixes was also inversely related to income in all regions; however, the per household consumption of prepared flour mixes was directly related to income.

In the South the per household consumption of cold wheat cereals was directly related to income. The per household consumption of hot wheat cereals was inversely related to income.

The per household consumption of macaroni, spaghetti, and noodles was inversely related to income in the Northeast and directly related to income in the North Central. Households in the North Central region would consume more of their local wheat products in the future if incomes increase.

The per household consumption of bakery products was directly related to income in all regions and the same was true for all bakery products other than bread. In the South the per household consumption of white and whole wheat bread also was directly related to income.

Changes in Consumption of Wheat Products in the United States

Families were using 10 percent less of the foods in the bread-cereal group (flour equivalent) in 1965 than 1955; whereas, its money value was up 30 percent.[16] The higher money value or cost of wheat products for less food was primarily the result of a dramatic shift to bakery products other than bread and to ready-to-eat breakfast cereals and away from the cheaper flour, cereals other than ready-to-eat ones, and bread.[17] Higher income families used more bakery products and less flour and cereals.[18]

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[16]Agricultural Research Service, Changing Food Patterns in the United States, Talk at the 58th Annual meeting of the American Home Economics Association, U. S. Department of Agriculture, Dallas, Texas, June 27, 1967, p. 5.

[17]Ibid.

[18]Food Consumption of Households in the United States, Report No. 1, Agricultural Research Service, U. S. Department of Agriculture, Hyattsville, Maryland, August 1967, p. 5.

The consumption of bakery products has increased considerably from 1955 to 1965 in the United States. This was expected because of a direct relationship between consumption of bakery products and disposable income. The decline in the consumption of flour was expected because of the inverse relationship between consumption and disposable income. Overall, the consumption of bread and cereal products in households declined 10 percent. The number of households of two or more persons increased 14.4 percent. Thus, the total consumption of bread and cereal products has increased slightly from 1955 to 1965.

Urbanization and region of consumption are two factors other than income that affected the consumption of the bread and cereal group. The per capita consumption of the bread and cereal group declined from 1955 to 1965. Farm families consumed about 40 percent more of the bread-cereal group than urban families.[19] Families in the South consumed 1.2 pounds more bread and cereal than families of the North. This is possibly caused by lower incomes in the South.

Summary

The quality of hard red spring wheat was considered higher than the other classes of wheat when used in the production of bread flours. The quality of hard red winter wheat and hard white wheat was fairly high but usually required blending with hard red spring wheat for bread flours. The soft wheats were especially suited for the production of flour used in pastry products. Durum wheat had quality characteristics necessary for macaroni, spaghetti, and noodles.

The consumption of all-purpose flour by households in the United States declined as household incomes increased; whereas, the household consumption of prepared flour mixes and bakery products other than bread increased as household incomes increased. This indicated an increasing trend by households to consume more convenience foods and to do less baking at home as incomes increase.

The decline in the consumption of wheat products by households has been more than offset by an increase in the number of households. The total consumption of bread and cereal products has increased 4.4 percent for 1955 through 1965.

Wheat Processor Demand for Wheat By Class and Region

The wheat purchases by wheat processors have also changed with respect to region and class of wheat. The purpose of this analysis is

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[19] Changing Food Patterns in the United States, op. cit., p. 6.

to determine the present and future wheat purchases of wheat by class in each region by processors.

Flour Milling Industry

The flour milling industry has changed considerably from 1950 to 1966. The number of mills has been reduced by half and the total output of wheat products has increased slightly.

The flour milling industry is now composed of a hundred companies which operate 230 mills of commercial importance. Commercial importance in a broad sense indicates any mill that distributes flour beyond the community in which the plant is located. Sixty of the 230 large mills produce approximately half of the flour produced in the United States. These mills have at least 5,000 hundredweight daily capacity. The largest mill, with 30,900 hundredweight capacity, is also the world's largest. The remaining commercial mills, which have daily hundredweight capacity as low as 400, produce about one-half of the total United States production of flour.[20]

In addition to the 230 commercial mills operating, there are approximately 330 small mills that serve local communities. These mills produce less than one percent of the flour produced in the United States.

Uniform Product Policy

Basically, flour is a standardized product which must maintain a minimum quality as set by the government. Production of flour of uniform quality necessitates the accumulation of wheat from a large area to balance or blend; the unevenness in quality is due to the local growing conditions. This blending, which requires technical skills, affords considerable opportunity for variations in efficiency between different mills and slight variations in product quality.

Pricing Policies of Flour Millers in Buying Wheat

The domestic production of wheat is normally more than adequate. Changes in supplies are relatively unimportant to flour millers except during periods of unusually high foreign demand. Furthermore, support prices set a virtual floor under wheat quotations.

Millers have an average storage capacity for about 46 percent of the wheat they grind in one year. Out of each 100 pounds of wheat

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[20]Steen, Herman, Flour Milling in America, T. S. Denison and Company, Incorporated, Minneapolis, Minnesota, 1963, p. 13.

purchased, approximately 72 pounds of flour and 28 pounds of millfeed, including clears, are produced. The risk for price change in wheat can be hedged by buying futures or actually buying the wheat needed if the mill has elevator space.[21]

Wheat Purchases by Region

The United States was divided into 17 regions for the purpose of studying the distribution or flows of the various classes of wheat in the United States (Figure 14). Several factors were considered when determining the size and location of these regions. These were: the production of wheat by class, the locations of wheat processors, the distribution patterns of wheat by class, and geographical locations or boundaries.

Data on domestic wheat purchases by class and region for 1950, 1955, 1960, and 1965 were obtained from a mail survey of all wheat processors in the United States.

Thirty-seven percent of the total wheat grindings for these years were accounted for by the questionnaires that were returned. The proportions of the wheat ground, reported for 1950, 1955, 1960, and 1965, were 29.0, 34.3, 41.1, and 43.5 percent, respectively.

Ratio estimators were used to expand the data received by the questionnaires that were returned (Table 15). Thus, the total wheat purchases by class and region were derived from 37 percent of the wheat purchases that were known. A larger proportion of the wheat ground was reported for the later years than for earlier years. Mill closures, lack of records, and changes of ownership were responsible for this increase in wheat grindings reported.

Wheat purchases have been significantly increasing in regions 2, 4, 12, 13, 15, and 17. Wheat purchases in California and Nevada have increased 68.4 percent from 1950 through 1965. Processors in region 4 have purchased 40.8 percent more wheat in 1965 than in 1950. Wheat purchases in regions 12, 13, and 15 have increased by 36.6, 74.0, and 7.7 percent, respectively, from 1950 through 1965. This indicates a shift of milling capacity to the Southwestern states, East North Central states, and the East South Central states. Population increases have been the reasons in some regions. The population of California has

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[21]National Commission on Food Marketing, Organization and Competition in the Milling and Baking Industries, Technical Study No. 5, Washington, D. C., June 1966, p. 43.

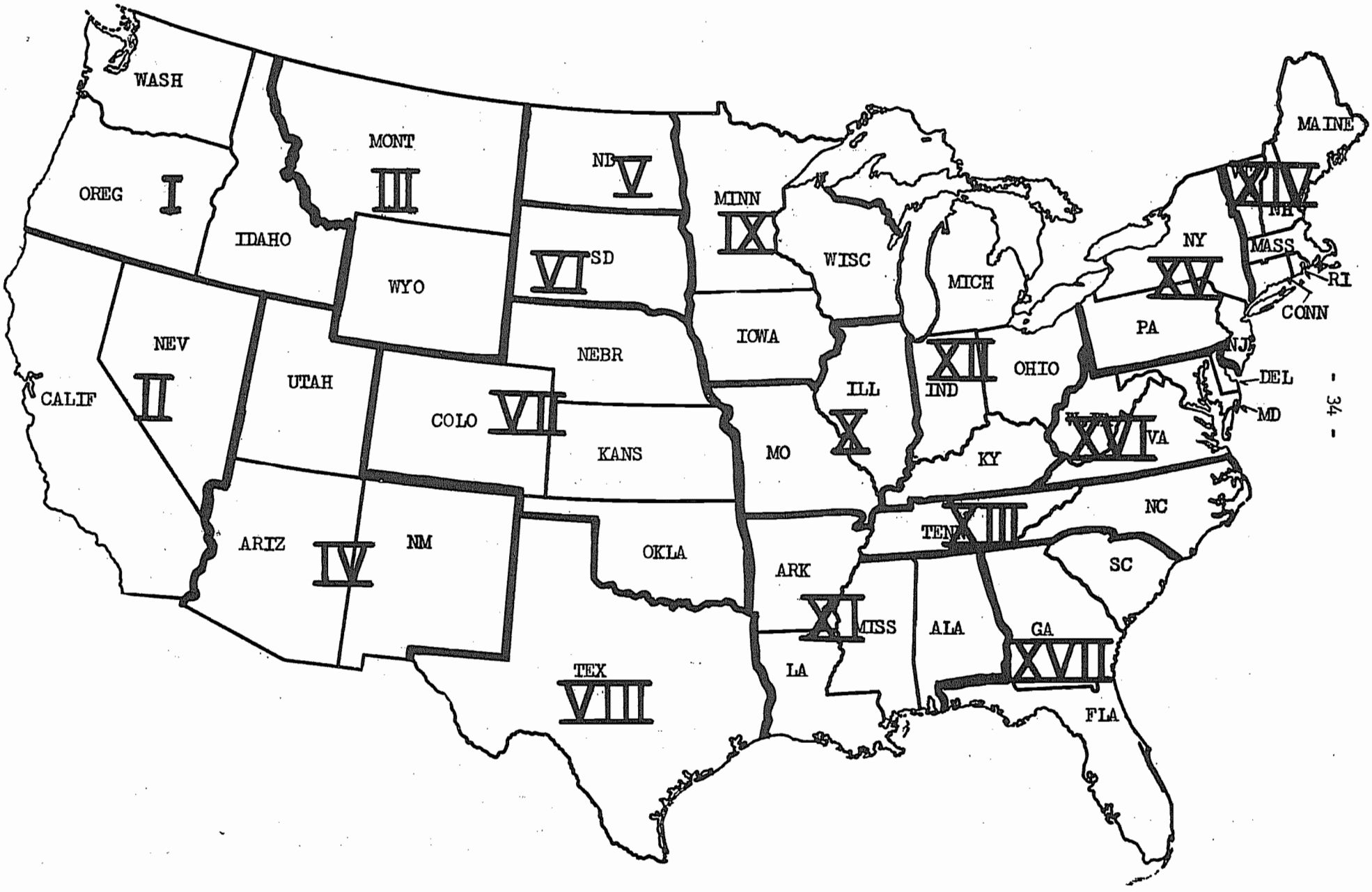

Figure 14. Boundaries of the Seventeen Wheat Consumption Regions of the United States.

TABLE 15. TOTAL WHEAT GROUND, REPORTED WHEAT GROUND, AND RATIO ESTIMATES BY REGION FOR 1950, 1955, 1960, AND 1965

Region	Total Wheat Ground				Reported Wheat Ground				Ratio Estimators			
	1950	1955	1960	1965	1950	1955	1960	1965	1950	1955	1960	1965
	(000 bushels)				(000 bushels)							
I	34,829	37,852	39,865	33,563	4,500	18,075	27,978	27,245	7.74	2.09	1.42	1.23
II	10,441	12,975	14,801	17,584	573	779	8,005	13,627	18.23[c]	16.65[c]	1.85	1.29
III	7,153	7,685	6,775	6,668	6,600	6,404	6,775	6,560	1.08	1.20	1.00	1.02
IV	9,493	12,823	14,734	13,366	416	815	4,189	924	22.83[c]	15.74[c]	3.52	14.46[c]
V	6,285	6,703	7,655	6,990	4,039	4,955	4,224	5,824	1.56	1.35	1.81	1.20
VI	1,406	2,365	3,169	1,816	890	971	1,332	1,513	1.58	2.44	2.38	1.20
VII	128,629	116,173	138,274	127,015	14,022	22,421	35,083	32,989	9.17	5.18	3.94	3.85
VIII	31,364	28,354	34,451	29,601	10,848	11,224	11,659	13,340	2.89	2.53	2.95	2.22
IX	79,914	84,188	85,336	78,245	32,778	33,826	41,975	45,405	2.44	2.49	2.03	1.72
X	76,755	79,754	86,456	77,384	21,419	23,340	34,448	43,084	3.58	3.42	2.51	1.80
XI[a]	0	0	0	0	0	0	0	0	-	-	-	-
XII	49,872	49,959	57,377	68,139	16,003	16,385	22,028	21,929	3.12	3.05	2.60	3.11
XIII	12,278	8,965	9,009	21,367	3,165	3,682	3,786	4,260	3.88	2.44	2.38	5.01
XIV[a]	0	0	0	0	0	0	0	0	-	-	-	-
XV	66,759	65,593	74,623	71,920	32,744	32,684	33,956	24,840	2.04	2.01	2.20	2.90
XVI	6,885	4,793	6,220	6,467	1,861	1,968	2,614	2,564	3.70	2.44	2.38	2.52
XVII	2,000	4,668	4,710	4,598	1,970	1,917	1,979	1,823	1.02	2.43	2.38	2.52
Total[d]	523,441	522,851	583,453	564,724	151,827	179,445	240,032	245,926	3.45	2.91	2.43	2.30

[a]Wheat purchases in these regions were insignificant.
[b]Total wheat ground estimated from reported wheat ground.
[c]Several mills did not have records for this year.
[d]Totals were calculated before figures were rounded to thousands.

SOURCE: Bureau of Census, Current Industrial Reports, U.S. Department of Commerce, Series M20A (64-67).

increased 56.8 percent from 1950 to 1960.[22] The population of Florida increased 105.8 percent in this same period.[23]

Wheat processors have shown a tendency to purchase the class of wheat which is produced adjacent to the mill (Table 16). This was especially true with respect to the soft wheat classes. Hard wheat classes were sometimes milled in regions other than the production regions.

Soft red winter wheat was processed in the Central and Eastern regions in the United States. Wheat processors in region 12 purchased the largest amount of soft red winter wheat. This trend has increased over the last 20 years (Table 17). Wheat processors in regions 10, 13, and 15 purchased a considerable amount of soft red winter wheat. Soft red winter wheat was the largest class of wheat processed in regions 12, 13, 16, and 17 (Table 18).

Hard red winter wheat was processed in every region in the United States where a substantial amount of wheat was ground. Wheat purchases of hard red winter wheat in region 7 were by far the largest amount purchased by any region. Region 10 ranked second to region 7 in wheat purchases of hard red winter wheat. Wheat processors in regions 1, 2, 4, 6, 7, 8, and 10 processed more hard red winter wheat than any other class of wheat. Hard red spring wheat was processed in nearly every region of the United States. The amount of hard red spring wheat processed in these regions was generally small except in regions 9 and 15. Wheat processors in region 9 purchased the largest amount of hard red spring wheat. Wheat processors in regions 3, 5, 9, and 15 purchased more hard red spring wheat than any other class of wheat.

White wheat has been processed in Western and Northeastern regions of the United States. Wheat processors in region 7 purchased the largest amount of white wheat. White wheat purchases in regions 1 and 4 were also important. White wheat was not the major class of wheat milled in any one region. Generally, more hard red winter wheat or soft red winter wheat than white wheat was milled in any one region.

Wheat processors in region 9 have purchased most of the durum wheat. Some durum wheat has been processed in regions 1, 2, 3, 5, and 7. Durum wheat has not been the major class of wheat processed in any one region.

Wheat processors in region 7 purchased the largest amount of all classes of wheat. Wheat purchases in regions 9, 10, 12, and 15 were also relatively large.

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[22]Bureau of the Census, Statistical Abstract of the United States, U. S. Department of Commerce, Washington, D. C., 1967.

[23]Ibid.

TABLE 16. WHEAT PURCHASES BY CLASS AND REGION IN THE UNITED STATES FOR 1950, 1955, 1960, AND 1965

Class of Wheat Purchased	Year	Wheat Purchases by Region																	Total[a]
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	
		(000 bushels)																	
SRW	1950	0	0	0	0	0	0	0	523	0	27,954	0	15,415	12,275	0	12,319	6,404	1,513	76,403
	1955	0	0	0	0	0	0	5,637	448	0	27,838	0	19,154	8,842	0	12,490	4,477	3,207	82,092
	1960	0	4,157	0	0	0	0	4,410	541	0	23,293	0	28,722	8,982	0	16,870	5,910	2,996	95,882
	1965	0	1,141	0	0	0	0	3,804	1,662	0	19,933	0	39,735	21,322	0	14,693	6,139	2,782	111,212
HRW	1950	30,185	6,356	2,681	5,585	1,271	741	128,583	30,841	9,669	39,272	0	10,728	0	0	21,006	111	487	287,518
	1955	20,505	7,345	3,052	7,335	1,403	1,704	108,682	27,906	10,287	42,959	0	6,525	122	0	21,078	73	1,315	260,291
	1960	21,294	3,649	2,646	8,814	1,734	2,258	130,435	33,910	7,882	56,179	0	6,691	0	0	22,918	71	1,428	299,909
	1965	19,360	8,888	2,344	7,379	1,263	1,286	118,987	27,789	15,708	52,188	0	2,189	0	0	20,521	76	1,513	279,491
HRS	1950	4,644	1,402	4,472	46	3,268	665	46	0	45,716	6,459	0	7,061	0	0	31,427	185	0	105,390
	1955	11,324	1,643	4,633	63	3,878	660	962	0	46,561	6,006	0	3,600	0	0	29,894	122	146	109,493
	1960	9,218	2,269	4,129	1,642	4,486	911	2,788	0	50,313	4,778	0	3,586	0	0	32,251	119	285	116,775
	1965	5,498	2,601	4,013	14	3,291	530	3,338	150	40,057	3,233	0	2,268	0	0	32,571	126	303	97,995
White	1950	0	2,683	0	3,862	0	0	0	0	0	3,070	0	16,668	3	0	2,007	185	0	28,477
	1955	5,694	3,787	0	5,425	0	0	0	0	0	2,950	0	20,680	1	0	2,132	122	0	40,792
	1960	8,503	3,995	0	4,278	0	0	0	0	0	2,206	0	18,378	27	0	2,584	119	0	40,090
	1965	7,521	4,540	0	5,973	0	0	0	0	0	2,030	0	23,947	45	0	4,135	126	0	48,315
Durum	1950	0	0	0	0	1,746	0	0	0	24,528	0	0	0	0	0	0	0	0	26,274
	1955	329	200	0	0	1,422	0	892	0	27,340	0	0	0	0	0	0	0	0	30,182
	1960	851	730	0	0	1,435	0	641	0	27,141	0	0	0	0	0	0	0	0	30,798
	1965	1,184	414	311	0	2,437	0	887	0	22,479	0	0	0	0	0	0	0	0	27,712

[a]Total of unrounded figures.

TABLE 17. REGIONAL PROPORTIONS OF WHEAT PURCHASES BY CLASS IN THE UNITED STATES FOR 1950, 1955, 1960, AND 1965

Class of Wheat Purchased	Year	Regional Proportion of Wheat Purchases																	
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	Total
		(percent)																	
SRW	1950	.0	.0	.0	.0	.0	.0	.0	.7	.0	36.6	.0	20.2	16.1	.0	16.1	8.4	2.0	100
	1955	.0	.0	.0	.0	.0	.0	6.9	.6	.0	33.9	.0	23.3	10.8	.0	15.2	5.5	3.9	100
	1960	.0	4.3	.0	.0	.0	.0	4.6	.6	.0	24.3	.0	30.0	9.4	.0	17.6	6.2	3.1	100
	1965	.0	1.0	.0	.0	.0	.0	3.4	1.5	.0	17.9	.0	35.7	19.2	.0	13.2	5.5	2.5	100
HRW	1950	10.5	2.2	.9	1.9	.4	.3	44.7	10.7	3.4	13.7	.0	3.7	.0	.0	7.3	.0	.2	100
	1955	7.9	2.8	1.2	2.8	.5	.7	41.8	10.7	4.0	16.5	.0	2.5	.1	.0	8.1	.0	.5	100
	1960	7.1	1.2	.9	2.9	.6	.8	43.5	11.3	2.6	18.7	.0	2.2	.0	.0	7.6	.0	.5	100
	1965	6.9	3.2	.8	2.6	.5	.5	42.6	9.9	5.6	18.7	.0	.8	.0	.0	7.3	.0	.5	100
HRS	1950	4.4	1.3	4.2	.0	3.1	.6	.0	.0	43.4	6.1	.0	6.7	.0	.0	29.8	.2	.0	100
	1955	10.3	1.5	4.2	.1	3.5	.6	.9	.0	42.5	5.5	.0	3.3	.0	.0	27.3	.1	.1	100
	1960	7.9	1.9	3.5	1.4	3.8	.8	2.4	.0	43.1	4.1	.0	3.1	.0	.0	27.6	.1	.2	100
	1965	5.6	2.7	4.1	.0	3.4	.5	3.4	.2	40.9	3.3	.0	2.3	.0	.0	33.2	.1	.3	100
White	1950	.0	9.4	.0	13.6	.0	.0	.0	.0	.0	10.8	.0	58.5	.0	.0	7.1	.7	.0	100
	1955	14.0	9.3	.0	13.3	.0	.0	.0	.0	.0	7.2	.0	50.7	.0	.0	5.2	.3	.0	100
	1960	21.2	10.0	.0	10.7	.0	.0	.0	.0	.0	5.5	.0	45.8	.1	.0	6.5	.3	.0	100
	1965	15.6	9.4	.0	12.4	.0	.0	.0	.0	.0	4.2	.0	49.6	.1	.0	8.6	.3	.0	100
Durum	1950	.0	.0	.0	.0	6.6	.0	.0	.0	93.4	.0	.0	.0	.0	.0	.0	.0	.0	100
	1955	1.1	.7	.0	.0	4.7	.0	3.0	.0	90.6	.0	.0	.0	.0	.0	.0	.0	.0	100
	1960	2.8	2.4	.0	.0	4.7	.0	2.1	.0	88.1	.0	.0	.0	.0	.0	.0	.0	.0	100
	1965	4.3	1.5	1.1	.0	8.8	.0	3.2	.0	81.1	.0	.0	.0	.0	.0	.0	.0	.0	100
All Wheat	1950	6.7	2.0	1.4	1.8	1.2	.3	24.5	6.0	15.3	14.7	.0	9.5	2.3	.0	12.7	1.3	.4	100
	1955	7.2	2.5	1.5	2.5	1.3	.5	22.2	5.4	16.1	15.3	.0	9.6	1.7	.0	12.6	.9	.9	100
	1960	6.8	2.5	1.2	2.5	1.3	.5	23.7	5.9	14.6	14.8	.0	9.8	1.5	.0	12.8	1.1	.8	100
	1965	5.9	3.1	1.2	2.4	1.2	.3	22.5	5.2	13.9	13.7	.0	12.1	3.8	.0	12.7	1.2	.8	100

TABLE 18. CLASS PROPORTIONS OF WHEAT PURCHASES BY REGION IN THE UNITED STATES FOR 1950, 1955, 1960, AND 1965

Class of Wheat Purchased	Year	Class Proportions of Wheat Purchases by Region																
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII
		(percent)																
SRW	1950	.0	.0	.0	.0	.0	.0	.0	1.7	.0	36.4	.0	30.9	100.0	.0	18.5	93.0	75.6
	1955	.0	.0	.0	.0	.0	.0	4.9	1.6	.0	34.9	.0	38.3	98.6	.0	19.0	93.4	68.7
	1960	.0	28.1	.0	.0	.0	.0	3.2	1.6	.0	26.9	.0	50.1	99.7	.0	22.6	95.0	63.6
	1965	.0	6.5	.0	.0	.0	.0	3.0	5.6	.0	25.8	.0	58.3	99.8	.0	20.4	94.9	60.5
HRW	1950	86.7	60.9	37.5	58.8	20.2	52.7	100.0	98.3	12.1	51.2	.0	21.5	.0	.0	31.5	1.6	24.4
	1955	54.2	56.6	39.7	57.2	20.9	72.1	93.6	98.4	12.2	53.9	.0	13.1	1.4	.0	32.1	1.5	28.2
	1960	53.4	24.7	39.1	59.8	22.7	71.3	94.3	98.4	9.2	65.0	.0	11.7	.0	.0	30.7	1.2	30.3
	1965	57.7	50.5	35.2	55.2	18.1	70.8	93.7	93.9	20.1	67.4	.0	3.2	.0	.0	28.5	1.2	32.9
HRS	1950	13.3	13.4	62.5	.5	52.0	47.3	.0	.0	57.2	8.4	.0	14.2	.0	.0	47.1	2.7	.0
	1955	29.9	12.7	60.3	.5	57.9	27.9	.8	.0	55.3	7.5	.0	7.2	.0	.0	45.6	2.5	3.1
	1960	23.1	15.3	60.9	11.1	58.6	28.7	2.0	.0	59.0	5.5	.0	6.3	.0	.0	43.2	1.9	6.1
	1965	16.4	14.8	60.2	.1	47.1	29.2	2.6	.5	51.2	4.2	.0	3.3	.0	.0	45.3	2.0	6.6
White	1950	.0	25.7	.0	40.7	.0	.0	.0	.0	.0	4.0	.0	33.4	.0	.0	3.0	2.7	.0
	1955	15.0	29.2	.0	42.3	.0	.0	.0	.0	.0	3.7	.0	41.4	.0	.0	3.3	2.5	.0
	1960	21.3	27.0	.0	29.0	.0	.0	.0	.0	.0	2.6	.0	32.0	.3	.0	3.5	1.9	.0
	1965	22.4	25.8	.0	44.7	.0	.0	.0	.0	.0	2.6	.0	35.1	.2	.0	5.8	2.0	.0
Durum	1950	.0	.0	.0	.0	27.8	.0	.0	.0	30.7	.0	.0	.0	.0	.0	.0	.0	.0
	1955	.9	1.5	.0	.0	21.2	.0	.8	.0	32.5	.0	.0	.0	.0	.0	.0	.0	.0
	1960	2.1	4.9	.0	.0	18.8	.0	.5	.0	31.8	.0	.0	.0	.0	.0	.0	.0	.0
	1965	3.5	2.4	4.7	.0	34.9	.0	.7	.0	28.7	.0	.0	.0	.0	.0	.0	.0	.0

Projected Wheat Purchases by Region

The volume of all classes of wheat processed in the United States has been increasing during the last 16 years with the exception of 1965 when the volume processed decreased because of a reduction in exports of wheat flour. Accurate separation of domestic flour consumption and flour exports data would be difficult because of the volume of wheat flour held in bond from foreign countries. Thus, it was necessary to project total wheat processed in the United States by percentage change or historical trend. The average percentage change was .5400 percent per year. Total wheat processed was projected at 580,303,000 bushels and 596,143,000 bushels for 1970 and 1975, respectively (Table 19).

Projections of wheat purchases by region for 1970 were developed by adding the average change in the proportion of total wheat purchased in that region to the proportion of the total wheat purchased in that region for 1965. Projections of wheat purchases by class for 1970 were made by adding the average changes in the proportion of that class of wheat purchases in that region to the proportion of that class of wheat purchased in that region for 1965. The same technique was used for 1975.

TABLE 19. TOTAL WHEAT GROUND BY COMMERCIAL MILLS IN THE UNITED STATES 1950 THROUGH 1966 AND PROJECTED FOR 1970 AND 1975

Year	Commercial Wheat Grindings
	(000 bushels)
1950	523,411
1951	535,235
1952	532,374
1953	515,446
1954	514,028
1955	522,851
1956	527,159
1957	548,532
1958	566,688
1959	570,856
1960	582,719
1961	591,999
1962	595,353
1963	599,710
1964	602,209
1965	564,724
1966	567,936
1970	580,303
1975	596,143

Source: Bureau of the Census, Current Industrial Reports, U. S. Department of Commerce, Series M20A (64-67).

The amount of wheat purchases by region and class was found by multiplying the proportions times the projected total wheat purchases for 1970 and 1975 (Table 20).

Soft red winter wheat purchases were projected to increase by approximately 11 million bushels from 1970 to 1975. Increases were found in all regions purchasing soft red winter wheat except regions 10 and 16. Large increases in soft red winter wheat purchases were found for regions 12 and 13.

Hard red winter wheat purchases were projected to remain relatively constant at approximately 278 million bushels. Purchases of hard red winter wheat were projected to substantially increase in regions 9 and 10 and substantially decline in regions 1, 7, and 8.

Purchases of hard red spring wheat were projected to remain relatively constant at approximately 95 million bushels. Hard red spring wheat purchases were projected to substantially increase in region 7 and substantially decrease in regions 9 and 10. Slight increases in wheat purchases were projected for regions 1, 2, 8, 15, and 17.

White wheat purchases by wheat processors were projected to increase by approximately five million bushels from 1970 to 1975. Substantial increases in white wheat purchases were projected for regions 1, 2, 4, 12, and 15. There was no breakdown as to whether these increases will be of hard or soft white wheat. White wheat purchases in regions 10, 13, and 16 have little affect on total white wheat purchases.

Projections in durum wheat purchases indicate a slight increase of approximately one-half million bushels. This increase was not found in the major processing region 9 for this class. Slight increases in durum wheat purchases were projected in regions 1, 2, 3, 5, and 7. No other regions reported durum wheat purchases; however, it is possible that durum wheat has been processed in region 15.

All wheat purchases were projected to substantially increase in regions 2, 4, 12, 13, 15, and 17. The greatest increases were projected for regions 2, 12, 13, and 15. The largest increases in wheat purchases were projected for regions 12,and 13. Both of these regions indicated large amounts of soft red winter wheat purchases. The purchases of white wheat were largest in region 12. Wheat purchases in regions 12 and 13 were projected to increase by large amounts and soft red winter wheat and white wheat have been the only classes of wheat projected to be processed in large quantities in at least one of these regions. Therefore, the large projected increases of soft red winter wheat and white wheat purchases were basically a result of the projected increases for regions 12 and 13 where no other classes of wheat have been projected to be processed.

Wheat purchases of hard red winter wheat, hard red spring wheat, and durum wheat should increase if they are made available to wheat processors in regions 12 and 13. However, during the last 20 years there has been both hard red winter wheat and hard red spring wheat purchased

TABLE 20. WHEAT PURCHASES BY CLASS AND REGION IN THE UNITED STATES; PROJECTED FOR 1970 AND 1975

Class of Wheat Purchased	Year	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	Total
									(000 bushels)										
SRW	1970	0	1,749	0	0	0	0	5,053	2,008	0	17,245	0	49,016	24,653	0	15,590	6,082	3,068	124,464
	1975	0	2,487	0	0	0	0	6,285	2,334	0	14,528	0	55,691	28,161	0	16,516	5,984	3,296	135,282
HRW	1970	15,893	9,520	2,234	8,010	1,261	1,502	115,891	26,771	17,674	56,588	0	0	0	0	20,371	65	1,978	277,758
	1975	12,501	10,035	2,124	8,620	1,255	1,747	112,681	25,722	19,577	60,980	0	0	0	0	20,185	54	2,524	278,005
HRS	1970	5,758	2,082	3,860	0	3,305	452	4,419	196	38,241	2,148	0	0	0	0	33,040	108	486	95,095
	1975	6,000	3,610	3,704	0	3,307	360	5,486	239	36,380	1,054	0	0	0	0	33,489	91	718	94,438
White	1970	9,888	5,227	0	6,826	0	0	0	0	0	1,681	0	25,957	67	0	4,926	108	0	54,680
	1975	12,170	5,954	0	7,734	0	0	0	0	0	1,328	0	26,392	94	0	5,755	91	0	59,518
Durum	1970	1,556	635	404	0	2,707	0	1,178	0	21,825	0	0	0	0	0	0	0	0	28,305
	1975	1,916	903	492	0	2,988	0	1,465	0	21,139	0	0	0	0	0	0	0	0	28,903
All Wheat	1970	33,095	20,213	6,499	14,836	7,273	1,954	126,541	28,975	77,739	77,661	0	74,973	24,720	0	73,928	6,364	5,532	580,303
	1975	32,587	22,989	6,319	16,354	7,550	2,107	125,917	28,295	77,096	77,890	0	82,083	28,255	0	75,944	6,220	6,537	596,143

in region 12. Hard red winter wheat and hard red spring wheat purchases in region 12 have shown a distinct declining trend and were projected to approach zero by 1970.

APPENDIX

Dependent and independent variables employed in domestic demand analysis using regression techniques.

Dependent Variables

Y_1 = Per capita disappearance of hard red spring wheat.

Y_2 = Per capita disappearance of hard red winter wheat.

Y_3 = Per capita disappearance of soft red winter wheat.

Y_4 = Per capita disappearance of white wheat.

Y_5 = Per capita disappearance of durum wheat.

Independent Variables

X_1 = Price of hard red spring wheat.

X_2 = Price of hard red winter wheat.

X_3 = Price of soft red winter wheat.

X_4 = Price of white wheat.

X_5 = Price of durum wheat.

X_6 = Per capita production of hard red spring wheat.

X_7 = Per capita production of hard red winter wheat.

X_8 = Per capita production of soft red winter wheat.

X_9 = Per capita production of white wheat.

X_{10}= Per capita production of durum wheat.

X_{11}= Protein content of hard red spring wheat.

X_{12}= Protein content of hard red winter wheat.

X_{13}= Per capita deflated disposable income.

X_{14}= Time (1947=1, 1948=2, 1949=3, ..., 1966=20).

<u>Equation 1</u>. (Per capita disappearance of hard red spring wheat = Y_1) 1947-1966.*

$$\text{Log}Y_1 = -.1943 \underset{(.00303)}{-.00781X_{14}} \underset{(.1070)}{+.3081\log X_6}$$

$$\underset{(.3218)}{-.5581\log X_{12}} \underset{(.0911)}{-.1093\log X_7}$$

$$\underset{(.5576)}{+.6842\log X_{11}} \underset{(.2516)}{+.2277\log X_2}$$

$R^2 = .8834$

<u>Equation 2</u>. (Per capita disappearance of hard red spring wheat = Y_1) 1952-1966 delete logarithms (price and time only).

$$\text{Log}Y_1 = .2663 \underset{(.0023)}{-.0157X_{14}} \underset{(.1920)}{-.4424\log X_1}$$

$R^2 = .8564$

<u>Equation 3</u>. (Per capita disappearance of hard red spring wheat = Y_1) 1952-1966 (all variables).

$$\text{Log}Y_1 = -4.6977 \underset{(.0066)}{-.0269X_{14}} \underset{(.2563)}{-.0689\log X_1}$$

$$\underset{(.8741)}{+1.5909\log X_{13}} \underset{(.0988)}{+.1533\log X_7} \underset{(.2676)}{-.2938\log X_{12}}$$

$R^2 = .9160$

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*Figures in brackets are the values of the standard error of the slope or beta coefficients.

Equation 4. (Per capita disappearance of hard red winter wheat = Y_2) 1947-1966, delete logarithms

$$Y_2 = .1605 - .0856X_{14} - 1.2035X_4 + .9587X_1 + .0014X_{13}$$

(.0255) (.3885) (.3791) (.00075)

$R^2 = .6810$

Equation 5. (Per capita disappearance of hard red winter wheat = Y_2) logarithms

$$Y_2 = .9541 - .0919X_{14} - 1.0139\log X_4 + .8951\log X_1$$

(.3829) (.3588)

$$+ .0018\log X_{13} + .0738\log X_7$$

(.00074) (.0431)

$R^2 = .7363$

Equation 6. (Per capita disappearance of soft red winter wheat = Y_3)

$$\text{Log}Y_3 = .0980 - .0100\log X_{14} + .2237\log X_8$$

(.0014) (.0816)

$$- .2629\log X_4$$

(.1206)

$R^2 = .9134$

Equation 7. (Per capita disappearance of white wheat = Y_4)

$$\text{Log}Y_4 = -14.2930 - .0711X_{14} - 1.2288\log X_4$$

(.0128) (.3802)

$$+ 4.6016\log X_{13}$$

(1.5530)

$R^2 = .8778$

Equation 8. (Per capita disappearance of durum wheat = Y_5)

$$\text{Log}Y_5 = .6085 - .3392\log X_5 + .4474\log X_7 + .3975\log X_6 + .5603\log X_{10}$$

$$(.1040) \qquad (.1755) \qquad (.1749) \qquad (.3050)$$

$$R^2 = .8423$$

Equation 9. (Per capita disappearance of hard red spring wheat = Y_1) using time and price only and time in logarithmic form, 1952-1966 to project demand through 1970.

$$\text{Log}Y_1 = .48888 - .41961\log X_{14} - .36144\log X_1$$

$$(.0456) \qquad (.1383)$$

$$R^2 = .9131$$

APPENDIX TABLE 1. REGRESSION ANALYSIS OF INCOME ON THE CONSUMPTION OF DIFFERENT WHEAT PRODUCTS, UNITED STATES, 1955 AND 1965[a]

Wheat Products (Dependent Variables)	Type of[b] Equation		Coefficient of Determination		A		B_1	
	1955	1965	1955	1965	1955	1965	1955	1965
Flour and other cereal products	Log	Square	.9571	.8022	2.0424	5.9810	-.3558	-.0002578
White flour	Log	Square	.9283	.9169	2.2739	2.6056	-.5295	-.0002251
Prepared flour mixes	Square	Log	.9235	.9321	.2375	-1.9499	.0001275	.4353
Cold wheat cereals	Square	Square	.7982	.9091	.1125	.0908	.00003692	.00003013
Hot wheat cereals	—	—	—	—	—	—	—	—
Macaroni, Spaghetti, Noodles	Square	Log	.7557	.6981	.2681	-1.5054	.00005828	.2984
Bakery products	Square	Square	.8805	.9013	3.6252	4.0583	.001074	.0008617
White and whole wheat bread	Square	Square	.7564	.7312	2.7039	2.5295	.0005943	.0004052
Baked goods other than bread	Square	Square	.9532	.9674	.8724	1.4658	.0003633	.0004081

[a]Variables Y_1, Y_2, Y_3, Y_4, Y_7, and Y_9 were significant at the 99 percentile in 1955 and 1965. Variable Y_5 was insignificant at the 95 percentile in 1955 and 1965. Variables Y_6 and Y_8 were significant at the 95 percentile in 1955 and at the 99 percentile in 1965.

[b]Linear indicates a linear equation. Log indicates a logarithmic equation. Square indicates a quadratic equation.

[c]The income level of maximum and minimum consumptions was found by setting the first derivative of the quadratic equations equal to zero. The calculated incomes were generally high in comparison to the data used in deriving the regression equations because of the quadratic form of the curve and a lack of data for higher incomes.

Table is continued on following page.

APPENDIX TABLE 1. REGRESSION ANALYSIS OF INCOME ON THE CONSUMPTION OF DIFFERENT WHEAT PRODUCTS, UNITED STATES, 1955 AND 1965[a] (Continued)

Wheat Products (Dependent Variables)	B_2		Income of[c] Maximum Quantity		Income of[c] Minimum Quantity	
	1955	1965	1955	1965	1955	1965
Flour and other cereal products	—	.000000006359	—	—	—	20,191
White flour	—	.000000006421	—	—	—	17,528
Prepared flour mixes	-.000000005895	—	10,812	—	—	—
Cold wheat cereals	-.000000001920	-.000000001082	9,612	13,919	—	—
Hot wheat cereals	—	—	—	—	—	—
Macaroni, Spaghetti, Noodles	-.000000002986	—	9,757	—	—	—
Bakery products	-.00000005056	-.00000002995	10,621	14,386	—	—
White and whole wheat bread	-.00000003124	-.00000001715	9,511	11,812	—	—
Baked goods other than bread	-.0000000146	-.00000001182	12,442	17,260	—	—

[a]Variables Y_1, Y_2, Y_3, Y_4, Y_7, and Y_9 were significant at the 99 percentile in 1955 and 1965. Variable Y_5 was insignificant at the 95 percentile in 1955 and 1965. Variables Y_6 and Y_8 were significant at the 95 percentile in 1955 and at the 99 percentile in 1965.

[b]Linear indicates a linear equation. Log indicates a logarithmic equation. Square indicates a quadratic equation.

[c]The income level of maximum and minimum consumptions was found by setting the first derivative of the quadratic equations equal to zero. The calculated incomes were generally high in comparison to the data used in deriving the regression equations because of the quadratic form of the curve and a lack of data for higher incomes.

APPENDIX TABLE 2. REGRESSION ANALYSIS OF INCOME ON THE CONSUMPTION OF VARIOUS WHEAT PRODUCTS IN FOUR REGIONS OF THE UNITED STATES IN 1955

Region	Flour and Other Cereal Products	Flour Other Than Mixes	Prepared Flour Mixes	Cold Wheat Cereals	Hot Wheat Cereals	Macaroni Spaghetti Noodles	Bakery Products	White and Whole Wheat Bread	Baked Goods Other Than Bread
Northeast									
Significance[a]	*	*	*	NS	NS	*	*	NS	**
Type of equation[b]	Log	Log	Square			Linear	Square		Square
Relationship	Inverse	Inverse	Direct			Inverse	Direct		Direct
R-squared	.5829	.6664	.7864			.6771	.7282		.8662
A	.0119	1.7423	.3048			.7534	4.8119		.8029
B_1	-.1717	-.4634	.0000948			-.0000199	.000879		.000464
B_2			-.00000000536				-.0000000493		-.0000000241
North Central									
Significance[a]	*	**	*	NS	NS	**	**	NS	**
Type of equation[b]	Square	Square	Log			Log	Log		Log
Relationship	Inverse	Inverse	Direct			Direct	Direct		Direct
R-squared	.6988	.6360	.6360			.8230	.7071		.9274
A	5.898	-.9749	-.9749			-1.646	.1753		-.8595
B_1	-.000223	.2368	.2368			.3547	.1941		.3268
B_2	.00000000599	.0000000112							
South									
Significance[a]	**	**	*	*	NS	NS	**	**	**
Type of equation[b]	Square	Square	Log	Log			Square	Square	Log
Relationship	Inverse	Inverse	Direct	Direct			Direct	Direct	Direct
R-squared	.9874	.9794	.5009	.6613			.9562	.8464	.9495
A	16.2683	8.4389	-1.535	-2.125			2.7211	1.9971	-1.3199
B_1	-.002256	-.00122	.3393	.3535			.00126	.000804	.4565
B_2	.000000104	.0000000530					-.0000000601	-.0000000443	
West									
Significance[a]	*	*	*	NS	*	NS	*	NS	**
Type of equation[b]	Linear	Square	Log		Log		Log		Square
Relationship	Inverse	Inverse	Direct		Inverse		Direct		Direct
R-squared	.5944	.8129	.6790		.5298		.6844		.9495
A	5.6481	3.3384	-.1160		.4415		.3371		.9663
B_1	-.000127	-.000326	.3009		-.3512		.1409		.000238
B_2		.0000000111							.00000000630

[a]NS indicates not significant.
[b]Linear indicates a linear equation. Log indicates a logarithmic equation. Square indicates a quadratic equation.
*Significant at the 95 percentile.
**Significant at the 99 percentile.