Role of Hard Red Winter Wheat in the Pacific Northwest

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The Pacific Northwest is an important producer of soft white wheat, which is utilized primarily in foreign markets. In recent years 85 percent of PNW white wheat has been exported, with much of it going into the Japanese cash market to make noodles, cakes, pastries, and snack foods. Some observers now are suggesting that the nature of this market is shifting toward increased consumption of bread and rolls as income levels increase and taste and preferences become more "westernized" [1,8,17,22]. This implies that a substantial portion of future growth in demand for food wheat in Asia then would be for hard red wheats used in roll and bread making. Although the drop of white wheat exports from PNW ports in 1968 from 4.1 million to 2.7 million tons was due primarily to a seasonal quality issue, it has been suggested that this adjustment also might have represented a vanguard signal in a foreign market shift toward bread wheats.[2/] An Oregon State University Wheat Task Force was commissioned to review possible changes in wheat production and marketing for the Pacific Northwest including prospects for shifts in demand toward hard red wheats [7].

The OSU Task Force urged that a research effort be conducted to evaluate prospects of some PNW wheat producers shifting from production of soft white wheat to hard red winter wheat. Complex technical and economic issues are involved in determining whether shifts in this direction can and should be made in view of existing alternatives and uncertainties. Climates and

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[2/] Total wheat exports from PNW ports during 1968 were considerably in excess of those amounts since large volumes of Great Plains hard wheat are exported to the Far East through PNW ports.

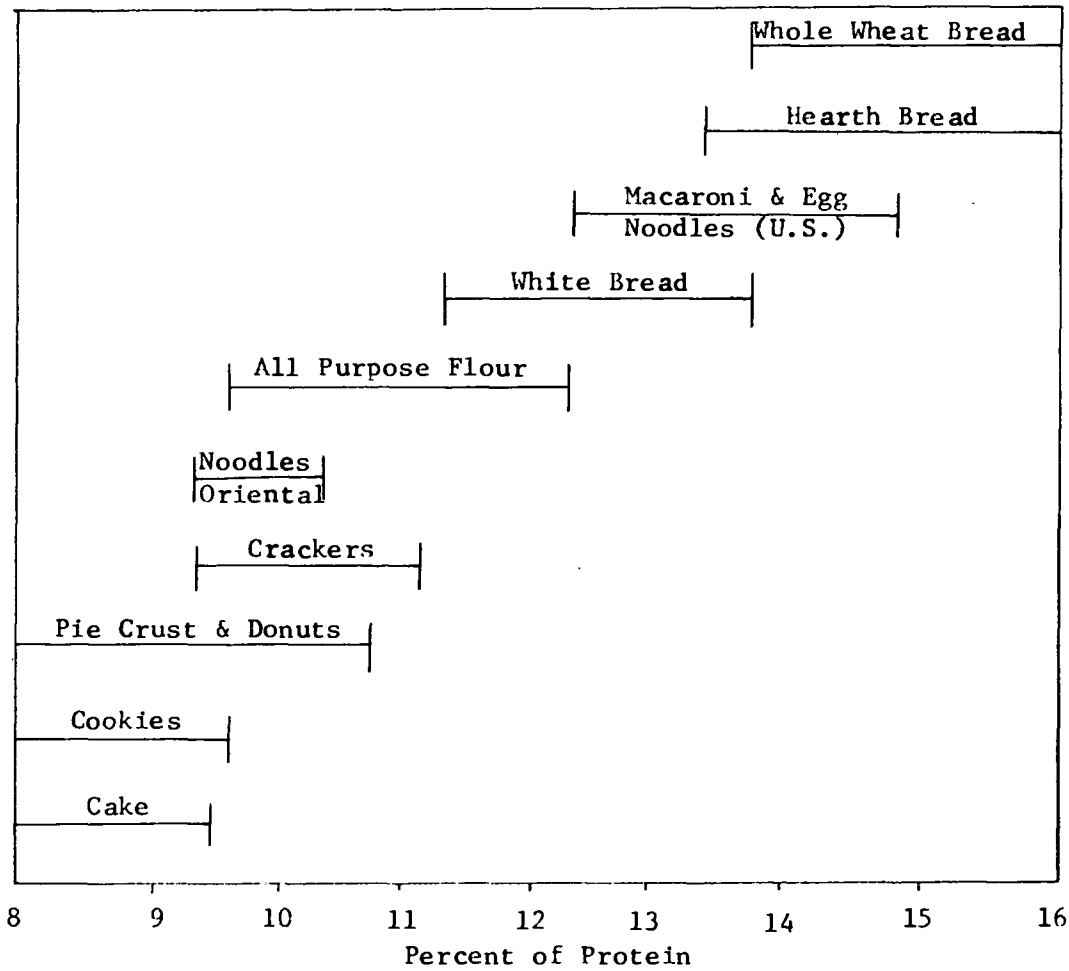
soils of the region, cultural practices, yields, product quality, inter-regional competition, government programs, and scope of domestic and foreign markets provide but a partial listing of factors that will affect farm price and production costs which, in turn, affect profitability of wheat production in the PNW.

The purpose of this report is (1) to trace the nature and scope of the hard red winter wheat market by reviewing supply and demand conditions for wheat in foreign, domestic, and local markets, and (2) to evaluate this information for possible implications that it may have for PNW wheat producers. Data used in this study were obtained from available secondary sources.

The World Market with Emphasis on Hard Wheat

Wheat destined for human consumption is not a homogeneous product. There are distinct types of wheat used for separate purposes, and sold in different markets. This is recognized by the three wheat markets identified in foreign trade in terms of commercial trade classification [3]. They are Hard, Soft, and Durum wheats. This provides the official basis for "differentiating" wheat markets. Hard wheats are used in baking of breads and hard rolls. Protein content of these wheats range from 10 to 17 percent. Breads made from hard wheat normally have a longer shelf life than those from soft wheats. Soft wheat is used chiefly for baking of cakes, pastries, cookies, crackers, and breakfast cereals. Protein content ranges from 6 to 11 percent yielding a flour of weak strength and poor stability for bread making. Unless blended with hard wheat flour, soft wheat is undesirable for bread. Durum wheat has a very hard and flinty kernel. This special characteristic directs its use in milling of semolina flour to produce spaghetti, macaroni, and other pasta products. Derived demand by millers for the various market classes of wheat, generally speaking, is related to the range in protein levels required to produce various consumer products made from wheat. Quisenberry, et. al., summarized the relationship between use and protein content as shown in Figure 1 [14].

FIGURE 1. Percentages of Protein in Wheat Used in Different End Products.



Trends in World Demand

While many U.S. and world demand studies on wheat have been conducted, none of them separate wheat into major market (human, livestock, and industrial use) or commercial trade classifications. Division by trade classification would be required to single out world demand for hard wheats. Even if accomplished, it is not obvious that such a division would be particularly meaningful since flour millers blend wheat classes with varying protein and baking qualities to achieve the desired end product. Consequently, any discussion on world demand for hard red winter wheat, by necessity, must focus upon world demand for wheat in general.[3/]

[3/] An excellent review of recent wheat demand studies are provided in "World Demand Prospects for Wheat in 1980," Agricultural Economic Report No. 62, ERS, USDA, July 1970.

Final demand for wheat in the world food market is an economic issue. It is not related directly to human need or nutritional considerations, but rather to the various quantities of wheat which world consumers are willing to purchase at various prices. The quantity of wheat demanded is affected principally by (1) the number of world consumers, (2) consumer incomes, (3) consumer tastes and preferences, (4) price of wheat, and (5) price of wheat substitutes. Each of the five demand factors will be discussed individually with heavy reliance placed upon results of the ERS demand studies. While each of the factors will be discussed singly, the reader must be cautioned that elements of total world demand are interrelated, dynamic, and complex in character.

World Population. World population levels and growth rates affect demand for wheat. In most developing countries where low per capita incomes dominate, net annual population growth rates are high, ranging from 2.6 to 3.6 percent. In most countries with high per capita incomes, net annual population growth rates are much lower, ranging from .1 to 2.0 percent [27]. However, the number of mouths to feed is not a crucial factor affecting world demand. Since demand is a market economy concept, it is influenced more strongly by consumer purchasing power than population levels. Furthermore, considerable volume of world wheat consumption at local and village levels is not accounted for, since it does not enter normal marketing channels.

Consumer Incomes. Generally speaking, the demand for wheat is responsive to income changes in low income countries and unresponsive in high income countries. As per capita incomes rise in most high-income wheat-producing nations, with other factors held constant, per capita consumption of wheat declines. This is the case with the United States, Canada, most European countries, and Australia. The trend is expected to continue. As per capita incomes rise in most low income countries where wheat consumption is relatively low, per capita wheat consumption is expected to increase with the rate of increase influenced not only by consumer incomes, but also by economic forces discussed in the next four sections. Increased income in Japan since WWII is one of the factors which contributed to increased wheat demand in that country.

Demand for wheat as a feed in livestock production also may develop since red meat consumption is highly income responsive. The relative price

of substitute feed grains is an important consideration since wheat is used as a feed only when it is priced competitively with feed grains.

Consumer Tastes and Preferences. Changes in consumer tastes and preferences affect food consumption patterns. On the world scene, this has been pronounced most for wheat consumption in Japan since WWII. Wheat has substituted substantially for rice in the Japanese diet due, in part, to income changes, but primarily to changes in eating habits attributed to (1) a national school lunch program initiated in 1947, (2) promotion of the nutritional benefits of wheat products, (3) emulation of "Western" tastes, and (4) urbanization.

Wheat Price. Demand for food wheat is affected by its price level. Generalization of the recent ERS demand studies indicate that for wheat producing regions of the world (both developed and less developed) consumer responses to changes in price of wheat is relatively small. On the other hand, in wheat deficit countries, the demand response to changes in price is relatively large.

Prices of Food Grain Substitutes. Rice is an important food grain in many of the developing countries, particularly in Southeast Asia, Japan, East Asia, and portions of Africa. In these regions, wheat is an important competitive food substitute for rice and sorghum. If certain conditions caused the price of rice to decline, such as increased rice supplies, more rice will be consumed in the diet with a corresponding reduction in food wheat consumption. Internal governmental pricing policies and availability of wheat substitutes appear as dominant factors in determining price responsiveness.

Prices of Feed Grain Substitutes. In both U.S. and world feed grain markets, the price of coarse grains (corn, barley, oats, rye, and grain sorghum) are important in determining the extent to which wheat will substitute for coarse feed grains and, hence, the aggregate demand for wheat. In the U.S., as the price differential between corn and wheat narrows, the amount of wheat entering feed grain markets increases, reflecting, in part, the derived demand responsiveness to red meat consumption. Historically, wheat has been priced higher than other coarse feed grains in both U.S. and world markets.

Wheat stocks have accumulated resulting in lower wheat prices with correspondingly greater use of wheat as a feed grain.

Potential World Demand for Hard Wheats. What impact might the factors which affect changes in world demand, described above, have upon hard wheat demand? In Japan and South Korea, the largest single use of wheat is for noodles resulting in 40 percent of total wheat imported being soft wheat. However, an apparent recent trend in Asian countries is toward use of higher protein wheat for bread, rolls, and convenience foods, such as prepared sandwiches. Recent studies by Baum [1], Barse [8], and Taylor [7] attribute this trend to higher per capita income and changes in consumer tastes. The Western Wheat Associates 1969-70 Marketing Plan reports that bread has been accepted as a food staple in recent years [22]. Baum further predicts that countries such as India, with internal transportation and distribution problems, will demand higher protein bread-type grain for their population centers. Much of this wheat could be supplied by imports. Seevers suggests that hard wheats may not be displacing soft wheats at all and that the trend actually reflects increased world demand for both hard and soft wheats with little evidence of substitution between them [16].

World Production and Distribution

World grain production of wheat, rice, corn, barley, rye, oats, and sorghum is dominated by the U.S., Mainland China, U.S.S.R., India, Canada, and the European community. World grain production for selected recent years are shown in Table 1.

TABLE 1. World Production of All Grains for Selected Years, 1962-1971.

Country	Production in million metric tons			
	1963	1966	1969	1971
United States.....	174.7	183.2	203.1	229.0
Mainland China.....	155.0	168.0	179.0	189.0
U.S.S.R.....	107.5	171.2	162.4	180.0
India.....	101.5	90.0	116.8	133.0
European Community.....	57.8	59.8	71.4	76.0
Canada.....	34.0	38.5	36.5	39.0
All other countries.....	195.5	215.3	234.8	243.0
Total.....	826.0	926.0	1004.0	1089.0

SOURCE: The Southwestern Miller, Vol. 50, No. 40, November 30, 1971.

Wheat accounts for approximately 26 percent of world grain production. Rice, corn, barley, oats, rye, and other grains account for 24, 22, 8, 6, 4, and 10 percent respectively. World production of wheat shows significant production increases in recent years in U.S.S.R., Asia, and Oceania, as shown in Table 2 [20].

TABLE 2. World Wheat Production by Region, Selected Years 1954/55 through 1970/71.

Region	1954/55--1958/59	1967/68	1968/69	1969/70	1970/71
	million bushels				
Europe.....	1784.4	2671.5	2653.0	2600.7	2461.6
U.S.S.R.....	2143.9	2840.3	3431.6	2936.4	3490.7
North & Central America	1553.1	2193.8	2293.0	2225.6	1793.8
South America.....	347.4	347.8	311.6	376.3	295.4
Asia.....	1017.2	1395.9	1655.7	1742.4	1722.9
Mainland China.....	909.0	845.1	771.6	819.4	845.1
Africa.....	206.2	241.4	308.6	273.8	297.6
Oceania.....	166.1	293.1	560.0	398.0	289.5
TOTAL.....	8127.3	10,828.9	11,985.1	11,362.6	11,196.6

SOURCE: "1971 World Wheat Statistics," International Wheat Council, London.

Use of short-stemmed wheat varieties from the "Green Revolution" accounts for much of the production increases in Asia.[4/] These increases are being absorbed currently by domestic demands. However, an increasing number of developing nations throughout the world now are meeting their own domestic food and feed needs with wheat, rice, and corn and are looking to foreign markets as an outlet for their expanded grain production and a hopeful basis to provide and conserve needed foreign exchange to fuel their expanding industrial needs. Much of wheat production increases in the U.S.S.R. and Oceania are intended for export. Wheat production decreases since 1967/68 occurred in the high-income regions of Europe and North and Central America reflecting lower domestic consumer demands and lower world wheat prices with corresponding shifts to other crops. Low wheat production in South America reflects, in part, the dominance of corn as the principal food grain.

[4/] "Green Revolution" is a term used in recent development literature to represent the marked world grain production increases attributed to genetic advances in small grains, particularly wheat, corn, and rice. A review of developments in this area is provided by Lester R. Brown's Seeds of Change: The Green Revolution and Development in the 1970's, Praeger, 1970.

Of the major world grain producing countries, only the U.S., U.S.S.R., and Canada traditionally have produced sufficient volume in excess of domestic demand to be major world exporters. Wheat is the major export grain accounting for 57 percent of total grain exports [26]. Coarse grains (mainly corn) account for 34 percent and rice 7 percent of world grain exports. The U.S. is the single largest exporter of each of the three grain types.

Six countries -- U.S., Canada, Australia, France, U.S.S.R., and Argentina -- account for more than 90 percent of world wheat and wheat flour exports in recent years, as shown in Table 3.

TABLE 3. Major World Wheat and Wheat Flour Exporters.

Country	Ave. 1959/64	1966/67	1968/69	1969/70[a/]
	1000 metric tons			
United States.....	18,359	19,978	14,693	16,480
Canada.....	10,175	14,833	8,700	8,999
Australia.....	5,408	6,984	5,369	7,250
France.....	2,164	3,070	6,048	6,125
U.S.S.R.....	4,449	4,126	5,397	5,887
Argentina.....	2,210	3,059	2,785	2,108
TOTAL.....	42,765	52,050	42,992	46,843
WORLD TOTAL.....	45,367	55,563	44,995	50,257

SOURCE: "1971 World Wheat Statistics," International Wheat Council, London.
[a/] Preliminary.

France and the U.S.S.R. have increased their share of the market in recent years with a corresponding decline for U.S., Canada, and Argentina. A factor contributing to the U.S. loss of market shares has been the difficulty of the U.S. in adjusting prices under terms of the International Grains Agreement of 1969 [13].

The major world markets for U.S. wheat exports are shown in Table 4.

TABLE 4. U.S. Exports of Wheat and Wheat Flour to Major World Market Areas, Selected Years.

Destination	1958/59[a/]	1963/64[a/]	1968/69[a/]	1969/70[a/b/]
	----------1000 metric tons----------			
Europe.....	3,476	5,334	2,279	2,219
North & Central America	518	340	537	525
South America.....	1,084	2,560	2,209	2,442
Asia.....	6,187	7,763	8,819	10,108
-- Japan.....	946	1,036	1,839	2,382
-- India.....	3,330	2,545	2,317	2,315
-- Pakistan.....	495	720	505	988
Africa.....	766	3,059	846	1,151
All others.....	35	480	3	35
TOTAL.....	12,066	19,536	14,493	16,480

SOURCE: World Wheat Statistics, International Wheat Council, London.
[a/] July 1 through June 31.
[b/] Preliminary.

The volume of exports to Europe has declined reflecting their increased domestic wheat production and exports, particularly from France. The largest export increases went to Asia, particularly Japan and Pakistan, with decreased volume to India in recent years. The hard wheat class has dominated international wheat trading by accounting for 60 to 80 percent of world wheat exports [25]. Climatic considerations have contributed to this emphasis.

Climatically, hard wheats, of either winter or spring habit, grow best in the medium temperate zones under fairly dry weather conditions. The kernel is small and plump, and has a hard texture and is vitreous. The United States, Canada, and the U.S.S.R. have vast areas climatically suited to hard wheats; consequently, it comes as no surprise that they are, by far, the largest hard wheat producers. Hard red winters and hard red springs make up the most important part of the U.S. contribution of this world wheat export class. Hard red spring is Canada's major subclass, accounting for over 90 percent of their total wheat output. Canadian spring wheats, exported as Canadian Western Red, have been the quality wheats of long standing on the international market. Australia produces a prime hard wheat containing 11 to 13 percent protein. These wheats account for about 8 percent of the wheat

area in Australia. In Australia and Argentina there are medium-hard or semi-hard wheats that fall between the hard and soft classes, thereby gaining the trade name "filler wheat". These wheats, most often used for blending, are lower in protein, ranging from 9 to 12 percent. The U.S. produces some medium hard wheats in both hard winter and hard white subclasses.

U.S. Production and Utilization

Hard wheats have increased in importance relative to the other wheat classes grown in the U.S. during the 45-year period from 1919 through 1964, as shown in Table 5. U.S. wheat acreage devoted to hard wheats increased from 56 to 73 percent. While some small portion may be attributed to increased domestic demand for bread-type wheats, U.S. feed grain pricing policy has played a significant role. In the soft wheat regions, as wheat prices have declined over the past two decades, farmers have shifted production to soybeans and corn. In the drier hard wheat regions, however, few alternative crops existed, leaving farmers with the singular choice of increasing hard wheat production to compensate for lower wheat prices.

TABLE 5. Percentage of Wheat Acreage in U.S. Occupied by Market Classes, 1919-1964.

	Hard wheats		Soft Wheats		
Year	Winter	Spring	Red Winter	White	Durum
1919....	32.0	24.2	30.1	7.3	6.4
1929....	43.5	22.0	17.1	7.4	9.4
1939....	47.6	20.9	19.6	6.6	5.3
1949....	54.2	20.8	13.0	7.8	4.2
1959....	56.7	19.5	12.7	9.0	2.1
1964....	57.6	15.6	13.6	8.4	4.8

SOURCE: Agricultural Research Service, USDA. Based on Distribution of the Varieties and Classes of Wheat in the United States, published in 1959 and 1964.

Hard red winter wheat (HRW) is the largest and most important market class of wheat grown in the United States. More than 50 percent of domestic

wheat produced and distributed in the U.S. and Abroad is hard red winter, as shown in Table 6.

TABLE 6. U.S. Supply and Disappearance of Wheat by Class, 1970-71 Preliminary.

Item	Hard wheats		Soft wheats			
	Winter	Spring	Red Winter	White	Durum	Total
	million bushels					
Carry-over, July 1.....	625	129	23	30	78	885
Production.....	768	198	182	180	50	1378
TOTAL SUPPLY.....	1393	328	205	210	128	2264
Domestic disappearance[a/]	391	124	164	80	35	794
Exports[b/].....	451	113	24	110	39	739
TOTAL DISAPPEARANCE..	842	237	190	190	74	1533
CARRY-OVER, June 30..	551	91	15	20	54	731

SOURCE: Wheat Situation. ERS, USDA, November 1971.

a/ Wheat used for food (in the United States and U.S. territories, and by the military, both at home and abroad), feed, seed, and industry.

b/ Exports are of wheat, including flour and other products in terms of wheat.

Hard red winter wheats are grown in areas of limited rainfall where soils are relatively high in available nitrogen. Both conditions contribute to high protein content of hard wheats. The heart of HRW wheat production is the Great Plains region with Kansas producing about one-third of the U.S. HRW wheat crop. HRW wheat production competes with SRW wheat in the eastern areas of higher rainfall. In the north, fall-seeded HRW wheat gives way to HRS and Durum wheats. Some HRW wheat production is scattered throughout the Inter-Mountain and Western States. Production location by major wheat classes is shown in Figure 2.

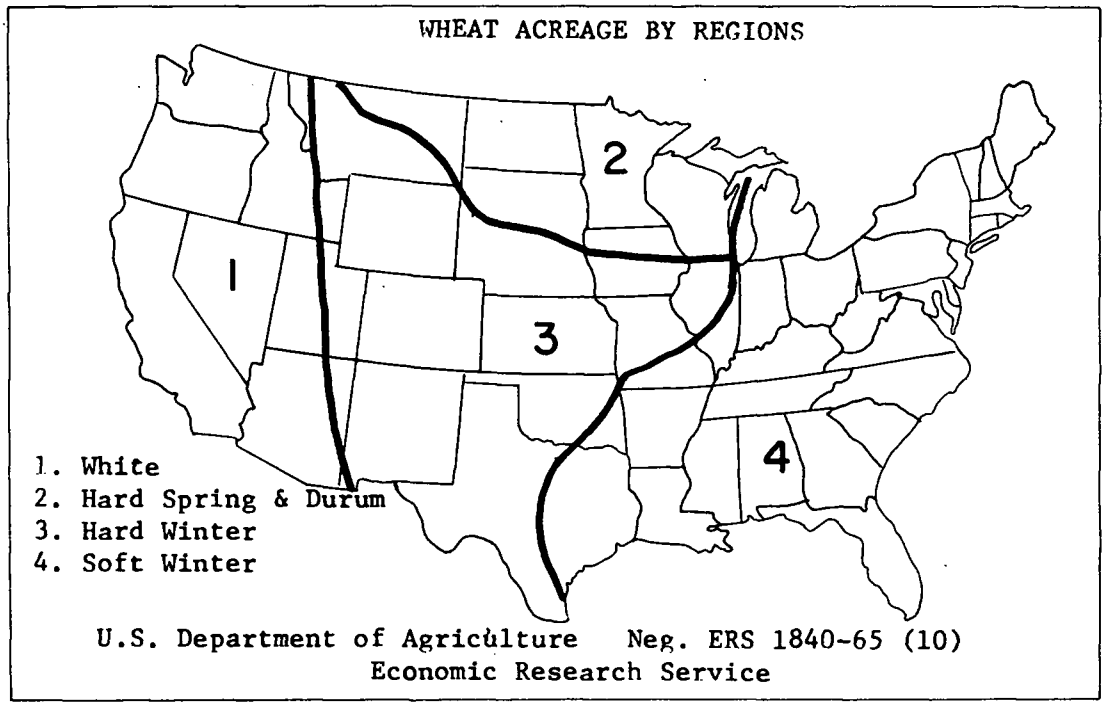


FIGURE 2. Production location by major wheat classes.

Hard Red Spring Wheat is the millers' standard of excellence in bread making. It is grown principally in the northern sections of the U.S., where climatic extremes require spring-sown grains. HRS is also grown in the Inter-Mountain area, including Idaho, with traces found in several adjacent states. Since World War II, domestic use of Hard Red Spring Wheat has averaged 140 million bushels a year. As much as 85 percent of the hard red springs move into food use in the United States. At times, HRS is blended with Durum wheat to produce flour for macaroni products. This normally occurs only when Durum is in short supply. U.S. HRS supplies sometimes are supplemented by small amounts of wheat imported from Canada. Historically, HRS exports seldom have been larger than 50 million bushels, but much greater quantities have been shipped in recent years. Normally, because of price, HRS has been an unattractive purchase for countries buying wheat under food aid programs. Even though HRS is grown in northern central U.S., less than half the total spring wheat exports normally move through the Great Lakes. In recent years, the majority of export shipments have been from the Atlantic ports to Europe and from the Pacific ports to Japan.

Durum, the hardest of all wheats, is grown principally in Northeastern North Dakota. Over four-fifths of the U.S. Durum crop is produced in that state. Durum production is affected by the price of hard wheats. As Durum supplies increase, the premium paid for it over HRW wheat decreases, thus tending to discourage further expansion. The United States now exports a large portion of its annual production of Durum, as noted from Table 6.

Wheat exports in 1970/71 accounted for almost one-half of total supply disappearance. Since 1960, from 50 to 75 percent of wheat exports have been from U.S. governmental concessional sales, as shown in Table 7. During that time, the U.S. government exported an average of 450 million bushels of wheat annually.

TABLE 7. U.S. Exports of Wheat and Wheat Flour by Program, 1960-69.

Year	Under Gov't. programs[a/]	For dollars	Total exports
	million bushels		
1960.....	457.7	203.8	661.5
1961.....	491.1	228.3	719.4
1962.....	485.4	158.4	643.8
1963.....	503.4	352.7	856.1
1964.....	567.3	157.7	725.0
1965.....	568.9	298.5	867.4
1966.....	373.0	371.3	744.3
1967.....	477.5	283.6	761.1
1968.....	302.5	241.7	544.2
1969.....	320.8	285.3	606.1

SOURCE: 1971 Agricultural Statistics. USDA, Washington, D.C.

[a/] Public Law 480 programs represent nearly all of the government exports. Only a trace is marketed through Mutual Security (AID) programs. PL 480 programs are divided into four categories: Title I (Sales for Foreign Currency), Title II (Disaster Relief), Title III (Foreign Donations and Barter), Title IV (Long-Term Dollar Sales).

Wheat exports under food aid programs reached a high of 569 million bushels in 1965 with a low of 302.5 million bushels in 1968. The 1969-70 fiscal year saw a slight increase to 321 million bushels of wheat shipped. The future of concessional wheat sales will be determined, in part, by the U.S. Congress and its attitude toward funding of food aid programs, as well as the future world market for food and feed grains.

The Pacific Northwest Market and Role of Hard Wheats

Trends in Milling Demand

Scarcity of hard wheats produced in the PNW historically has resulted in domestic in-shipments of hard wheat for milling of multi-purpose family flour. During the past 30 years, PNW millers annually used about 35 million bushels of hard wheat [24]. This was blended with some 15 to 20 million bushels of PNW white wheat with the amount used dependent upon the protein content and price of the PNW white wheat crop. A rapid decline of millers in the PNW over the past decade has resulted in greater importation of bread flour with PNW white wheat blended in to meet protein specifications.

Location and Transportation

During early history of the PNW wheat industry, large shipments of PNW grain were moved to various domestic markets in the U.S. [24]. In recent years, changes in the freight rate structure have altered the patterns of commerce. Shipments to domestic markets outside the region, including California, have been limited. PNW farmers have freight rate advantage for grain used within the primary market region but are at a distinct disadvantage in secondary markets, such as California. Prevailing freight rates favor westbound traffic giving Montana hard wheat and wheat flours an advantage in supplying hard wheat demands by PNW millers [2]. For the export market, however, PNW producers have a freight advantage.

Asian countries prefer wheat from North Coast ports since transportation time is a week less than from Gulf Ports, resulting in lower sea freight and interest charges [19]. Being able to provide both soft and hard wheat and blended cargoes from North Coast ports is another advantage.

Production and Distribution

A wide diversity of wheat classes and varieties have been grown in the Pacific Northwest area. Since 1919, white wheat has been the most important wheat class and has continued to gain in favor over the years, as noted from Table 8. The PNW produced substantial quantities of HRW wheat from 1924 through 1949. Since 1949, it has declined in importance reaching a low of 3.8 percent of total production in 1967. Improved white wheat varieties,

TABLE 8. Percentage of Wheat Production by Wheat Classes in Oregon and Washington, Selected Years 1919-1970.a/

Year	White	Hard Red Winter	Hard Red Spring	Soft Red Winter
	----------Percentage----------			
1919.....	58.6	9.4	8.4	9.8
1924.....	52.6	25.1	4.2	11.0
1939.....	65.8	25.8	2.0	4.3
1949.....	72.7	24.1	1.7	1.0
1953.....	88.0	11.5	0.1	0.4
1955.....	89.0	10.5	0.2	0.2
1959.....	92.9	6.4	0.4	0.2
1962.....	95.4	4.0	0.3	0.3
1967.....	96.0	3.8	T	.2
1969.....	91.1	8.7	T	.2
1970.....	85.3	14.2	T	.2

SOURCE: Data from 1919 through 1953 were obtained from "Pacific Northwest Wheat," by Harold F. Hollands, Oregon Agricultural Experiment Station Bulletin 556, Oregon State University, Corvallis, May 1956; 1955 through 1962 data were from "Wheat--Supply, Distribution, and Value in the Pacific Northwest Wheat Project," Statistical Bulletin No. 2, Western Wheat Associates, USA, Inc., and USDA cooperating, November 1963. Data from 1967 through 1970 are wheat production estimates by variety prepared by the Oregon and Washington Crop Reporting Services in cooperation with the Pacific Northwest Crop Improvement Association.

a/ Excludes minor counties representing less than 10% of Oregon and 1% of Washington production.

climatic conditions favoring white wheat production, and lack of premiums on red, all contributed to the decline of HRW wheat production. Since 1967, HRW production in the PNW has been on the increase with some 14 percent of 1970 production coming from HRW wheat varieties. Wanser and McCall predominate as the major improved HRW wheat varieties [21]. This increase apparently is based upon greater adaptability of the improved HRW varieties for PNW growing conditions, increased export demand, and anticipated price advantage of ordinary HRW wheat over soft white wheats.

Export Trends. Total exports from PNW ports, shown in Table 9, rose sharply in the early 1960's, until 1968, when white wheat seasonal quality problems and adjustments in world price, following abandonment of the International Grains Arrangement program, caused a marked reduction in white wheat exports [4,23]. Hard red wheats, both winter and spring, increased in percentage

of total exports from 31 to 47 percent from 1964 to 1969, but dropped again to 31 percent in 1970. Of special note is the dramatic increase in hard red spring exports produced principally in Montana and North Dakota. Agronomic research progress may permit future consideration by PNW producers of this class of hard wheat.

TABLE 9. Wheat Exports: Pacific Northwest by Class and Year.

Year	Hard Red Spring	Hard Red Winter	White	Mixed & Other	Total
			1000 bushels		
1964-65[a/] ..	3,766	44,922	93,873	175	142,756
1965-66....	19,930	68,987	94,690	126	183,933
1966-67....	25,060	47,853	119,199	657	192,769
1967-68....	36,782	52,617	143,134	878	233,411
1968-69....	38,893	56,775	90,334	-	186,634
1969-70....	41,235	58,430	109,111	-	210,535
1970-71....	54,555	52,302	105,406	2,238	214,390

SOURCE: Compiled from Pacific Northwest Wheat Summary Quarterly Reports (July 1971), Statistical Reporting Service, USDA, and Grain Market News, Grain Division. Consumer and Marketing Service, USDA.

[a/] July 1 to June 30 reporting year.

Total white wheat exports from PNW ports have fluctuated annually from 90 to 140 million bushels during the decade of the 1960's, as shown in Table 10. The composition of countries acquiring this wheat has changed markedly, too. India and Japan have been the major buyers for white wheat exported from PNW ports. From 1960 through 1965 their acquisitions accounted for two-thirds of the white wheat exports. Wheat sales to Japan were for cash, while those to India were concessional under the PL 480 program. From 1965 through 1969, concessional sales to India declined, cash sales to Japan more or less maintained their pre-1965 level, and concessional sales to Pakistan and Korea increased markedly. So, although hard wheat exports from PNW ports have increased significantly since the early 1960's, as evident from Table 9, evidence from Table 10 indicates that it may not have been at the expense of Western white wheat exports. Certainly, factors of wheat quality and other demand factors have separated the cash and concessional export markets. U.S. concessional sales, primarily of HRW wheat, may continue their decline.

TABLE 10. White Wheat Exports from Pacific Ports by Country of Destination, 1960-1969 Crop Years.[a/]

Crop Year	India	Japan	Pakistan	Korea	Philippines	Taiwan	Other Countries	Total
	1000 Bushels							
1960.....	46,047	23,348	13,019	8,020	2,668	4,636	23,000	120,828
1961.....	34,288	20,814	12,754	6,046	2,861	5,368	7,845	89,976
1962.....	40,385	17,984	19,983	9,489	3,665	4,282	2,870	98,658
	(zero)	(100)	(zero)	(zero)	(100)	(zero)	(71.95)	(24.04)
1963.....	38,737	34,112	9,815	7,117	2,433	4,039	10,234	106,487
	(zero)	(100)	(zero)	(4.12)	(100)	(6.56)	(82.14)	(42.74)
1964.....	32,759	26,973	18,913	4,087	2,971	5,699	2,821	94,233
	(zero)	(100)	(zero)	(zero)	(100)	(34.09)	(77.17)	(36.15)
1965.....	45,836	27,875	2,774	4,976	2,838	5,266	5,190	94,755
	(zero)	(100)	(zero)	(zero)	(100)	(38.44)	(59.02)	(37.78)
1966.....	50,360	30,044	13,131	10,789	3,374	4,727	6,896	119,321
	(zero)	(100)	(zero)	(10.84)	(100)	(zero)	(81.02)	(33.67)
1967.....	48,65	29,877	19,987	18,907	4,020	7,992	14,009	143,197
	(zero)	(100)	(zero)	(zero)	(100)	(17.09)	(28.30)	(27.37)
1968.....	27,532	23,255	3,925	24,376	2,347	6,094	2,805	90,334
	(zero)	(100)	(36.89)	(zero)	(100)	(zero)	(57.97)	(31.74)
1969.....	29,957	28,728	20,342	16,048	3,032	6,648	4,356	109,111
	(zero)	(100)	(zero)	(zero)	(32.75)	(zero)	(68.64)	(29.98)
TOTAL.....	394,506	263,010	134,643	109,855	30,209	54,551	80,116	1066,890
Average Annual.....	39,451	26,301	13,464	10,986	3,021	5,455	8,012	106,689

SOURCE: Seevers, Gary L. "Pacific Northwest White Wheat Exports During the 1970's", Special Report 314, Oregon Agricultural Experiment Station, Oregon State University, Corvallis, November 1970.

[a/] Beginning in 1962, cash and concessional exports have been reported separately. Cash sales as a percent of total since 1962 are given in parentheses.

PNW Price Patterns. Western White No. 2 is the major white wheat subclass (a blend of soft white and white club) exported from the West Coast. Hard red winter ordinary (hard wheat with less than 11 percent protein) is the major hard wheat produced in the PNW and the only class of red wheat for which export payment information is available [5]. Table 11 compares the Portland cash price for No. 2 Western White with No. 1 Hard Red Winter Ordinary from 1954 through 1971. Equivalent world prices have been calculated by subtracting average export payments from cash price for both western white and HRW ordinary.[5/]

TABLE 11. Cash price to growers vs. World Price of Western White and HRW Ordinary at Portland, Oregon.

Year Beginning July 1	Cash Price To Growers For No. 2 Western White $/bu.	Export Payment White $/bu.	World Price White	Cash Price To Growers For #1 HRW Ordinary Protein	Export Payment Ordinary Hard Winter	World Price HRW Ordinary
1954/55.....	2.37	0.69	1.68	2.36	Unavailable	
1956/57.....	2.42	0.81	1.61	2.36	Unavailable	
1958/59.....	2.04	0.39	1.65	2.07	Unavailable	
1960/61.....	2.06	0.49	1.57	2.15	Unavailable	
1962/63.....	2.19	0.55	1.64	2.35	0.69	1.66
1964/65[a/]....	1.54	0.16	1.63	1.65	0.24	1.66
1966/67.....	1.80	0.05	1.75	1.91	0.13	1.78
1968/69.....	1.52	-0.10	1.62	1.56	-0.08	1.64
1970/71.....	1.74	.13	1.61	1.74	.20	1.54

SOURCE: Data compiled from information supplied by offices of Grain Market News, C&MS, USDA, and the ASCS, USDA, Portland Office, with assistance of Marion D. Thomas, Extension Economist, Oregon State University.

[a/] During 1964-65, U.S. exporters were required to purchase government export certificates costing 25 cents per bushel of wheat exported. At the same time, they received export payments averaging 16 cents a bushel of soft white wheat and 24 cents for hard red winter. Thus, with the soft white cash market average of $1.54 and a 25 cent certificate, the total cost to exporter was $1.79; but the net cost (equivalent world price) after deducting the 16 cent payment was only $1.63. Likewise, for hard red winter $1.65 plus 25 cents minus 24 cents equals $1.66. The apparent decline in cash price to growers is a result of changes in farm programs wherein growers received certificate payments averaging 65 cents per bushel.

[5/] Export payments were made by the federal government to U.S. exporters abiding by objectives of the International Wheat Agreement. These payments approximated the difference between domestic and export or "world" wheat prices.

These data indicate similar cash prices between white and red wheat from 1954 through 1958. From 1958 through 1969 a difference of 4 cents to 16 cents per bushel, favoring HRW ordinary, is noted in cash price to growers. The cost to the foreign buyer from 1962 through 1970, however, shows 2 cents a bushel more for HRW wheat since the export payments paid by the U.S. government is subtracted from the cash price to permit U.S. wheat to be competitive in the world market. Continuation of price premiums for HRW wheat is far from certain. Note 1970/71 when the world price of HRW wheat averaged 7 cents a bushel under soft white wheat at Portland.

Generally known is the fact that cash prices of ordinary HRW at Portland have been a few to several cents higher than soft white wheat prices most of the time. Not so well known, is the fact that for a decade or more, most of the price difference has reflected effects of U.S. government pricing policies and decisions made daily regarding export payments and domestic certificates [18]. The higher domestic HRW prices have been consistent with federal program objectives of maintaining pre-war domestic wheat price relationships. Hence, the higher HRW prices have not reflected necessarily the superior baking qualities or realities of the world wheat market into which most soft white and hard red winter wheat move. Continuation of a price premium on HRW may be doubtful due to changes in world wheat markets, declining political power of U.S. agriculture, and more competitive world trade policies. Table 11 shows that 1970/71 is the first year since 1956 that the cash price of No. 2 Western White Wheat was equal to, or greater than, No. 1 HRW wheat in the PNW.

Considerations for Production of HRW Wheat in the PNW

Potential Areas of Production

Cold winters, followed by dry, hot summers that induce fast ripening characterize the Great Plains of North America and the steppes of Soviet Russia where hard wheats of high protein content are produced [11]. Drought stress that curtails kernel development also induces high protein content. Environmental factors that interfere with translocation of carbohydrate from the plant to the grain during the two weeks pre-ripe period appear to exert dramatic influence on the final protein level in the grain. The shorter the

period between formation and ripening of the kernel, the higher the percentage of protein. Thus, a weather condition that induces physiological drought shortly before maturity seems instrumental in producing high protein wheat [20]. Weather also affects yield [15]. Generally speaking, yield and protein are inversely related. In years of above normal precipitation, yield is higher and protein level lower than average. The reverse situation prevails in dry seasons.

Historically, wide variation in PNW climatic conditions from one year to another contributed to the decline in popularity of HRW wheats because of its adverse effect on yield and protein levels. Although the temperature reaches 100 degrees F. or more along the Columbia River, the marine climate of the West Coast is characterized by cool night temperatures during the ripening period. Consequently, opportunity for achieving protein levels sufficiently high to produce quality HRW wheat using improved varieties appears possible only on the shallower and/or drier soil areas in the Oregon-Washington Basin area. Production areas with these characteristics, as identified by the OSU Wheat Task Force, are in western Umatilla, northern Morrow, northern Gilliam, southern Wasco, and southern Sherman counties where average annual rainfall does not exceed 12 inches [7]. These areas contain the drier phases of Walla Walla and Ritzville and the shallower Condon silt loams. Also identified were small dryland areas in Klamath, Jefferson, and Lake Counties where quality hard red winter wheat could be grown. The total area identified for Oregon is estimated to include 120,000 acres.

Although the weather in these areas is most likely to induce moisture stress during the two weeks ripening period which results in high protein levels, cool weather and/or rain before harvest can occur in these areas providing a potential risk for reversing the necessary condition.

This suggests need for a study of weather patterns and review of meteorological data from the weather stations located in the wheat producing regions of Oregon to provide a basis for specifying probabilities of cool weather and/or rain during the critical moisture stress period prior to kernel ripening.

Fertilization

A limited number of field trials on hard wheats in Oregon have been conducted which consider the effect of fertilization on protein levels and yield [6,9]. These indicate that initial applications of nitrogen fertilizer cause dramatic yield increases, but only slight protein increases. Heavy applications of nitrogen fertilizer have lower incremental effects on yield with small increases in protein content. Major increases in protein content of hard wheats, when grown in low available moisture areas, usually are accompanied by either no net changes in yield or some yield reduction.

In 1969 and 1970, on field trials conducted in potential Umatilla County hard wheat growing areas, average protein content was raised from 11.9 to 14.3 percent by supplemental top dressings of up to 100 pounds of nitrogen in February with no effect on yield.

Experiments conducted in southern Wasco County in 1969, 1970, and 1971 demonstrate the influence of nitrogen fertilization and rainfall on yield and protein content of Wanser HRW. Results are presented in Table 12. In 1969 seasonably high rainfall in May and June resulted in low protein levels of 6.4 and 7.4 percent, but 60 pounds of nitrogen increased yield from 23.8 to 33 bushels per acre. During the more normal rainfall seasons of 1970 and 1971, higher protein levels ranging from 9.2 to 14.6 percent and from 7.3 to 11.2 percent, respectively, occurred using 0 and 60 pound nitrogen rates. No significant yield differences emerged.

The Umatilla and Wasco county experiments imply that high nitrogen rates designed to increase protein levels on hard wheats may not be economical [9]. If high rates cause no increases in yield, the costs of additional fertilizer then must be borne by any increased value of higher protein wheat. Although a small price premium has been paid for high protein bread wheat, as noted from Table 11, it may vary from year to year and be nonexistent for some years. Furthermore, the field trials indicate that weather effects in May and June are far more influential on protein content than nitrogen applications.

TABLE 12. Influence of Rainfall and Nitrogen on Yield and Protein of Wanser Hard Red Winter Wheat, Ashley Farm, Wasco County, Oregon, 1969-1971.

Item	Year 1969		1970		1971	
Fertilizer Treatment N lbs./A.	Yield Bu./A.	Protein %	Yield Bu/A.	Protein %	Yield Bu/A.	Protein %
0	23.8	6.4	27.8	9.19	26.4	7.3
60	33.0	7.4	23.1	14.62	28.9	11.2
	Inches of Rainfall					
Rainfall Level						
May	1.68		1.14		1.66	
June	2.15		0.57		0.61	
July	0.00		0.00		0.20	
Crop Year	14.96		12.32		10.64	

SOURCE: Unpublished data from grain fertility trials conducted by Dr. Hugh Gardner, Extension Soil Specialist, and Thomas W. Thompson, Wasco County Extension Agent, Cooperative Extension Service, Oregon State Unitersity.

HRW Wheat Varieties

Satisfactory HRW wheat varieties adapted to PNW conditions which provide both high yields and high protein levels only recently have become available. Current interest in HRW wheat for PNW has renewed agronomic research in this area.

During the past 20 years, only a few hard red winter wheat varieties have been released in the PNW. Only recently the State of Washington released varieties Wanser and McCall. Wanser is the only variety recommended for shallow-dry soil areas in Oregon where white wheat yields are under 50 bushels [12].

Recent work by plant breeders indicate that wide variations exist in protein levels between HRW wheat varieties grown under controlled conditions [10]. This suggests that physiological differences between varieties occur and that renewed research efforts in plant breeding and selection might prove

fruitful. Trials are underway in Oregon that include 20 varieties from the world endosperm plasma pool that were found to have high protein values when 9,500 different wheats were screened by research workers at the University of Nebraska.

Agricultural Experiment Station research is now attempting to (1) more clearly delineate geographical areas where hard red winter wheat varieties are best adapted, (2) determine the cultural practices which will optimize both protein and yield, and (3) compare nitrogen uptake efficiencies between varieties for both grain yield and protein content.

Production and Handling

Advantages and disadvantages in production and handling exist when red wheats are produced in the PNW white wheat area. Contamination of hard red wheat with soft white can result in price discounts in the market place even though the mixture may be insufficient to cause reduction in quality of the grain. Mixing can occur either by volunteer production in the field, during handling on the farm, or at commercial storage sites. Volunteer HRW wheat has been especially noticeable in the Oregon Columbia Basin counties in recent years.

On the other hand, production of HRW wheat can provide flexibility to the producer by providing varieties which are adapted to various soil types. A range of choice in wheat varieties also decreases the risk of disease which is more prevalent with one variety production such as occurred during the early 1960's with stripe rust.

Summary

Major opportunities for sale of PNW white wheat have come from export market development. About 60 percent of PNW white wheat export sales have moved under the PL 480 concessional program since 1962. Movement of PNW white wheat to domestic markets outside the area is of minor importance with little apparent opportunity for expansion. Use of white wheat as a domestic feed grain exists only when and where white wheat prices are equal to or lower than prices of coarse feed grains. A decline in concessional sales and an apparent shift in demand toward bread-type wheats in the world cash markets, particularly in Asia, suggested reassessment by PNW wheat producers of the potential role of hard red winter wheat.

High wheat yield producing areas of the PNW appear to have no advantage for producing hard red winter wheat over white wheat because of protein level problems. They are likely to continue production of high quality soft white wheat primarily to supply the steady and apparent increasing export and feed market for this class. Drier areas, which are more marginal in economic production of white wheat, may find it to their advantage to produce hard red winter bread wheats. However, price uncertainties surrounding domestic and foreign markets for HRW wheats relative to soft white wheats cloud the issue. A slight price advantage for HRW over white wheat has prevailed in the PNW from 1958 through 1969. Since 1962/63, however, the differential has declined and disappeared altogether in 1970/71. Forces which contributed to this situation include: (1) substitution of hard and soft wheats within specified tolerances to offset price differentials between wheat classes, (2) changes in world wheat production and demand influencing both cash and concessional sales of hard and soft wheats, (3) U.S. pricing policies affecting food and feed grain price differentials in the domestic markets, and (4) increased domestic supplies of high protein wheats.

Varietal improvement of HRW wheats now permit production at high yield and high protein levels when grown under PNW conditions. This development has stimulated a shift to bread type wheat production by some PNW wheat producers, as indicated by the large plantings to HRW wheat since 1969. Loss of the HRW wheat price advantage may limit further expansion. Relative yield and production cost differentials between soft white and HRW wheats then become dominant in determining which wheat type to be grown on individual farms.

The complex set of factors affecting the relative position of HRW and soft white wheats of (1) domestic markets, (2) foreign markets, and (3) governmental policy decision are interrelated, dynamic, and ever-changing over time. However, to the PNW wheat producer who has no individual control over price, his short-run decision choice centers around production cost differentials between HRW and soft white wheats, providing he has access to market for these choices.

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