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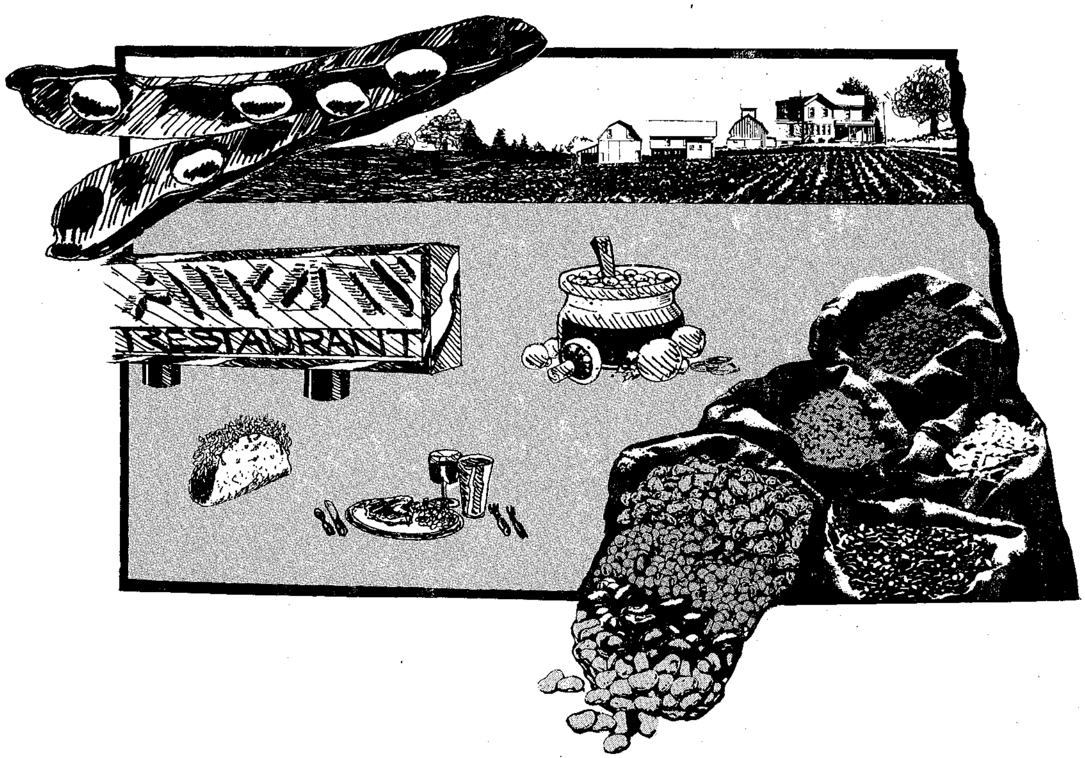
THE ECONOMIC FEASIBILITY OF ESTABLISHING VALUE-ADDED DRY EDIBLE BEAN PROCESSING PLANTS IN NORTH DAKOTA



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Preface

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Highlights

This study investigated the viability of value-added dry edible bean (DEB) processing as a new but complementary industry to North Dakota. Research completed included (1) an analysis of DEB production, foreign trade, marketing system, domestic consumption, pricing and supply response, (2) a review of new product development and current technology in dry edible bean processing, and (3) an economic analysis of value-added dry edible bean processing.

North Dakota accounts for 16 percent (5-year average 1981 to 1985) of the nation's navy bean production. North Dakota and Minnesota account for 24 percent. North Dakota is exceeded only by Colorado in the production of pinto beans. North Dakota'a 5-year market share is 23 percent. North Dakota's importance in the navy and pinto bean market is growing as its market share of production increases over time.

The United States DEB industry is becoming increasingly export-dependent. During 1980 and 1981 exports accounted for over 50 percent of the production. Exports currently account for approximately 30 percent of the production. The pinto bean market is the most volatile of the major bean markets. This is true for both production and price and is a result of greater volatility in the pinto bean export market than in the navy and great northern bean markets.

United States per capita consumption of DEBs is decreasing. However, no trend was detected in per capita pinto bean consumption. A decreasing trend for navy and great northern beans was detected.

Two technologically feasible processes were identified. One process was a dry roasting and milling process that would produce protein, starch, and fiber products for the food ingredient market. The other process, a steam-cooking process, produces a full-flavored precooked or quick-cook convenience bean product. This full-flavored convenience product could be marketed to Mexican restaurants or direct to consumers.

The dry roasting process produces high starch, high protein, and high fiber products for the food manufacturing industry. Although technologically feasible, this process was not economically feasible. In summary, the value of whole beans exceeds the sum of the values associated with its starch, protein, and fiber fractions. Under a very optimistic revenue assumption, the model bean processing plant generated a positive rate of return; however, the high level of revenue was determined to be unrealistic. The potential use of cull beans as a means of lowering raw material cost was also investigated. A major limitation is a limited and variable supply of edible culls. Partial replacement of whole beans by edible culls did not sufficiently reduce cost to make the plant economically feasible.

The production of precooked pinto beans was a much more viable option than producing food ingredient products. The most easily identifiable market *would be the Mexican restaurant trade. The quick-cook reconstitutable bean product could be used as a base for refried beans which are used in many of their entrees. In a nationwide survey of Mexican restaurant managers, 73 percent expressed interest in the product. The Mexican restaurant industry is growing. The number of franchise restaurants have increased by over three-fold from 1973 to 1983. Estimated internal rate of return for a precook bean plant under moderate revenue estimates exceeded 50 percent. The impact of lower than expected processing volumes was also determined. Internal rates of return exceeded 20 percent for the plant whether it operated one, two, or three shifts per day.*

A North Dakota based precooked pinto bean processing plant possesses a locational advantage over other existing and potential processing locations in the distribution of its product to eastern, central, and southern regions of the country. A North Dakota plant would have a disadvantage in shipping to the Southwest. However, given the high value of the product, there is sufficient margin to allow penetration of the Southwest market.

Economic impacts of the precooked pinto bean plant were also investigated. A bean processing plant operating at full capacity would generate $4.4 million in local expenditures annually. These local expenditures would, in turn, generate over $22 million in overall business activity.

THE ECONOMIC FEASIBILITY OF ESTABLISHING VALUE-ADDED DRY EDIBLE BEAN PROCESSING PLANTS IN NORTH DAKOTA

Scott M. Wulff and Delmer L. Helgeson*

Development of additional agricultural processing firms is one of the more feasible and attractive means of providing new job opportunities. Processing agricultural products produced in the state is highly complementary to agriculture, North Dakota's major industry.

This study investigates the viability of value-added dry edible bean processing, a new but complementary industry to North Dakota. Two different processes with different end products were researched. The first is a process that produces protein, fiber, and starch products for the food manufacturing industry. The second process produces a precooked full-flavor bean product that may be used in the Mexican food industry.

Specific objectives of the study include (1) an analysis of dry edible bean production, foreign trade, marketing system, domestic consumption, pricing and supply response, (2) a review of new product development and current technology in dry edible bean processing, (3) an economic analysis of value-added dry edible bean processing.

North Dakota is facing a challenge. That challenge is to modify the pattern of economic development to provide diversified employment for its residents. The urgency of this challenge is due to the fact that North Dakota lacks sufficient nonagriculturally-based activities that are expanding at a rate sufficient to absorb individuals displaced from agriculture and related economic activities.

Data and other information in this report was collected from interviews with various trade and industry personnel, trade publications, research by various universities, and government sources.

Dry Edible Bean Production

Domestic Production Area

Domestic dry edible bean (DEB) production is primarily concentrated in five distinct producing regions. These are eastern Michigan; a region that encompasses northeastern Colorado, western Nebraska, southeastern Wyoming, and northwestern Kansas; the Red River Valley of North Dakota and Minnesota; California; and south central Idaho. Geographic acreage distributions from the 1982 Census of Agriculture are presented in Figure 1. These five regions account for approximately 90 percent of United States' total DEB production.

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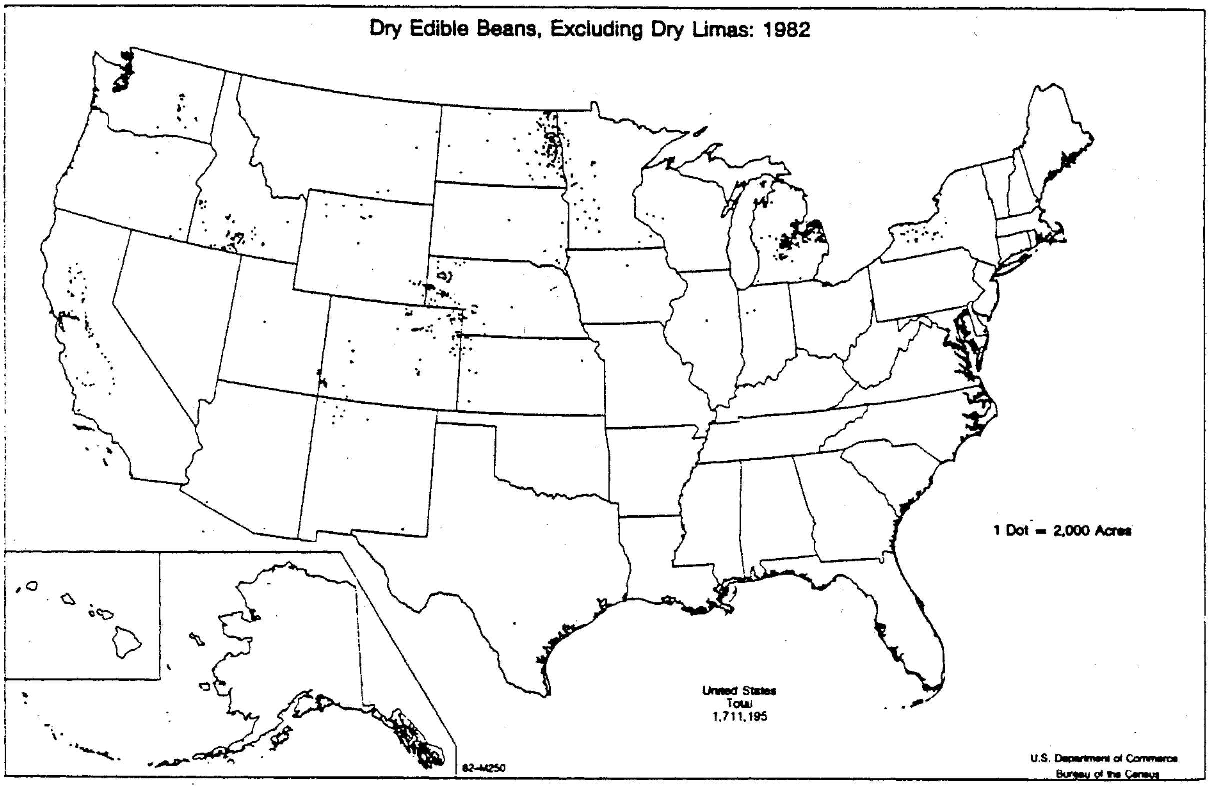

Figure 1. Geographic Distribution of Dry Edible Bean Acreage, Excluding Dry Limas, 1982

SOURCE: 1982 Census of Agriculture.

Remaining production is in the states of Washington and New York. Montana, Utah, Wisconsin, Illinois, and Indiana also produce limited amounts of DEB. State production figures are presented in Table 1.

Production of individual classes of DEBs with the exception of pintos is much more concentrated in specific growing areas than overall production. Navy beans are grown primarily in two regions: eastern Michigan and the Red River Valley of North Dakota and Minnesota. Michigan is the dominant producing region of navy beans. During the period from 1981 to 1985, Michigan accounted for 76 percent of production; North Dakota, 16 percent; and Minnesota, 8 percent (Figure 2). Pinto production is the most dispersed. Pinto beans are grown in all areas except California and New York. Colorado is the largest producer, accounting for 28 percent of the production (five-year average 1981 to 1985); followed by North Dakota, 23 percent; Idaho, 15 percent; and Nebraska, 12 percent (Figure 3). Great northerns are produced primarily in Nebraska, with lesser amounts produced in Idaho and Wyoming (Figure 4). Pink beans are produced primarily in California and Idaho and to a lesser extent in Washington. Small reds are produced primarily in Idaho and Washington. Red kidneys are primarily produced in California, Michigan, and New York. Michigan accounts for most of the Black Turtle production. New York also produces limited quantities. California is the principal or exclusive producer of large limas, baby limas, blackeye, and garbanzo beans (Appendix A contains detailed historical production by state and bean class).

TABLE 1. UNITED STATES DRY EDIBLE BEAN PRODUCTION BY STATE, 1970 THROUGH 1985.

State	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	1,000/cwt.															
California	2,666	2,141	2,460	2,708	3,991	2,606	2,800	2,887	3,323	3,600	3,813	4,105	3,585	2,412	3,218	3,466
Colorado	1,998	1,820	1,651	1,448	1,530	1,800	1,665	1,245	1,632	1,667	2,146	2,683	2,057	1,680	2,394	2,948
Idaho	1,974	2,024	2,136	2,119	2,503	2,580	2,655	2,165	2,494	2,460	3,329	4,277	2,594	1,452	2,470	2,006
Kansas	210	84	110	88	130	152	150	162	192	170	336	935	280	126	204	272
Michigan	6,153	5,643	7,139	5,320	6,902	4,732	5,450	5,664	5,980	6,440	7,752	7,198	7,975	4,550	4,290	5,412
Minnesota	234	203	418	592	696	384	364	396	592	562	966	1,277	949	452	700	868
Montana	187	176	187	162	154	176	153	104	126	175	176	218	139	37	152	57
Nebraska	1,548	1,628	1,710	1,664	2,145	1,920	1,980	1,767	1,947	2,160	2,730	4,025	3,180	2,188	3,230	2,701
New York	748	794	306	371	517	531	396	352	428	460	614	578	540	255	372	297
North Dakota	403	429	936	1,050	611	1,183	1,112	1,103	1,243	1,418	2,678	4,565	2,520	1,648	2,520	3,010
Utah	86	63	52	68	46	71	51	2	24	32	42	60	46	41	54	40
Washington	660	429	488	324	497	702	455	333	527	800	1,080	1,380	662	355	707	710
Wyoming	508	468	505	392	481	425	450	380	427	532	733	882	552	324	759	481
Other States	24	15	20	83	140	180	105	50	--	--	--	--	--	--	--	--
United States	17,399	15,917	18,118	16,389	20,343	17,442	17,786	16,610	18,935	20,476	26,395	32,183	25,049	15,520	21,070	22,268

SOURCE: Bean Market Summary, AMS, USDA.

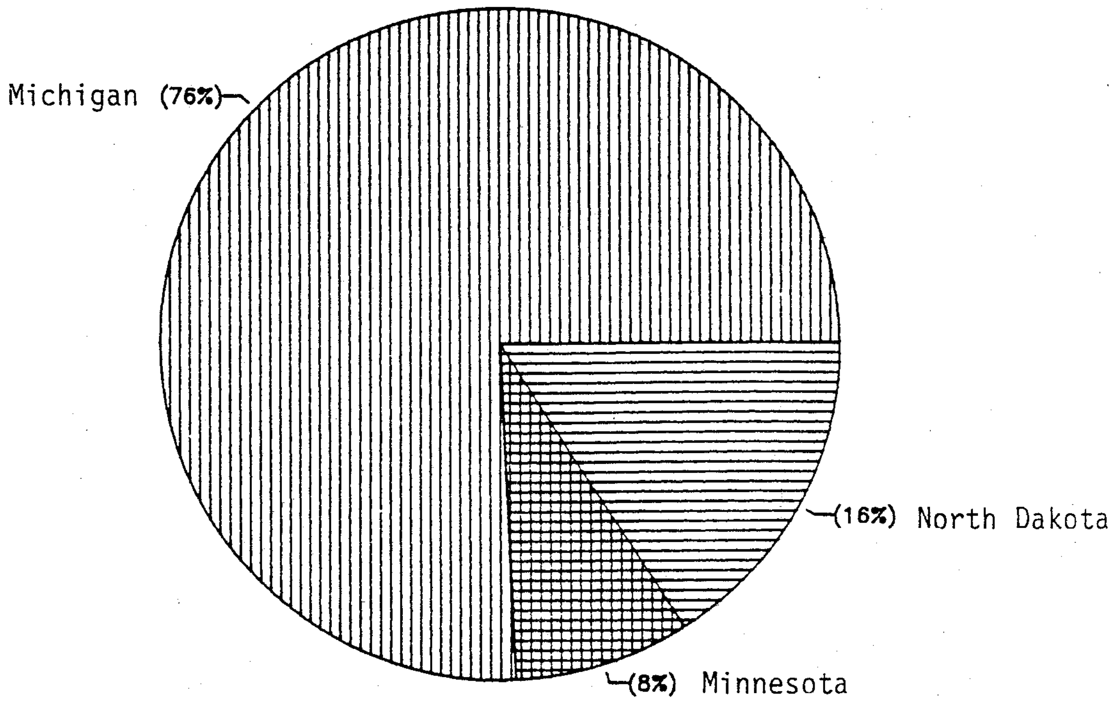

Figure 2. Navy Beans, Five-Year Average Market Share by State, 1981-1985

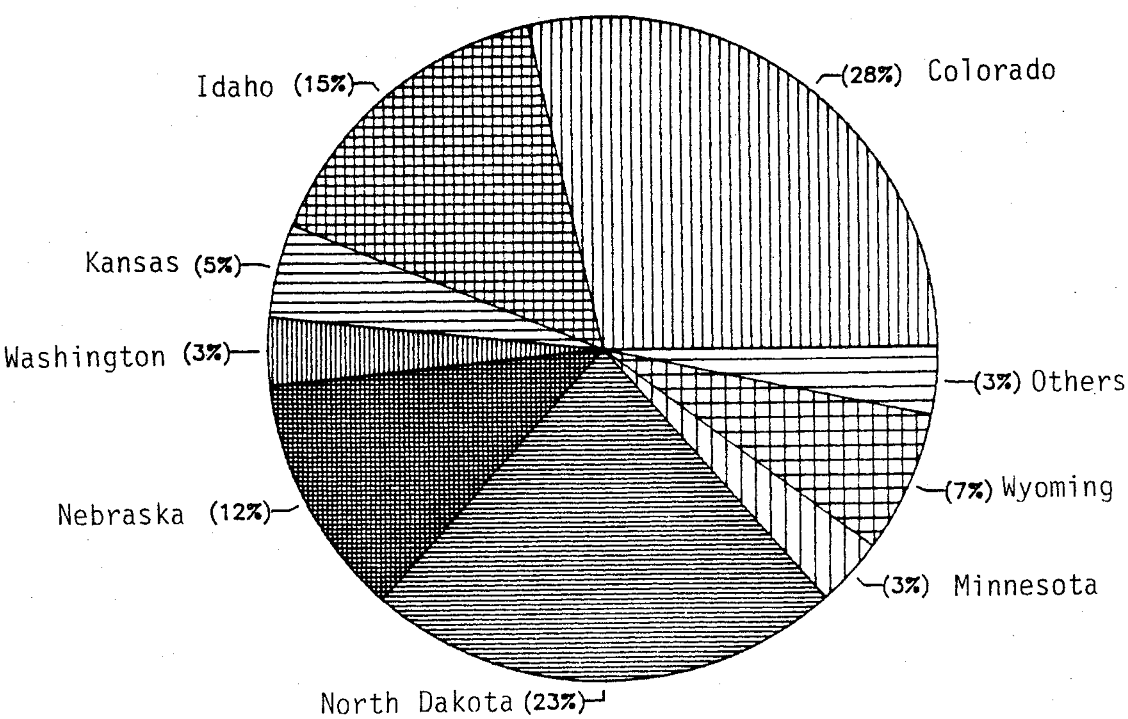

Figure 3. Pinto Beans, Five-Year Average Market Share by State, 1981-1985

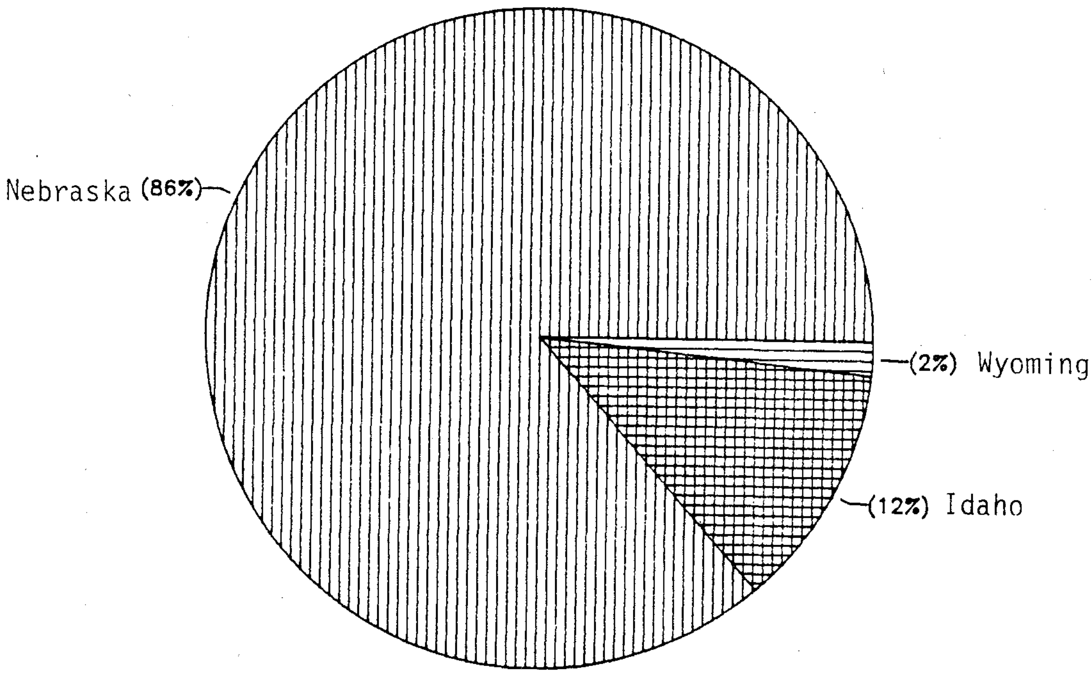

Figure 4. Great Northern Beans, Five-Year Average Market Share by State, 1981-1985

Production Trends

Dry edible bean production during the 1960s and most of the 1970s can be characterized as stable with no fundamental change in the marketplace. In that period production, prices, and yields were stable (Figure 5). Production fluctuated mainly between 16 and 19 million cwt. annually during that period. Stable production during this period is attributable to stable prices and yields. The high prices in 1973, 1974, and 1975 did not cause significant increases in production because this was a period of increased prices for all agricultural commodities. Consistent higher yields were not obtained until 1979. From 1966 to 1979 yields were quite stable at 1,200 to 1,500 pounds per acre. Yields in excess of 1,400 pounds per acre were common from 1979 on.

Production in 1980, 1981, and 1982 increased dramatically as a result of high prices and increased yields. Production peaked in the 1981 growing season at over 32 million cwt. By 1983 production fell to 15.5 million cwt. in response to a collapse in prices in 1982. Production rebounded to 20 and 22 million cwt. in 1984 and 1985 (Figure 5).

Pinto Bean Production Trends

Pinto bean production expanded sharply in 1980 and 1982 in response to high prices caused by a large Mexican demand. Production reached 14 million cwt. in 1981 before falling to 7 million in 1982, slightly more than a 50 percent decrease (Table 2). The production decrease was in response to low

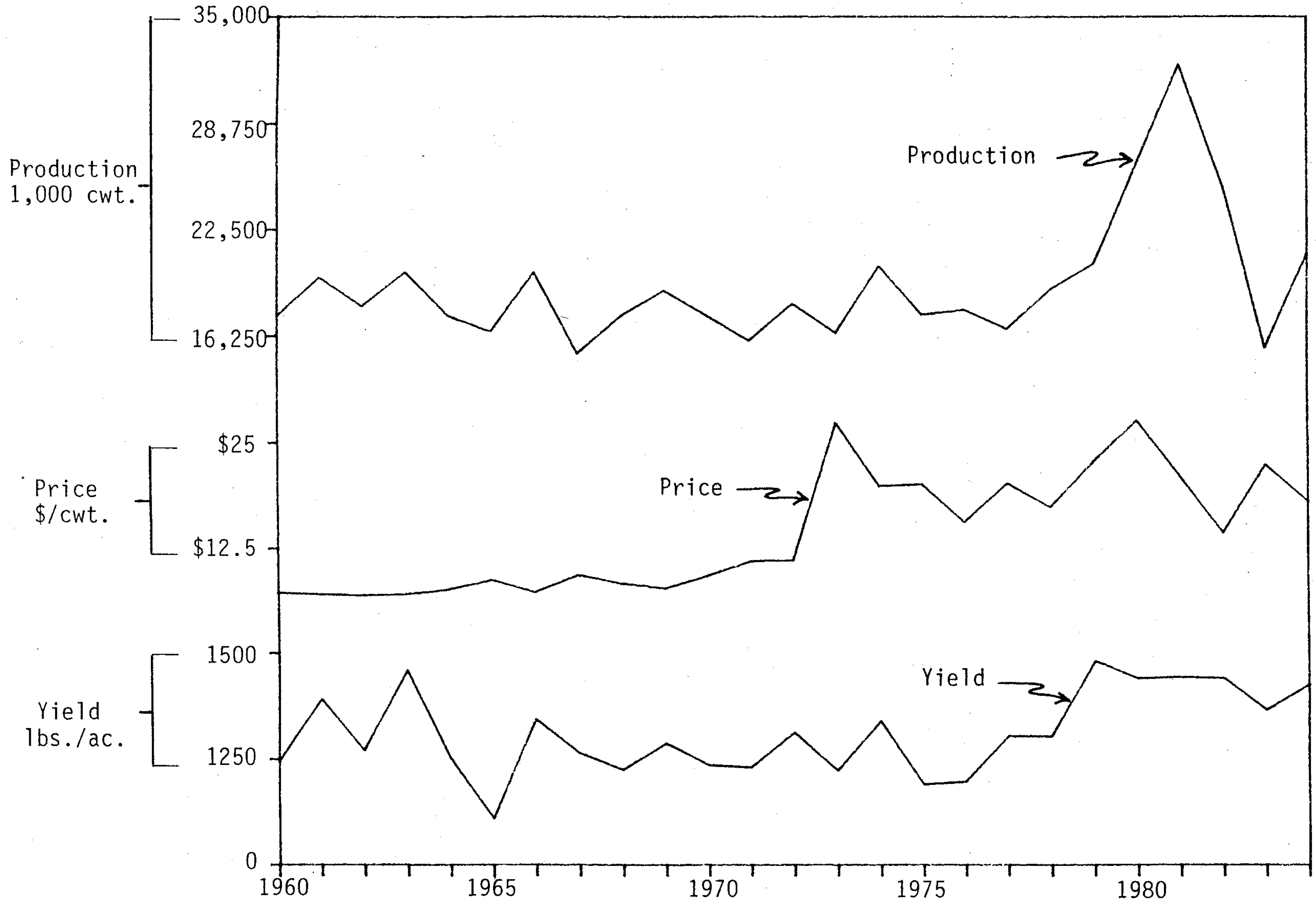

Figure 5. Dry Edible Bean Production, Prices, and Yields, United States, 1960-1984

SOURCE: Agricultural Statistics, USDA

prices as Mexico exited the market. Pinto production is driven to a large extent by prices in the previous year. However, the reduced production in the mid 1980s remains significantly higher than prior to the export boom in 1980.

Both Colorado and North Dakota have increased their market share of United States Pinto bean production (Figure 6). Colorado's three-year (1983 to 1985) average market share was 35.7 percent; North Dakota's, 22.4 percent. This is an increase from 24.6 percent and 16.4 percent of the three-year average from 1972 to 1974. The increased market shares have come at the expense of Idaho, Michigan, and Montana. This shift in market share was not a result of reduced production in the states of Idaho, Michigan, and Montana. Rather, Colorado and North Dakota have emerged to capture a greater share of the increase in pinto bean production.

Navy Bean Production Trends

Prior to 1972, Michigan was the exclusive producer of navy beans in the United States. Navy beans were introduced to Minnesota and North Dakota in the early 1970s. Minnesota and North Dakota have since taken a 26 percent market share, 1983 to 1985 average (Figure 7). North Dakota's growth has been greater than Minnesota's. Total navy bean production, unlike pinto bean production, has remained relatively stable, fluctuating mainly between 5 and 6 million cwt. (Table 2).

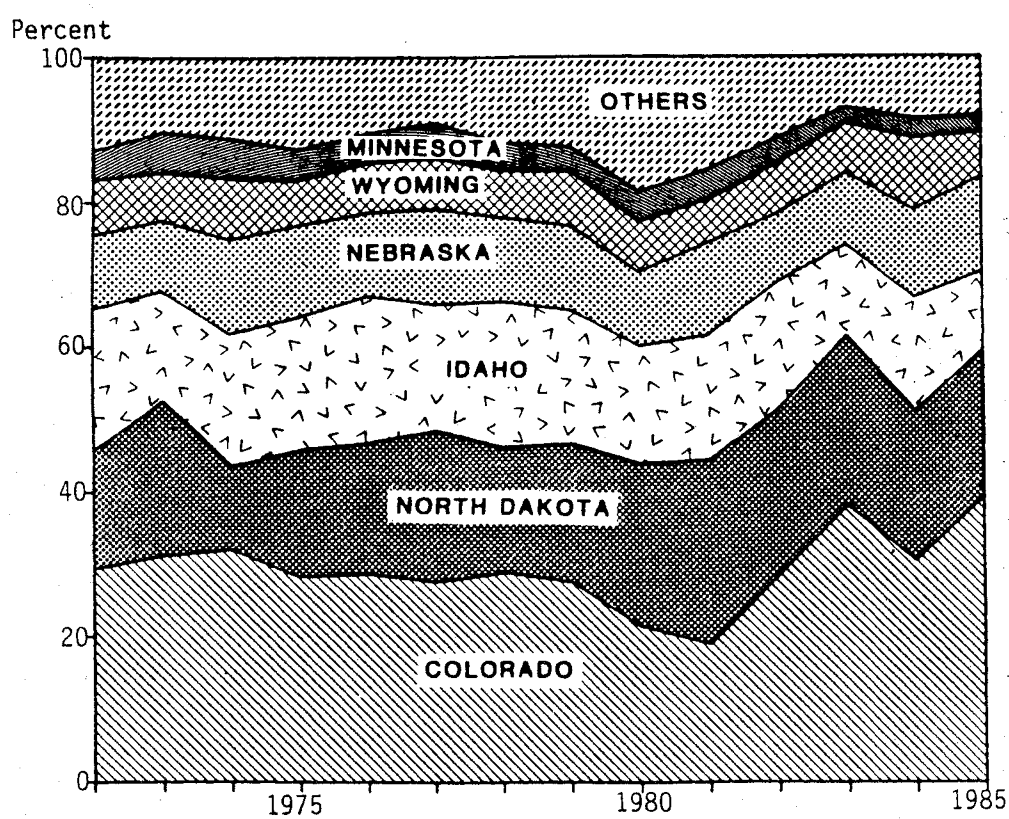

Figure 6. Pinto Bean Market Share by State, 1972-1985

TABLE 2. DRY EDIBLE BEAN PRODUCTION BY COMMERCIAL CLASS, UNITED STATES, 1970 THROUGH 1985

Class	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	1,000/cwt.															
Pinto	5,384	4,843	5,613	4,622	4,758	6,367	5,792	4,517	5,638	6,051	10,008	14,029	6,980	4,372	7,286	7,544
Peas, navy	5,180	5,022	6,450	4,882	6,737	4,140	4,846	5,209	5,604	5,858	5,717	5,550	7,937	4,618	4,966	6,349
Great northern	1,430	1,517	1,515	1,776	2,088	1,409	1,767	1,603	1,863	1,998	2,112	2,686	2,736	1,940	2,404	1,531
Red kidney	1,302	1,123	816	1,145	1,513	1,477	1,377	1,285	1,827	1,602	1,757	1,542	2,036	997	1,381	1,492
Large lima (Calif.)	558	398	471	533	670	408	522	540	458	529	758	639	580	463	648	912
Pink	678	724	624	804	1,030	1,154	990	753	687	817	1,750	1,941	872	639	841	794
Blackeye (Calif.)	712	413	801	766	1,092	499	607	800	778	943	698	875	1,050	623	930	775
Other	300	252	282	306	331	286	275	313	369	573	468	724	887	333	729	676
Baby lima (Calif.)	478	400	317	378	574	416	378	475	512	656	447	661	530	472	546	640
Small white	275	309	302	360	621	237	329	239	192	190	186	312	236	381	680	535
Small red	585	371	371	318	447	494	437	305	366	506	646	610	489	302	345	506
Cranberry	155	112	257	205	162	222	257	390	361	310	330	320	420	285	185	261
Black Turtle Soup	227	279	144	135	192	212	157	109	171	288	1,451	2,244	236	48	110	237
Garbanzo	68	85	60	98	83	119	46	63	101	152	67	50	60	47	19	16
Other	67	69	95	61	45	2	6	9	11	3	--	--	--	--	--	--
Total	17,399	15,917	18,118	16,389	20,343	17,442	17,786	16,610	18,938	20,476	26,395	32,183	25,049	15,520	21,070	22,268

SOURCE: Bean Marketing Summary, AMS, USDA.

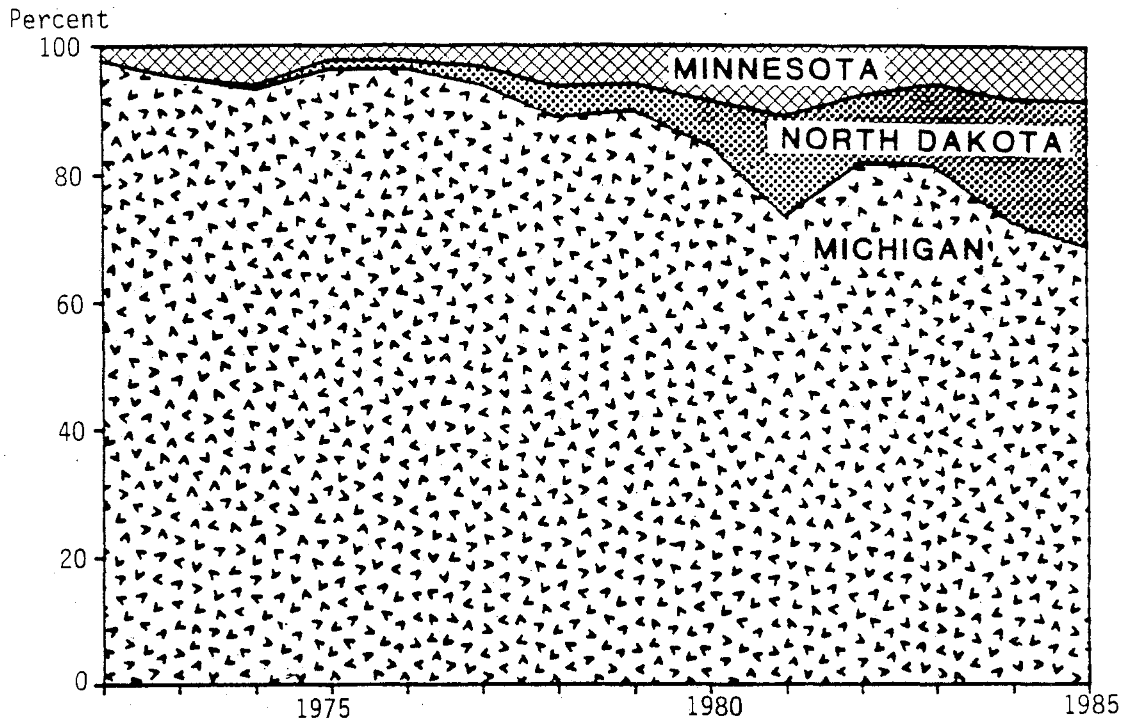

Figure 7. Navy Bean Market Share by State, 1972-1985

Great Northern Bean Production Trends

Great northern bean production peaked in 1981 and 1982 at 2.7 million cwt. Similar to pinto bean production, production of great northern beans since the export boom of 1980, 1981, and 1982 remains at or higher than levels prior to the export boom (Table 2). Nebraska has increased its market share to 89 percent (1983 to 1985 average) at the expense of Idaho and Wyoming (Figure 8).

Foreign Trade

Dry Edible Bean Exports

The United States is the largest dry edible bean exporter in the world. However, it ranks fourth behind India, Brazil, and Mexico in DEB production (Conklin 1985). Exports fluctuated between 2 and 4 million cwt. throughout the 1960s and early 1970s. Exports increased to between 4 and 6 million cwt. annually in the mid and late 1970s in response to world-wide protein shortages (Table 3). Exports increased sharply from 1979 to 1981, reaching a high of 17 million cwt. in 1981. The increase in exports from 1979 to 1981 was primarily the result of increased Mexican demand.

Mexico's dry bean crop was seriously affected by a drought in 1979. The shortage of DEB due to the drought and a rising demand due to high petroleum prices and rising incomes forced Mexico to import large quantities of DEB. Exports to Mexico rose from 2.1 to 9.9 million cwt. from 1979 to 1981

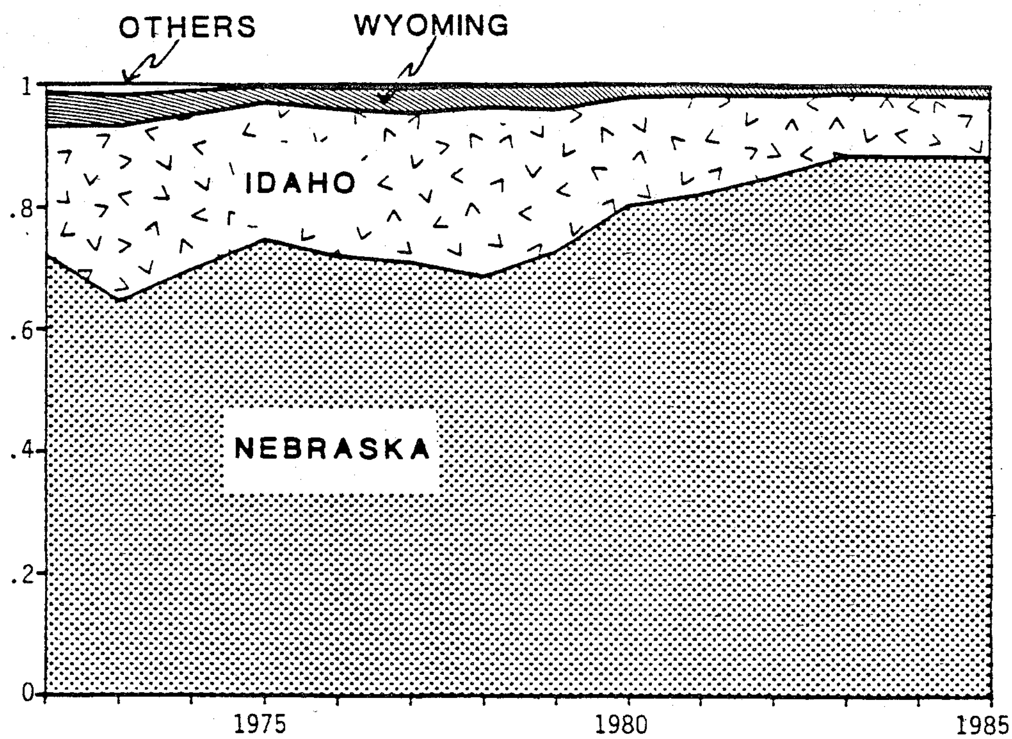

Figure 8. Great Northern Bean Market Share by States, 1972-1985

(Table 4). Mexico implemented a self-sufficiency plan for basic crops, including beans in 1980. By 1983, Mexico had large stocks of DEBs. Large stocks, declines in the value of the peso and the oil price collapse caused Mexico to virtually withdraw from the import market. Exports to Mexico fell to less than 8,000 cwt. in the 1982/1983 crop year.

Excluding Mexico, the export market has been fairly stable with a modest upward trend in exports. Exports from 1982 to 1984 averaged 5.8 million cwt. (Table 3). The United Kingdom and other European countries have been major export markets for the United States. Exports to western Europe have been primarily of the white commercial classes, navy and great northern beans. The United Kingdom shows a strong preference for navies while France prefers great northerns. Exports to Mexico have been primarily pintos, followed by black and other colored varieties. Columbia, Venezuela, and Japan have also been major DEB importers with no overriding concentration in any one variety.

All classes of beans benefited from the strong export demand from 1979 to 1981. In the export collapse during the 1982 to 1983 crop year, exports decreased to 6.3 million from 17.2 million cwt. the previous year. The colored classes of DEBs were the most affected, primarily pintos and blacks. Pinto exports fell from 8.5 to 0.3 million cwt. Thus, due to Mexico's preference for colored beans, all DEB classes have not been affected in the same manner. Great northerns have continued to have strong exports. Navy beans have shown a modest growth in exports. Red kidneys also continue to have good exports relative to pre-1979 exports.

TABLE 3. DRY EDIBLE BEAN EXPORTS, UNITED STATES, BY COMMERCIAL CLASS, 1967 THROUGH 1984

Year[a]	Navy or Pea	Great Northern	Other White	Pinto	Red Kidney	Other Colored	Seed[b]	Total
	1,000 cwt.							
1967	890	275	86	229	147	882	109	2,618
1968	1,122	342	63	227	72	1,360	103	3,289
1969	1,810	531	130	494	158	1,824	182	5,129
1970	1,418	338	54	424	218	1,684	154	4,290
1971	982	619	48	335	192	1,547	141	3,864
1972	1,355	693	50	249	111	1,366	184	4,008
1973	1,237	436	127	683	81	969	123	3,656
1974	1,459	964	57	1,850	213	1,629	138	6,311
1975	942	275	32	490	144	863	150	2,896
1976	724	908	38	659	252	1,469	139	4,188
1977	1,794	875	79	710	225	1,454	138	5,275
1978	1,438	1,067	103	965	383	1,526	126	5,608
1979	1,616	1,111	110	2,034	842	1,627	204	7,544
1980	2,229	1,416	137	6,981	571	3,419	298	15,052
1981	1,770	1,548	119	8,459	478	4,570	240	17,184
1982	1,966	1,518	99	315	453	1,913	--	6,264
1983	1,390	849	105	551	466	1,838	--	5,198
1984	1,384	1,213	74	1,435	292	1,644	--	6,043

[a]Marketing year beginning September.
[b]Series discontinued after 1981.

SOURCE: Agricultural Statistics, USDA.

TABLE 4. DRY EDIBLE BEAN EXPORTS TO SPECIFIED COUNTRIES, UNITED STATES CROP YEARS 1979 THROUGH 1983

Continent and Country	1979	1980	1981	1982	1983
	----------	----------	1,000 cwt	----------	----------
North America					
Canada	348	444	533	369	386
Dominican Republic	209	88	0	3	1
French West Indies	32	44	31	35	25
Mexico	2,107	7,805	9,872	8	8
Panama	79	69	92	161	71
Trinidad and Tobago	29	44	43	53	38
Total	2,804	8,496	10,570	629	529
South America					
Brazil	8	266	223	87	110
Columbia	113	37	291	176	104
Venezula	330	238	296	144	286
Total	450	542	809	407	501
Europe					
Belgium and Luxemburg	133	132	414	249	95
France	242	295	334	397	303
Germany, Fed. Rep. of.	128	208	322	272	78
Italy	112	149	176	261	143
Netherlands	363	529	590	644	429
Spain	41	90	77	129	33
United Kingdom	1,159	1,477	1,418	1,400	1,200
Total	2,180	2,881	3,331	3,353	2,280
Asia					
Israel	14	13	26	47	6
Japan	515	737	637	476	590
Philippines	23	24	30	16	21
Total	552	773	693	540	616
Oceania					
Australia	65	82	66	98	104
Other Countries	1,494	2,279	1,714	1,237	1,167
Grand Total	7,544	15,052	17,184	6,264	5,198

SOURCE: Agricultural Statistics, USDA.

Historically, navy beans have accounted for approximately 30 percent of all DEB exports. Only during the high pinto bean export years did the navy bean export market share fall below 25 percent. Great northerns have increased their market share from around 10 percent in the late 1960s to between 10 and 25 percent in the late 1970s and early 1980s. Pinto beans have also shown an improvement in market share but have also been the most volatile ranging from 9 percent of the export market in 1967 to 49 percent in 1981 before decreasing to 5 percent in 1983 (Table 5).

The DEB industry has become more export dependent. The United States exported less than 20 percent of its total production in the late 1960s. This percentage held true for each class of DEBs (Table 6). Exports exceeded 50 percent of production in 1980 and 1981. During the crop year 1984 to 1985 navy bean export levels were 30 percent of production; pinto's, 20 percent; and great northern's, 50 percent. Twenty-nine percent of the total production in 1984 was exported.

Imports

Imports have been generally of the specialty classes, primarily mung and garbanzo. Limited quantities of limas and red kidneys are also imported. Thus, imports do not directly compete with major bean classes grown in the United States. However, they do compete with some of the specialty production in California, primarily garbanzo beans. Imports have increased from 400 thousand cwt. in the mid 1970s to about 600 thousand cwt. in the mid 1980s (Table 7). Mung and garbanzo beans have accounted for most of the increase.

Export and Import Values and Prices

Value of exports in fiscal year 1984 was $142.9 million, less than 30 percent of the value exported in 1980. Import values in 1984 were 15 million dollars, down from 23 million in 1980. The three major classes for export value are pinto, navy, and great northern. Garbanzo and mung beans are the leading classes for import value. Total value of imports is small in comparison to the value of exports; import values are generally only 5 to 10 percent of total export value. Bureau of the Census data on value and prices of exports and imports are presented in Tables 8 and 9.

Trade Impediments

Foreign trade in dry edible beans is restricted by several of the United States trading partners. Trade impediments of selected importers of United States DEBs are presented in Table 10. The most common impediment, or barrier to trade, is an import tariff. The tariff, commonly called an import duty or an import tax, is generally in the form of a set rate per pound or other unit of measurement, or a percentage of the import's value. Tariffs of major United States trading partners range from $.01 per kilogram for Panama to a 25 percent tariff rate for Australia. Brazil officially has a 55 percent

TABLE 5. EXPORT MARKET SHARE BY CLASS, DRY EDIBLE BEAN, UNITED STATES, 1967 THROUGH 1984[a]

Year[a]	Navy or Pea	Great Northern	Other White	All White	Pinto	Red Kidney	Other Colored	Seed	Total
	percent								
1967	34	11	3	48	9	6	34	4	100
1968	34	10	2	46	7	2	41	3	100
1969	35	10	3	48	10	3	36	4	100
1970	33	8	1	42	10	5	39	4	100
1971	25	16	1	43	9	5	40	4	100
1972	34	17	1	52	6	3	34	5	100
1973	34	12	3	49	19	2	26	3	100
1974	23	15	1	39	29	3	26	2	100
1975	33	10	1	43	17	5	30	5	100
1976	17	22	1	40	16	6	35	3	100
1977	34	17	1	52	13	4	28	3	100
1978	26	19	2	47	17	7	27	2	100
1979	21	15	1	38	27	11	22	3	100
1980	15	9	1	25	46	4	23	2	100
1981	10	9	1	20	49	3	27	1	100
1982	31	24	2	57	5	7	31	0	100
1983	27	16	2	45	11	9	35	0	100
1984	23	20	1	44	24	5	27	0	100

[a]Marketing year beginning September.

SOURCE: Adapted from Table 3.

tariff, but the tariff is waived when imports are authorized by Brazil's government. Japan incorporates a quota in addition to a total tariff of 30 percent. In several countries--Costa Rica, Colombia, and the Dominican Republic, for example--trade is also restricted in that imports are primarily handled by a government agency. The United States also imposes an import tariff on beans (Table 11). However, dry beans are a General Scheme of Preference (GSP) commodity and enter the United States duty-free from

TABLE 6. EXPORTS AS PERCENTAGE OF PRODUCTION, DRY EDIBLE BEANS, 1967 THROUGH 1984

Year[a]	Navy	Great Northern	Other White	Pinto	Other Colored	All Bean
	percent					
1967	19	18	18	6	17	17
1968	20	25	20	5	18	19
1969	25	31	26	11	29	27
1970	27	24	25	8	24	25
1971	20	41	23	7	25	24
1972	21	46	24	4	20	22
1973	25	25	25	15	20	22
1974	22	46	26	39	36	31
1975	23	20	21	8	14	17
1976	15	51	23	11	24	24
1977	34	55	37	16	28	32
1978	26	57	32	17	28	30
1979	28	56	34	34	39	37
1980	39	67	45	70	62	57
1981	32	58	39	60	59	53
1982	25	55	32	5	20	25
1983	30	44	32	13	34	33
1984	28	50	32	20	26	29

[a]Marketing year beginning September.

SOURCE: Adapted from Tables 2 and 5.

TABLE 7. IMPORTS, DRY EDIBLE BEANS BY COMMERCIAL CLASS, 1975 THROUGH 1984[a]

Class	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
	1,000/cwt.									
Mung	120	49	195	22	38	295	89	50	172	300
Red kidney	17	21	19	33	30	13	18	8	24	10
Lima	0	0	0	1	1	1	2	1	0	3
Garbanzo	107	68	222	211	286	284	202	273	255	238
NSPF[b]	181	274	172	78	63	142	156	105	112	72
Total	425	412	607	345	418	736	466	437	564	623

[a]Marketing year beginning September.
[b]Not specifically provided for.

SOURCE: Foreign Agricultural Trade of the Unites States, USDA.

developing countries. United States' tariffs are lowered for certain classes during the four-month period prior to harvest.

Dry Edible Bean Marketing System

The dry edible bean marketing system can best be described by identifying three separate markets, the primary, intermediate, and final markets. The bean marketing system is depicted in Figure 9. A seed and cull market also exists.

Primary Market

Following harvest, dry beans are typically sold to a dealer/processor, the first step in the DEB marketing system. The processing includes cleaning, grading, and storage. Primary processors are generally located in local producing areas. Beans are generally shipped from the processor in 100 lb. bags or in bulk. The method of shipping depends on the facilities of both the processor and buyer. The trend is toward bulk shipments but bagged shipments are significant because many buyers do not have bulk unloading facilities. A significant portion of the export trade is bagged. Navy beans are also being shipped in 20,000 lb. containers via truck, rail, and ship to the United Kingdom. The processor also will engage in seed sales and field services. It is a matter of custom that the producer will generally store and/or sell his crop to the elevator from which he buys seed (Dufner 1978).

TABLE 8. EXPORT VALUES AND PRICES, DRY EDIBLE BEANS, UNITED STATES, 1980 THROUGH 1984[a]

Class	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984
	1,000 dollars					dollars per cwt.				
Navy	62,968	52,157	39,035	36,137	29,893	29.45	28.06	20.82	25.62	22.18
Great northern	42,373	41,762	32,993	17,386	25,875	31.70	27.31	20.29	23.38	20.89
White	3,513	2,901	2,036	2,017	1,515	24.07	25.31	19.48	21.33	19.18
Pinto	240,570	247,530	3,087	13,968	31,067	33.92	30.89	16.12	23.32	21.58
Black	47,972	59,000	2,684	4,311	1,220	33.24	30.72	26.32	26.94	22.65
Red kidney	18,578	13,783	10,920	12,276	9,772	33.22	29.13	24.90	26.82	33.66
Lima	14,430	13,704	8,879	8,958	8,431	30.37	30.37	30.37	30.37	30.37
Other	40,391	37,583	19,870	19,580	19,884	19.84	21.53	16.22	17.96	19.76
Seed	14,441	12,408	11,763	10,278	15,258	51.26	49.70	54.65	50.57	47.33
Total	485,236	480,828	131,267	124,911	142,915	31.29	29.36	21.40	24.54	23.42

[a]Marketing year beginning September.

SOURCE: Foreign Agricultural Trade of the United States.

TABLE 9. IMPORT VALUES AND PRICES, DRY EDIBLE BEANS, UNITED STATES 1980 THROUGH 1984[a]

Class	1980	1981	1982	1983	1984	1980	1981	1982	1983	1984
	1,000 dollars					dollars per cwt.				
Mung	8,841	2,481	1,426	4,624	6,150	29.93	27.91	28.30	26.90	20.50
Red kidney	440	437	186	687	224	34.64	24.90	22.68	28.98	21.71
Lima	88	106	23	20	104	73.91	65.85	34.77	50.39	35.20
Garbanzo	8,690	7,398	6,994	5,651	6,784	30.55	36.60	25.64	22.12	28.51
NSPH	4925	5,354	2,744	3,003	2,056	34.71	34.29	26.24	26.74	28.51
Total	22,984	15,777	11,375	13,988	15,324	31.24	33.83	26.05	24.81	24.58

[a]Marketing year beginning September.

SOURCE: Foreign Agricultural Trade of the United States.

TABLE 10. TRADE IMPEDIMENTS OF SELECTED IMPORTERS OF UNITED STATES DRY EDIBLE BEANS, 1985

Country	Trade Impediment
Algeria	Beans imported by Government Agency, OAIC.
Angola	$.01 per kilogram duty.
Australia	Duty of 25 percent of FOB (free on board) port of export value.
Brazil	55 percent duty on books. Waived when imports authorized by government.
Canada	$.015 per pound import duty.
Colombia	15 percent duty. Imports generally by Government Agency IDEMA.
Costa Rica	10 per kilogram duty plus a 30 percent surcharge. However, imports are handled by a government agency.
European Economic Community (EEC)	3.6 percent duty. Duty has not applied to beans for canning for 5 years.
Japan	10 percent duty plus a 20 percent surtax. Global pulse quota currently set a $55 million or 120,000 tons (beans, peas, azuki beans, broad beans).
Mexico	Duty free: License required. Imports under control of a government agency CONASUPA except for border trade.
Panama	$.01 per kilogram duty.
Philippines	5 percent of CIF value for bulk product, 45 kilogram or 100 pounds.
Saudi Arabia	No duty.
Taiwan	20 percent duty on red beans, 10 percent on others.
Trinidad	$.30 per cwt. duty.
Yugoslavia	10 percent duty.

SOURCE: Foreign Agricultural Service, USDA, 1985.

TABLE 11. UNITED STATES TARIFF SCHEDULE FOR DRY EDIBLE BEAN IMPORTS, 1985

Class	May/August	Sept/April
	dollars/cwt.	
Mung beans	.60	1.20
Red kidney	1.00	1.50
Other beans	.75	1.50
Garbanzos (whole)	1.40	1.40
(split)	1.20	1.20

SOURCE: Foreign Agricultural Service, 1985

Dealer/processors perform a vital marketing function in providing the means through which growers sell their crop. The dealer/processor will either purchase for his own account or act as a broker. Dealer/processors who buy beans for their own account are technically dealers.

Intermediate Market

Beans may follow many different marketing channels between the dealer/processor and the final market. Most beans are marketed directly or indirectly, through a trader or broker, to packagers, canners, or exporters.

Packagers

Packagers purchase the majority of the beans in the domestic market with the exception of navy beans. Ten percent of the navy beans are dry-packaged, according to industry sources. Two basic types of packagers exist: those whose sales are primarily beans and those who are diversified. Those whose primary business is beans may also sell products like sugar and rice. These firms package their own brands and also do some private label packaging.

The second group of packagers have a diversified product mix. These firms also do private labeling. They may be either regional or national packagers. National packagers have moved toward vertical integration. Some packagers also own elevators in bean-producing areas and thus procure a portion of their requirements directly from the producer.

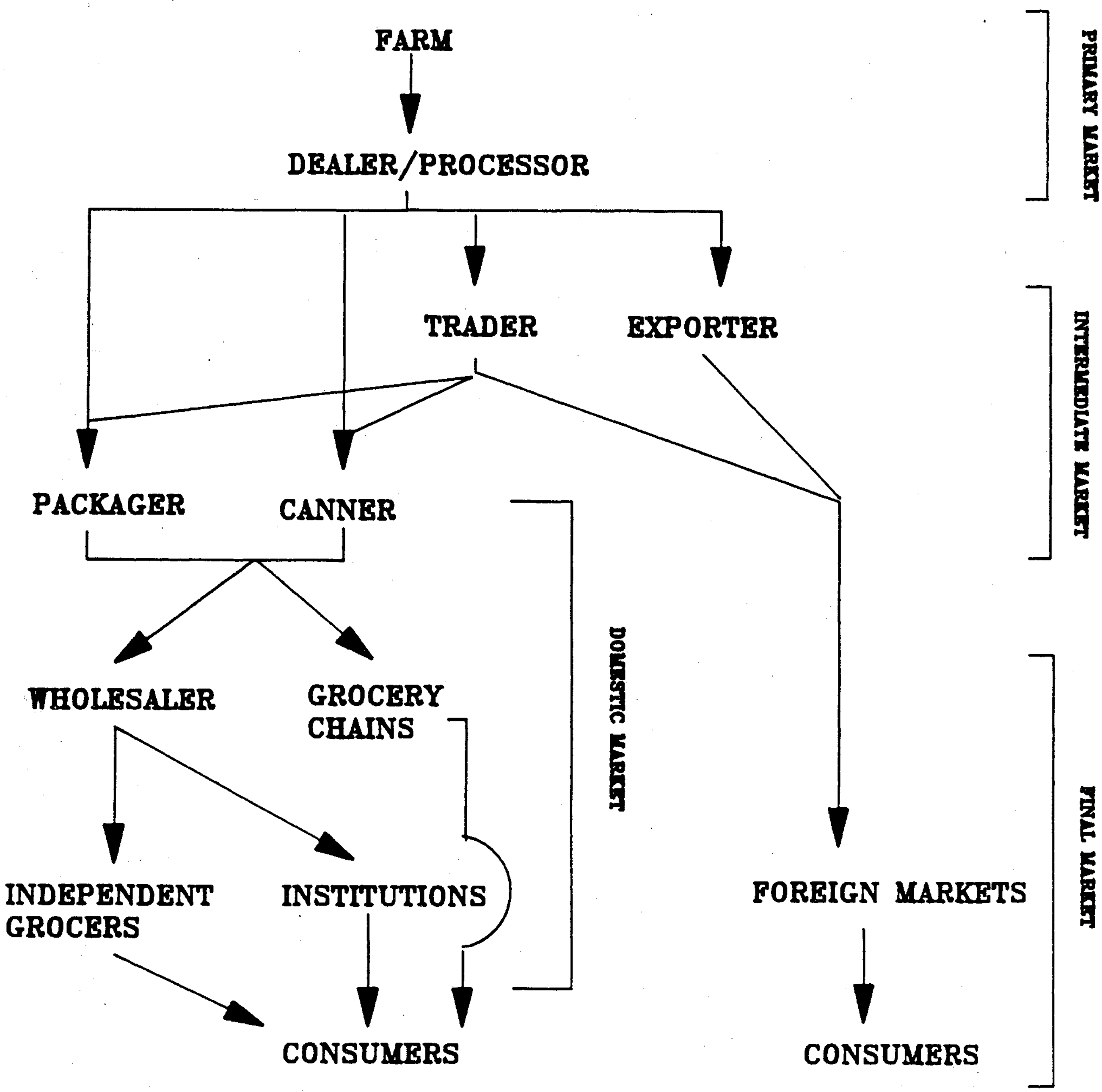

Figure 9. Bean Marketing System, United States

SOURCE: Dietz and Lusas, 1983.

Canners

Navy beans are the primary type that is canned. Nearly 90 percent, of the domestic navy bean market is canned, according to industry sources. DEB canners generally are not specialized; they are generally diversified and can a multitude of different vegetables. Canners purchase on their own account and are not vertically integrated in the bean industry.

Traders

Traders procure beans for their own account and sell in an opportune market or perform a brokerage function.

Exporters

Exporters generally are dependent on the spot market. They issue contracts at the time they procure beans, purchase for their own account, and do not trade in the intermediate market. They are not vertically integrated.

Final Markets

Grocery Stores

Beans are marketed from packagers and canners to chain stores or through wholesalers to independent grocers. Beans sold through large chains may be sold with the store's private label. Chains may contract with a packager, or, if large enough, may own their own packaging plants.

Institutions

Institutions (restaurants, cafeterias, hotels, schools) purchase primarily from wholesalers. Large institutional bean users may buy directly from the dealer/processor.

Seed Market

Approximately 5 percent of the annual DEB production is used as seed for the following year. Certified DEB seed is used almost exclusively; however, small amounts of uncertified seed are planted each year. Certified seed is ordinarily produced in regions of the country where disease problems can be minimized. Idaho is a major seed-producing state. For certification, seed must pass the inspection of state seed certification officials. Upon passing the inspection, the seed commands a premium over the market price of DEB destined for consumption.

Cull Market

The average DEB cull rate at the primary processing stage is generally between 4 and 8 percent. The cull rate is very dependent on growing and harvest weather conditions. In an optimal growing year, free of disease and a dry harvest, the cull rate may be lower. The cull rate in any specific year may exceed 15 percent, and may be higher in a year with an early frost or extremely wet harvest conditions.

Culls are comprised of split, moldy, disease-infected, discolored, or small-sized beans. Culls may be edible (fit for human consumption) or nonedible. The edible culls would be the split, discolored, and small-sized beans. Edible culls average approximately 2 percent of production.

Pintos, because of the dark color and the drier locations where they are grown, have a lower cull rate due to fewer discolored, moldy and disease-infected beans. However, in the Colorado region they do have a higher split rate due to a lower moisture content. Moisture content of Colorado harvested beans is generally 12-13 percent versus 15-18 percent for beans in the Red River Valley and in Michigan. The lower moisture level is due to drier harvest conditions.

There are essentially two cull bean markets, an edible (primarily splits) and an inedible bean cull market. Edible quality navy bean splits are generally exported to Japan; the splits are used in several of their dishes where the beans are processed into a paste. The other edible split market is the Mexican refried bean market. Edible pinto bean splits are utilized both by canners, in making a canned refried bean product, and institutional users, who use splits in making their refried bean dishes.

Prices of edible splits are determined by supply and demand factors. Generally the market price of edible splits is 50 to 60 percent of the price of whole beans. In a year with few edible splits and low overall production, split bean prices may approach those of whole beans.

Two markets exist for the inedible cull beans. One is export where the cull beans are utilized as a protein source for livestock to replace soybean meal. The Netherlands has been active in this market recently. The second market is in the domestic feed ingredient industry where cull beans are useful not only as a protein source, but as a binder in pelleting operations. The high starch content of beans acts as a binder in the pelleting operation. Culls destined for the feed ingredient market are priced according to their nutrient composition. Prices follow middle protein feed ingredients when priced as a protein source (sunflower meal for example) or wheat middlings when priced on a starch basis.

Domestic Consumption

Historically, when consumption of dry edible beans was discussed in the literature, it was simply stated that consumption was declining. However, no attempt has been made to analyze the consumption trends of the different

DEB classes. Identification of consumption trends of specific classes is necessary due to the low degree of substitutability between classes in consumption markets.

Researchers have tended to discuss DEB consumption in the aggregate because in the production process there is a high degree of substitutability. Different DEB classes require very similar cultural practices.

The consumption markets vary significantly between classes. For example, navy beans are traditionally canned (90 percent or more of domestic consumption) and consumed by the white Anglo-Saxon population in the northern United States. Pinto beans are primarily sold in dry packaged form, while approximately 20 percent (industry estimates) of the domestic market is canned. Major consumers of the pinto bean are Mexican-Americans of the Southwest and the black population of the Southeast.

In general, commercial classes of white beans (navies, great northern, cranberry, and small whites) cannot be substituted in the colored bean market (i.e., pintos, blacks, red kidneys, and small reds). Within each group, whites and colored, there may be some substitutability.

Trends

Reliable annual estimates of DEB consumption are not available for beans in aggregate or for each variety. The USDA, prior to 1985, published annual per capita DEB consumption estimates, but the series was discontinued because of unreliable and nonexistent end-of-the-year DEB stock information.

Trends in consumption can still be identified for beans in aggregate and for specific DEB classes. In this analysis, one assumption must be made; that is, that in the long run production minus exports must equal domestic consumption. For a specific year, the estimate of domestic consumption is the current year's production minus current year's exports unadjusted for stocks. Consequently, year-to-year estimates of consumption may vary widely, but given sufficient yearly data, underlying trends will be detectable. Per-capita consumption trends were investigated for beans in aggregate, navies, great northerns, and pintos. The period of analysis was from 1967 to 1984. Data prior to 1967 were not used due to a change in the method of reporting exports.

Per capita consumption is declining for beans in aggregate, navies, and great northerns. No significant trend was found for pintos. The annual decrease in lbs. per capita for beans in aggregate was 0.042; for navies, 0.0347; and for great northerns, 0.0075. This is equivalent to an annual decrease of 0.67 percent for all beans, 1.8 percent for navies, and 1.7 percent for great northerns. A five-year moving average of per capita consumption estimates is presented in Figures 10-13 for all DEBs, navies, pintos, and great northerns.

The cause of the overall decline in DEB consumption, specifically navy beans, is not easily discerned. A survey conducted in 1976 by the USDA Human

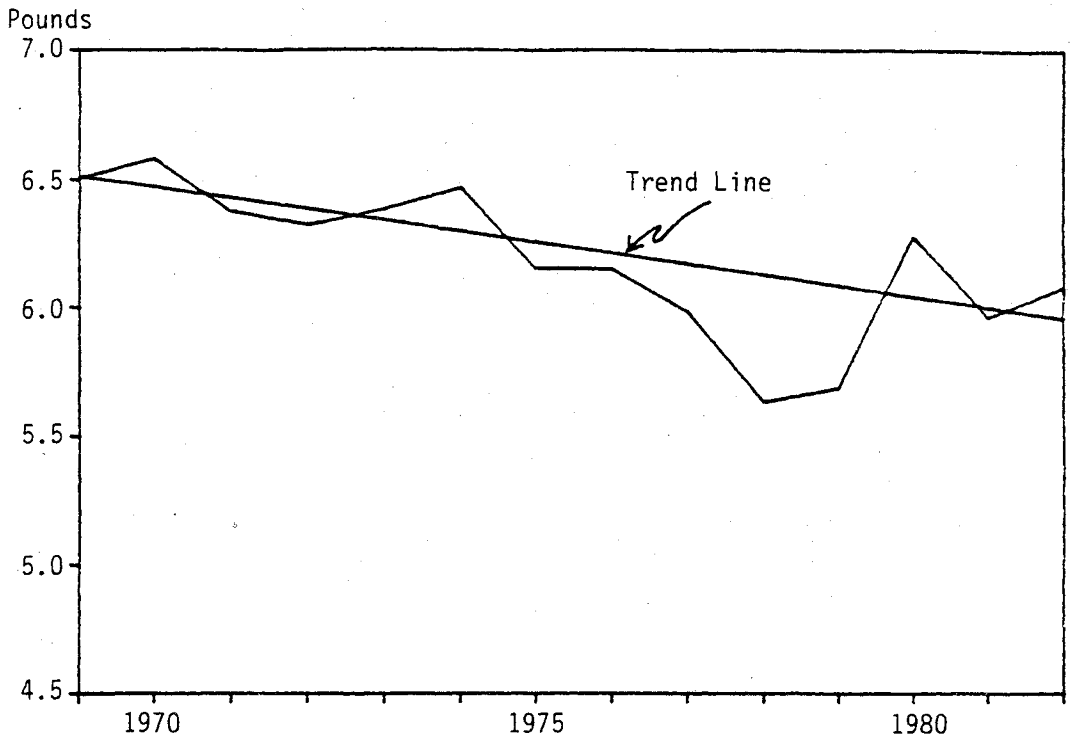

Figure 10. Per Capita Domestic Consumption of Dry Edible Beans, Five-Year Moving Average, 1969-1982

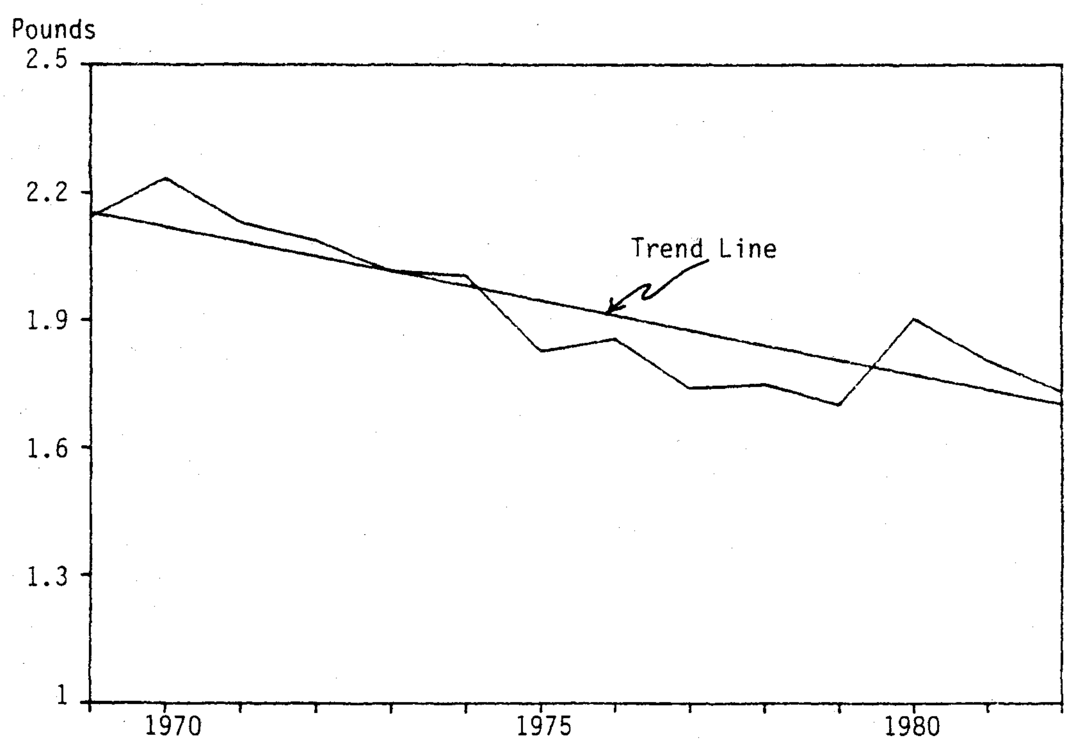

Figure 11. Navy Beans, Per Capita Domestic Consumption, Five-Year Moving Average, 1969-1982

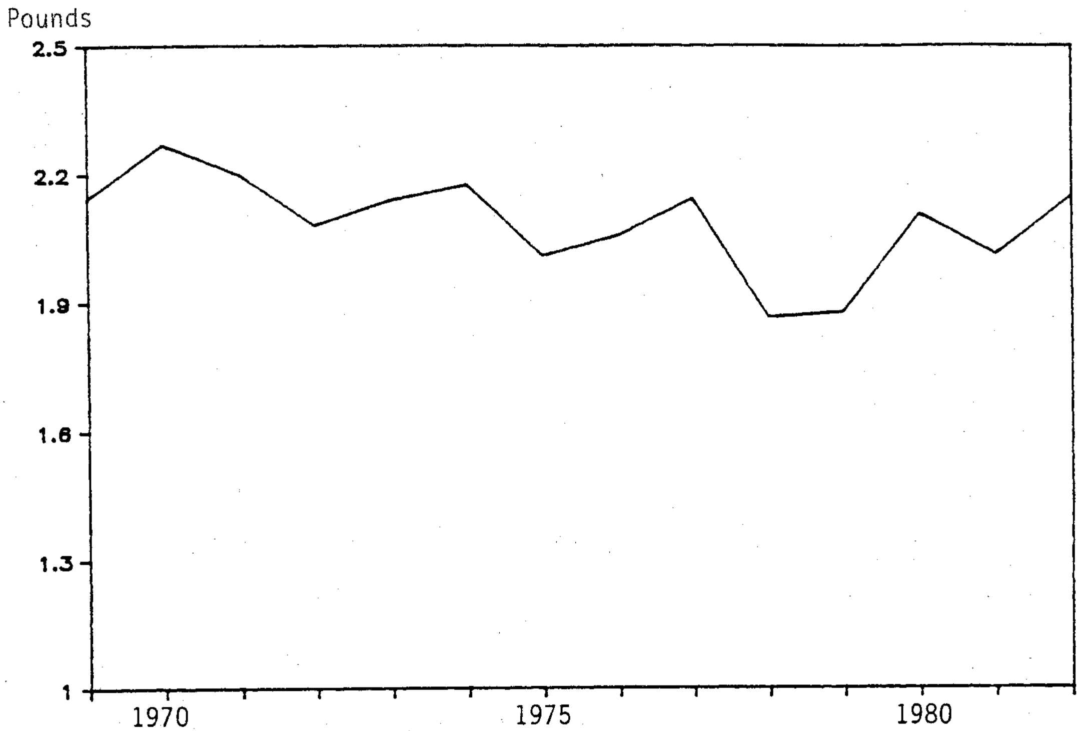

Figure 12. Pinto Beans, Per Capita Domestic Consumption, Five-Year Moving Average, 1969-1982

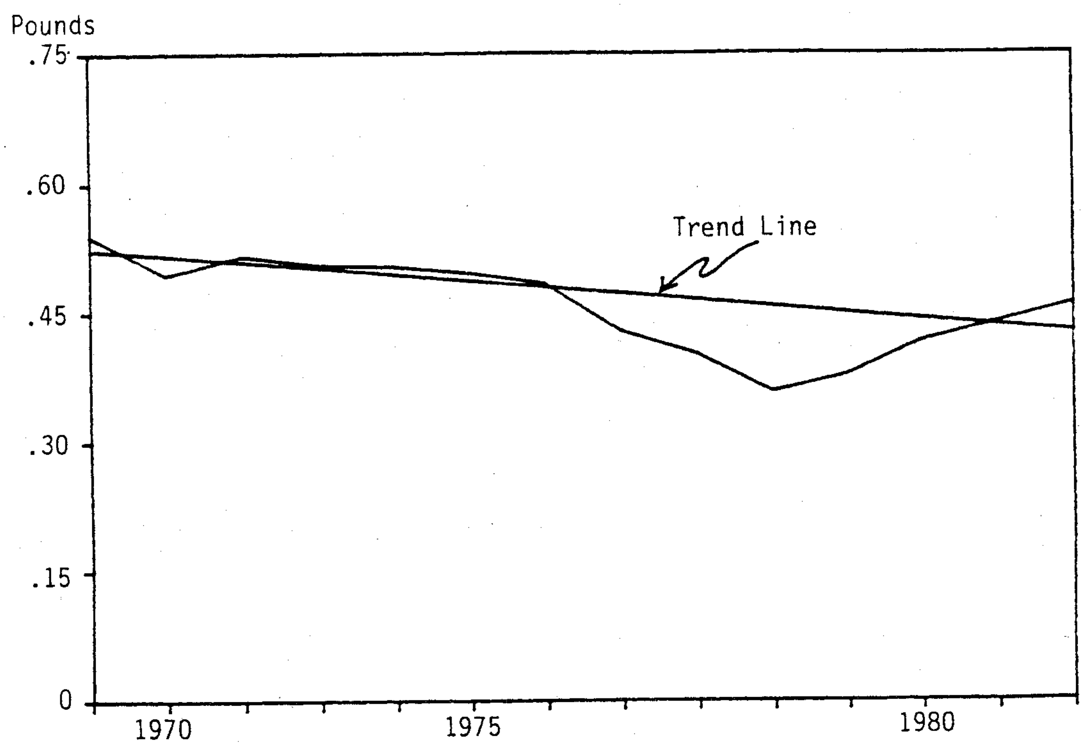

Figure 13. Great Northern Beans, Per Capita Domestic Consumption, Five-Year Moving Average, 1969-1982

Nutrition Information System indicates that as household income rises, bean consumption drops (Table 12 and Figure 14). The survey data also indicate a higher level of DEB consumption in the West and South. In comparing the 1976 survey to an earlier survey, the decrease in household DEB consumption from 1964 to 1976 is greater in the northeast, north central, and southern areas of the country (Table 12). This disproportionate decrease and the consideration that population growth is slower in the Northeast and North Central (strong navy bean markets) than the South and West, could explain the decrease in per capita navy bean consumption. United States population change and projected change are depicted in Figure 15. The higher population growth rate in the South and West, both strong pinto bean markets, could explain the stability in pinto bean consumption.

Research on DEB demand (the relationship between consumption, prices, and income) suggests an income elasticity from .1 to -.4 (Conklin 1985). This implies that a 1 percent increase in income yields between a .1 percent increase in consumption to a .4 percent decrease in consumption. This income effect on consumption will be dependent upon its distribution. A change in income of lower income people will tend to have a positive effect on consumption while an increase in income of higher income people will not likely have an effect on consumption. Studies have also shown that consumption is not very responsive to price changes. A 1 percent price increase results in only a .25 percent decline in consumption (Conklin 1985).

The pinto bean market has been strengthened by the population growth in the South and West. The South and West are strong pinto bean markets because of the Mexican and Hispanic influence. Pinto bean consumption has also been helped by the popularity of ethnic foods. Mexican food is quite popular.

Domestic Consumption to 1990

Total domestic dry edible bean consumption is expected to remain equal to previous levels with a slight possibility of increasing. The increase in population will offset the trend of decreasing per capita consumption. However, based on current consumption trends, both navy and great northern

TABLE 12. ANNUAL HOUSEHOLD CONSUMPTION OF DRY EDIBLE BEANS, BY REGION, 1964 AND 1976

Year	Northeast	North Central	South	West	United States
	pounds				
1964	7.28	13.00	28.60	13.52	16.64
1976	4.16	5.72	16.31	14.04	9.88

SOURCE: Agricultural Research Service, USDA, 1977.

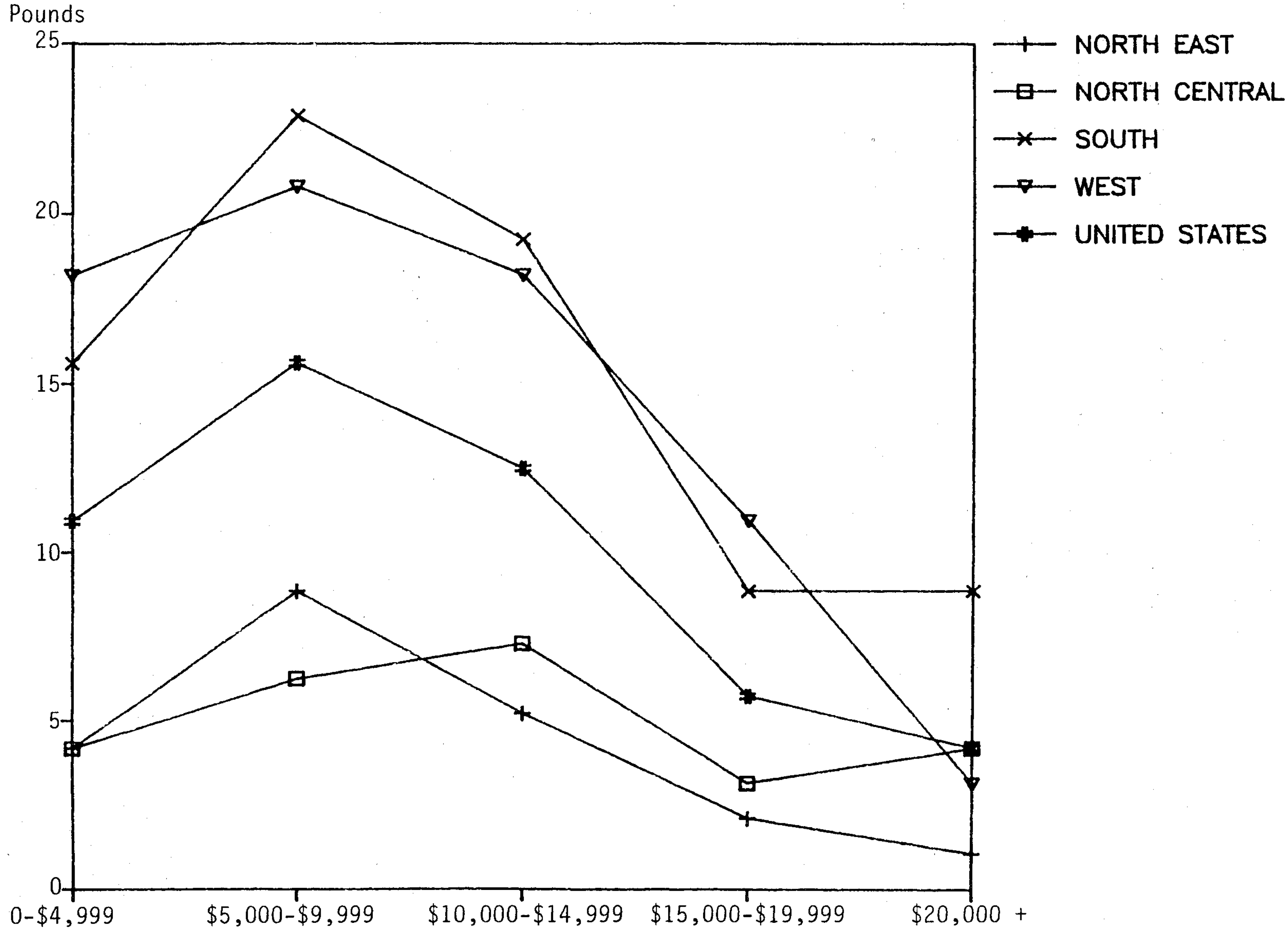

Figure 14. Annual Domestic Household Consumption of Dry Edible Beans by Income and Region, United States, 1976

SOURCE: Agricultural Research Service, USDA, 1977.

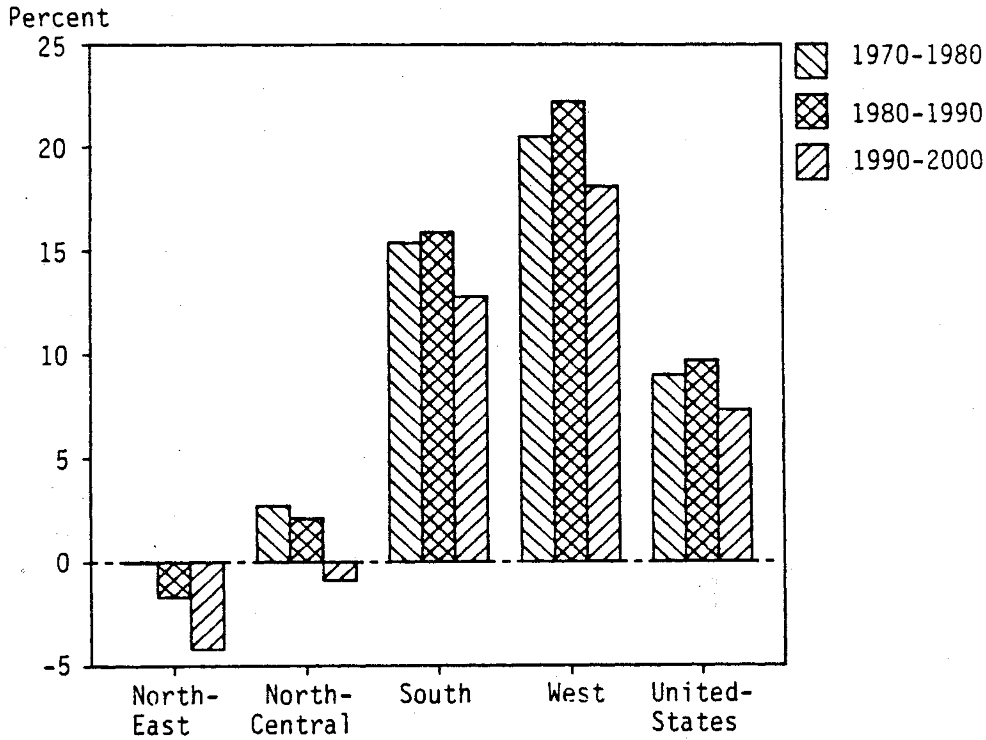

Figure 15. United States Population Change by Region

SOURCE: United States Department of Commerce, 1983.

bean consumption will decrease. Their rate of decrease is too large to be offset by the increase in population. The domestic market for pintos and other coloreds is expected to expand. This expansion is solely a result of population growth and not an increase in per capita consumption. Market projections by DEB class are presented in Table 13.

Pricing of Dry Edible Beans

Dry edible bean prices have become much more volatile in the 1970s and 1980s than in the 1960s. Prices of dry beans remained relatively stable in the 1960s, fluctuating primarily between $7 and $12 per cwt. Prices became much more volatile in the 1970s and 1980s, changing as much as 50 percent from year to year (Table 14).

The increase in volatility was due to many causes. Prices nearly tripled in response to a world-wide protein shortage and the high inflationary prices for all agricultural commodities (Conklin 1985). The market also became more export dependent in the 1970s. These exports became increasingly volatile in the 1970s and 1980s. Conklin, USDA 1985, stated that because domestic DEB demand is not very responsive to income changes, bean prices are primarily determined by production and exports.

TABLE 13. DOMESTIC CONSUMPTION[a], DRY EDIBLE BEANS, UNITED STATES, 1970 THROUGH 1982, AND FORECAST 1985 THROUGH 2000

Year	Population	Navy		Pinto		Great Northern		Other White		Other Colored		Total	
Year	(1,000)	5YA[b]	Trend[c]	5YA	Trend	5YA	Trend	5YA	Trend	5YA	Trend	5YA	Trend
1970	203,984	4,558	4,322	4,629	4,302	1,007	1,053	548	510	2,680	3,000	13,423	13,194
1971	206,827	4,403	4,310	4,545	4,362	1,067	1,052	523	517	2,639	3,042	13,177	13,289
1972	209,284	4,366	4,289	4,353	4,413	1,056	1,049	552	524	2,899	3,078	13,226	13,357
1973	211,357	4,257	4,258	4,522	4,457	1,063	1,043	549	529	3,104	3,109	13,494	13,399
1974	213,342	4,272	4,224	4,641	4,499	1,056	1,037	572	534	3,261	3,138	13,801	13,434
1975	215,465	3,935	4,191	4,329	4,544	1,040	1,031	563	539	3,389	3,169	13,256	13,475
1976	217,563	4,039	4,156	4,476	4,588	930	1,025	556	544	3,374	3,200	13,375	13,513
1977	219,760	3,823	4,121	4,708	4,634	882	1,019	480	550	3,258	3,232	13,150	13,556
1978	222,095	3,886	4,088	4,138	4,684	793	1,013	470	556	3,220	3,267	12,508	13,605
1979	224,567	3,818	4,055	4,215	4,736	847	1,008	461	562	3,434	3,303	12,775	13,660
1980	227,236	4,328	4,025	4,784	4,792	946	1,003	453	569	3,682	3,342	14,265	13,725
1981	229,542	4,144	3,986	4,616	4,841	1,005	996	465	574	3,851	3,376	13,680	13,766
1982	231,822	4,185	3,945	4,662	4,889	1,015	988	492	580	3,996	3,410	13,816	13,803
1985[d]	238,631	--	3,812	--	5,032	--	964	--	597	--	3,510	--	13,902
1990[d]	249,657	--	3,554	--	5,265	--	915	--	625	--	3,672	--	14,010
1995[d]	259,559	--	3,244	--	5,474	--	855	--	649	--	3,818	--	14,010
2000[d]	267,955	--	2,883	--	5,651	--	782	--	670	--	3,941	--	13,890

[a]Estimated domestic consumption = production - exports.
[b]Five-year moving average.
[c]Consumption based on per capita consumption trends.
[d]Forecasts.

TABLE 14. PRICES, DRY EDIBLE BEANS 1967 THROUGH 1984

Year	Navy[a]	Pinto[b]	Great Northern[c]	All[d]
1967	N.A.[e]	9.54	8.50	9.26
1968	N.A.	7.83	8.62	8.18
1969	N.A.	10.69	8.02	7.60
1970	N.A.	9.24	10.35	9.21
1971	11.50	11.60	11.60	10.90
1972	9.70	11.00	16.00	11.00
1973	30.00	39.15	30.60	27.30
1974	16.08	32.75	20.95	19.80
1975	28.11	17.85	21.15	20.10
1976	18.65	14.75	18.20	15.50
1977	22.10	23.25	23.80	20.20
1978	18.89	21.65	23.56	17.30
1979	22.74	31.76	27.25	22.80
1980	33.47	35.51	35.13	27.60
1981	31.88	17.82	26.62	21.00
1982	17.20	15.06	20.15	14.20
1983	26.49	21.84	23.47	22.40
1984	22.77	20.72	19.36	18.00

[a]Wholesale prices, F.O.B. Michigan Points.
[b]Wholesale prices, F.O.B. Colorado points.
[c]Wholesale prices, F.O.B. Western Nebraska points.
[d]Season average grower price, United States.
[e]N.A. = not available.

SOURCE: Agricultural Statistics, USDA.

The relationship between prices and domestic per capita supply is presented in Figures 16, 17, 18, and 19 for all beans, navies, pintos, and great northerns. It is evident that as the supply of beans decreases, the price increases. Likewise, when supply increases, prices fall. Per capita available supply is defined as production minus exports divided by U.S. resident population. Per capita available supply is used in lieu of available supply because it accounts for the changing population.

This price relationship can be mathematically modeled and used as a basis for price forecasting. Prices are modeled in the following general format

$$PB = b_0 + b_1AS + b_2LE$$

where

PB = Season average price measured in dollars per cwt.

AS = Available supply measured in pounds per capita

LE = Level of exports in 1,000 cwt.

A more accurate "Available Supply" estimate would be preferred, i.e., one that incorporates carryover stocks, but this is the best estimate available. Consistent estimates of DEB carryover stocks are not available. Although exports are already taken into account in calculating available supply, the level of exports is also included as an explanatory variable. Export demand puts an upward pressure on prices because exporters have to bid prices up in order to obtain beans. Thus, in two different years with identical available domestic supply, prices will not be identical. The year with a higher level of exports will have a higher price. The price relationship for navy, pinto, and great northerns will be statistically modeled using the previously specified model.

Navy Beans

The statistical estimate of the price relationship for navy beans was

$$\underset{(5.94)}{P = 47.66} \; - \underset{(2.45)}{12.82\,AS} \; + \underset{(2.05)}{2.41\,LE} \; + \underset{(.27)}{.53\,AR}$$ [1]

where

P = Wholesale price of navy beans per cwt., F.O.B. Michigan points

AS = Available supply of white beans in pounds per capita

LE = Level of white bean exports in million cwt.

AR = Autoregressive term

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[1]The numbers in parentheses are the standard errors of the regression coefficients and for all subsequent statistical models.

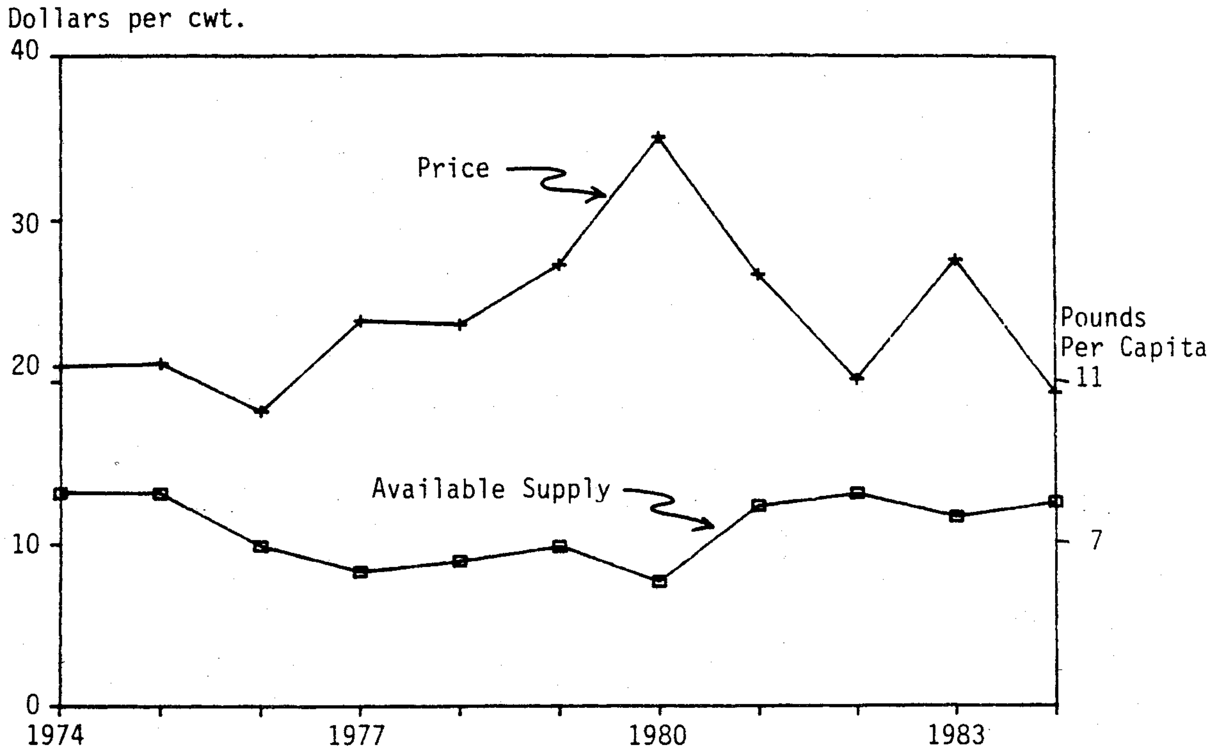

Figure 16. Dry Edible Beans, Price and Per Capita Supply, 1974-1984

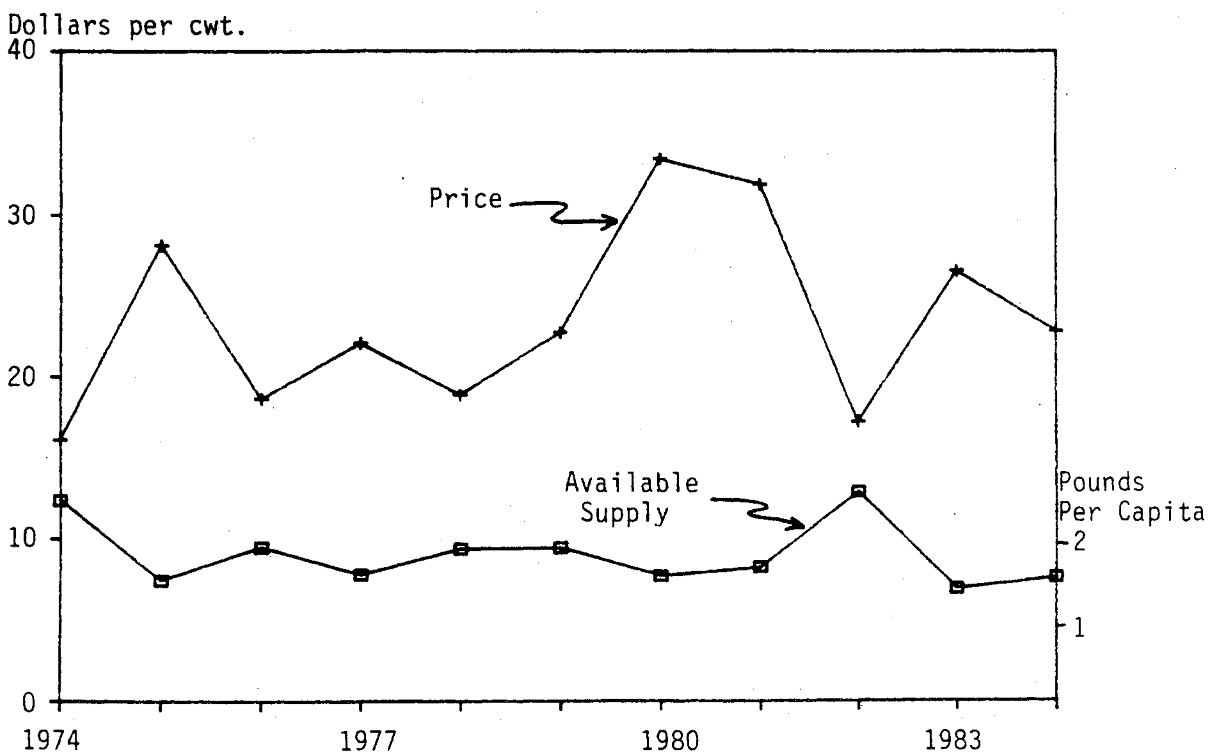

Figure 17. Navy Beans, Price and Per Capita Supply, 1974-1984

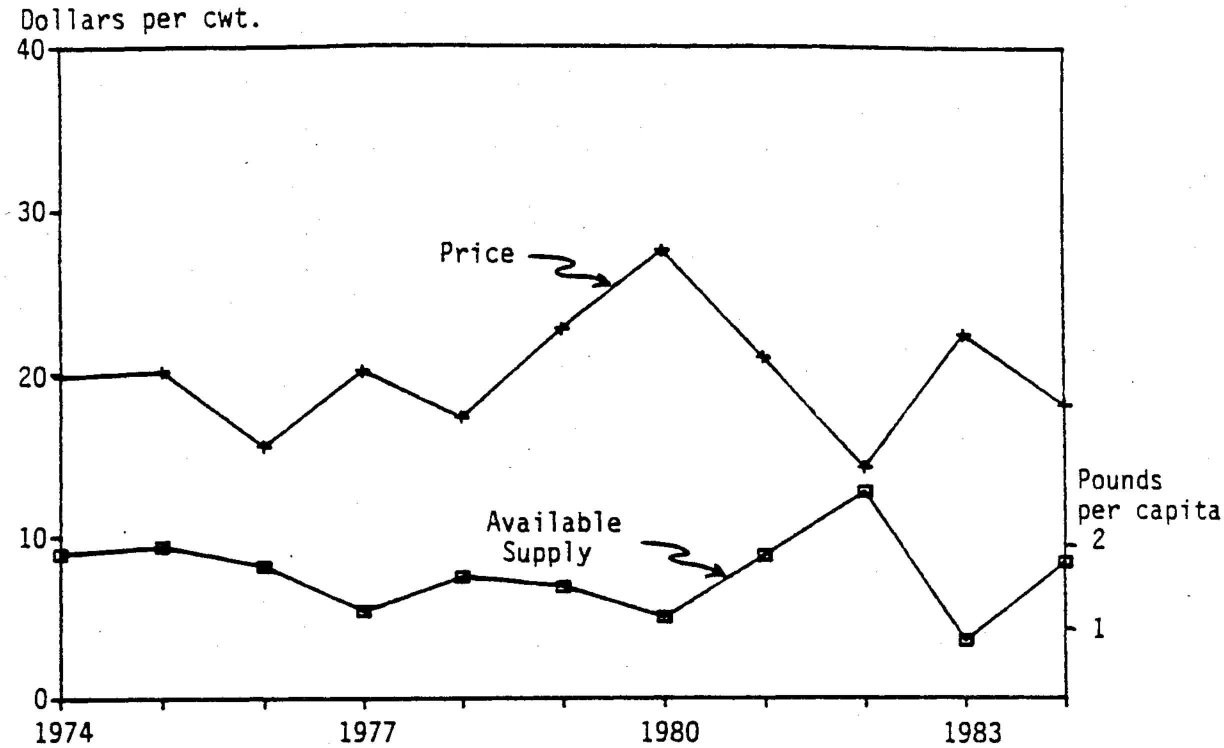

Figure 18. Pinto Beans, Price and Per Capita Available Supply, 1974-1984

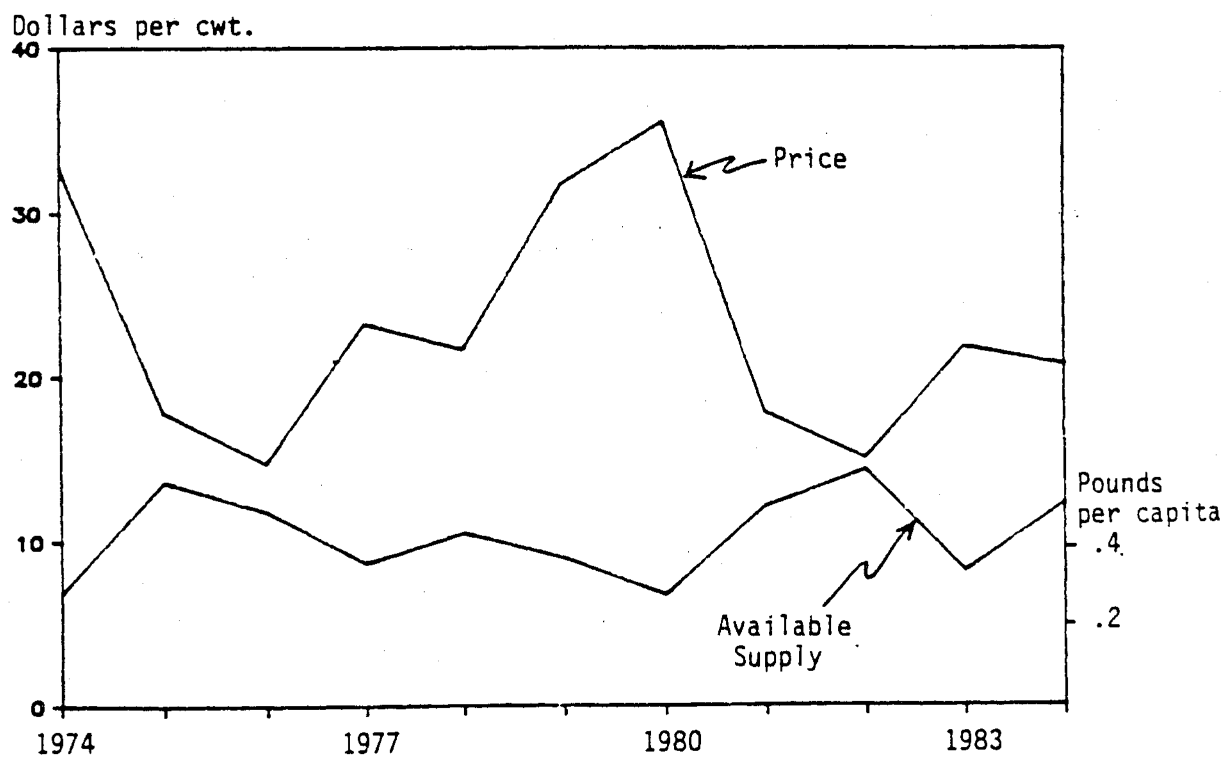

Figure 19. Great Northerns, Price and Per Capita Available Supply, 1974-1984

The coefficient of determination (R^2) was .76, indicating that 76 percent of the variation in price of navy beans was explained by the model. The category all white beans, instead of navy beans, was used to measure available supply. Using the broader category, white beans, instead of navy beans, gave a better fit in the model. Navy beans are the major class of white beans produced; they generally account for 70 percent or more of total white bean consumption. Using all white beans for calculating supply and level of exports is justified on the basis that individual classes of white beans may be substituted for each other in certain markets. Actual versus predicted navy bean prices are presented in Figure 20.

Great Northern Beans

The statistical estimate of the price relationship for great northerns was

$$P = \underset{(5.20)}{30.65} - \underset{(1.83)}{6.81}\,AS - \underset{(1.10)}{4.03}\,LE$$

where

P = Wholesale price of great northern beans per cwt., F.O.B. Western Nebraska points

AS = Available supply of white beans in pounds per capita

LE = White bean exports in million cwt.

The R^2 was .78, indicating 78 percent of the variation in the price of great northern beans was explained by the model. White beans were used as the basis for estimating supply and level of exports as great northerns may be substituted for other white beans in certain markets. Actual versus predicted great northern bean prices are presented in Figure 21.

Pinto Beans

The statistical estimate of the price relationship for pinto beans was

$$P = \underset{(4.97)}{46.82} - \underset{(2.32)}{11.48}\,AS$$

where

P = Wholesale price of pinto beans, F.O.B. Northern Colorado points

AS = Available supply of pinto beans in pounds per capita

The level of pinto bean exports was not significant in the model outside of calculating available supply. This is a result of pinto bean exports being quite minimal except for a few years in the export boom to Mexico. The model's R^2 was .73, indicating that 73 percent of the price variation was explained by the model. Actual versus predicted pinto bean prices are presented in Figure 22.

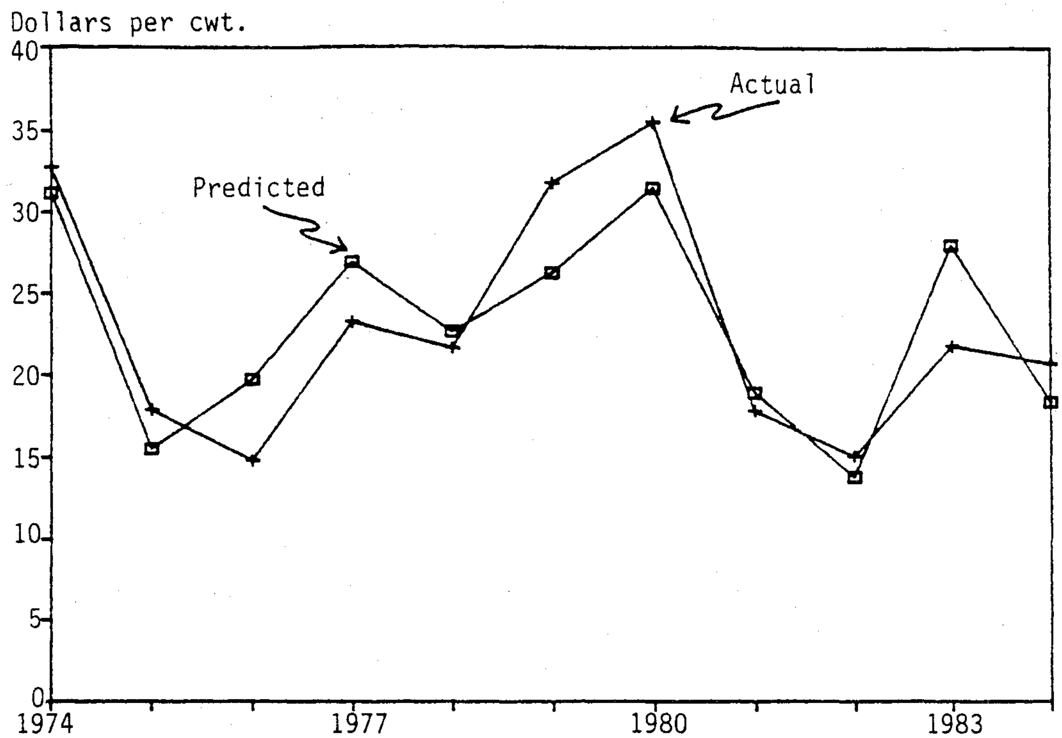

Figure 20. Actual and Predicted Prices, Navy Beans, 1974-1984

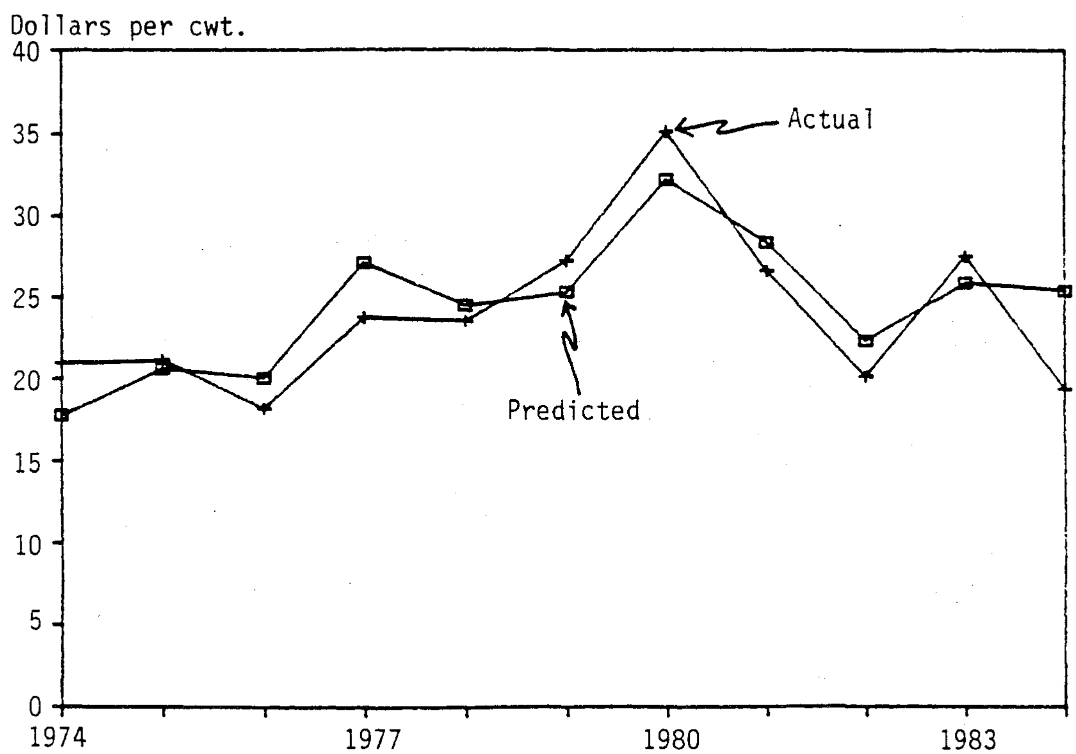

Figure 21. Actual and Predicted Prices, Great Northerns, 1974-1985

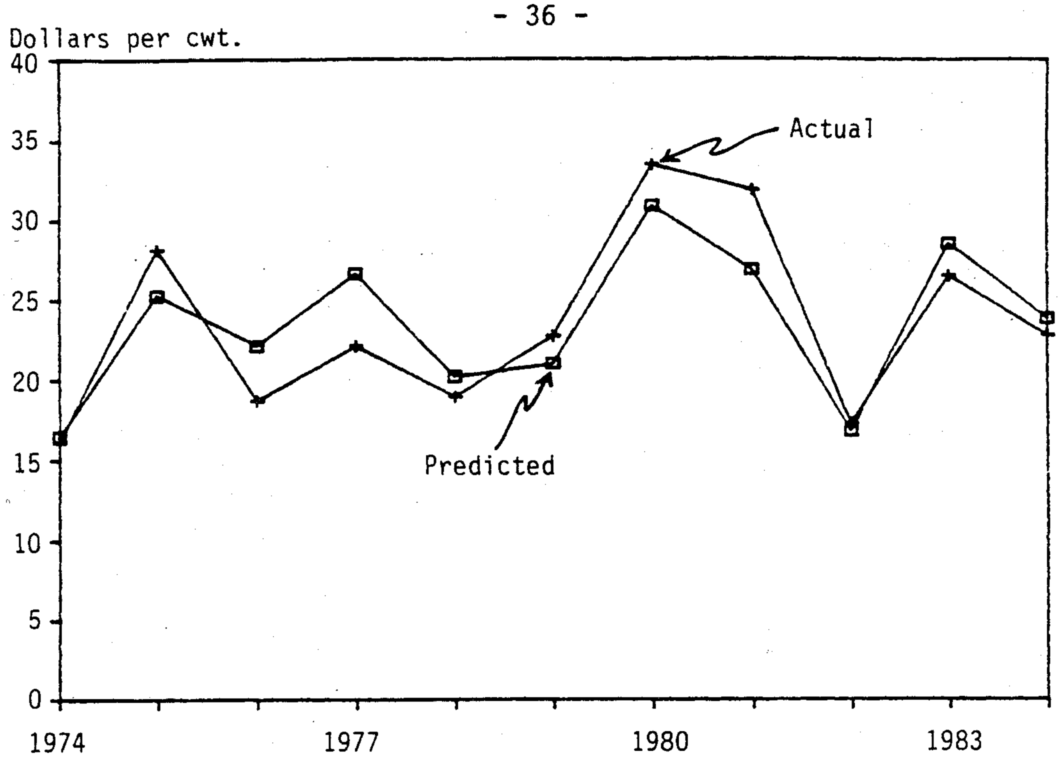

Figure 22. Actual and Predicted Prices, Pinto Beans, 1974-1984

Supply Response

The decision behavior of U.S. DEB producers in terms of planting acreage, is described in the following model

$$A_t = \underset{(650)}{230.30} + \underset{(.36)}{1.99}P^2_{t-1} + \underset{(.28)}{.84}P^2_{t-2} + \underset{(.49)}{.59}Y_{t-1} - \underset{(.74)}{1.68}W_{t-1}$$

where

A_t = U.S. dry bean acreage planted in 1,000s in year t

P^2_{t-1} = Season average price received by farmer for DEB in year t-1 squared

P^2_{t-2} = Season average DEB price received by farmers in year t-2 squared

Y_{t-1} = U.S. average DEB yield in pounds per acre in year t-1

W_{t-1} = U.S. average wheat price received by farmers in year t-1.

The model explained 88 percent (R^2 = .88) of the variation in planted acres. Farmers based their plantings not only on the previous years price but prices two years previously. They also considered the previous year's bean yield and price of a competing crop such as wheat. Actual versus predicted acreage is presented in Figure 23.

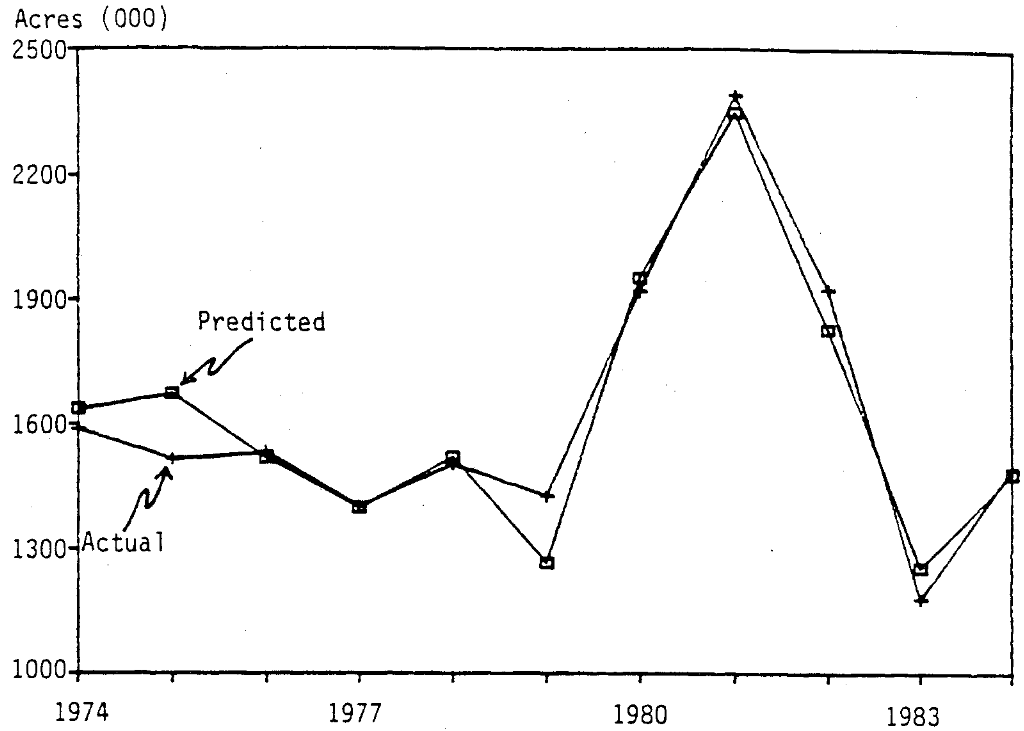

Figure 23. Planted Acreage, Dry Edible Beans, United States, Actual and Predicted, 1974-1984

A similar model was specified for the supply response in North Dakota. DEB yield and wheat price were no longer statistically significant. A yearly trend was statistically significant. The final model used was

$$A_t = \underset{(58.42)}{-170.42} + \underset{(.08)}{.42}P^2_{t-1} + \underset{(.07)}{.21}P^2_{t-2} + \underset{(4.3)}{17.68}T$$

where

A_t = North Dakota planted acreage in 1,000s in year t

P^2_{t-1} = Season average DEB price received by farmers in year t-1 squared

P^2_{t-2} = Season average DEB price received by farmers in year t-2 squared

T = Time in years, 1974=0

The model explained 86 percent (R^2 = .86) of the variation in planted acreage. The North Dakota response was similar to the United States model in that prices from two previous periods entered into the decision process. There was also a time trend of 17,680 acres per year. This could be a result of DEBs being a relatively new crop to North Dakota and every year more farmers were entering or expanding acreage as the crop became more familiar. Actual versus predicted North Dakota acreage is presented in Figure 24.

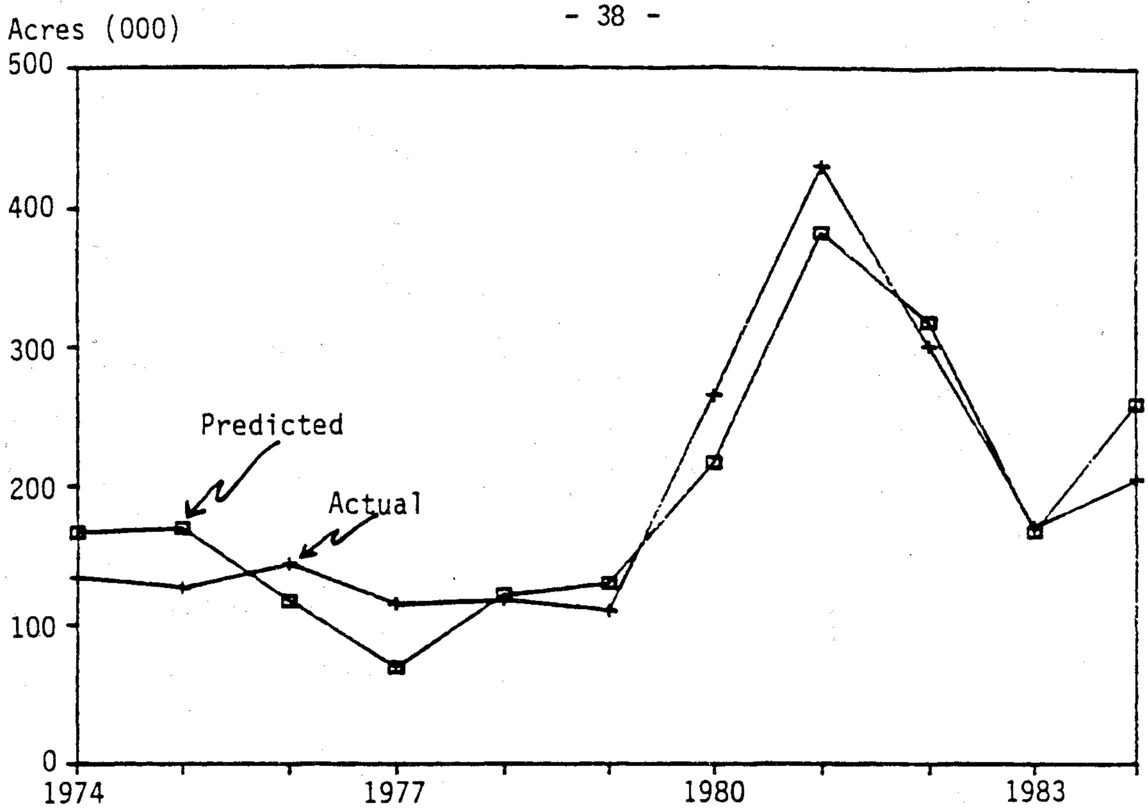

Figure 24. Planted Acreage, Dry Edible Beans, North Dakota, Actual and Predicted, 1974-1984

New Product Development of Dry Edible Beans

Dry edible beans are an under-utilized dietary protein and carbohydrate source in today's society. They contain 26 percent protein and 65 percent carbohydrates on the average. The high lysine content of the protein makes DEBs desirable complements to cereal grains (Dietz and Lusas 1983). The declining overall per capita consumption of DEB has placed an emphasis on improving the utilization of DEBs.

A 1978 study by the National Science Foundation identified the following needs for bean product development (Adam et al.).

- Development of expanded markets for food legumes

- Development of food products based on legumes

- Promotion of available legume products in order to increase use

- Development of more efficient methods of production, packaging, distribution, and marketing

- Development of economic, technological, and physical resources necessary for production and processing food legume should be developed

According to Dietz and Lusas (1983), the major factors limiting the utilization of DEBs in the world are local food habits, ethnic origin of consumers, geographic origin of bean varieties, and cultural and religious practices. Factors limiting the use of DEBs in the United States are unavailability of bean-based food ingredients, lack of convenience in preparation, and gastrointestinal distress of some bean consumers.

From a domestic consumption viewpoint there are two basic approaches in expanding DEB utilization. One is to develop new bean-based products for the food ingredient market utilizing the high protein and starch content of the bean; for example, a protein supplement for cereal grain-based food products. The second approach is to increase the usage in their traditional final product forms by improving the convenience of preparation. For example, a quick-cook or instant bean product would be one example that would reduce the energy, labor, water, and/or labor requirements of preparation. However, both approaches must take into consideration the naturally occurring anti-nutritional factors, trypsin and hemagglutinins, in DEBs. Controlled heat treatments have been used to inactivate these factors and thus improve the digestibility of bean products (Dietz and Lusas 1980).

Research in neither area, food ingredients or convenience, has been totally exclusive of the other. In the 1960s and early 1970s research centered around producing quick-cook or instant bean products. Rockland (1966) developed a process for preparing quick-cook dry lima beans. The process has been adapted to other common beans. The process consists of 1) intermittent vacuum treatment (hydravac process) for 30 to 60 minutes in a solution of inorganic salts, 2) a soak for six hours in the same salt solution, 3) rinsing, and 4) drying. Subjective cooking times of various legumes using the Rockland hydravac process are presented in Table 15. Rockland, utilizing a similar process as above, developed quick-cooking frozen products (Rockland 1969); and the described process was modified by replacing the drying process with a cryogenic freezing process.

Progress in the development of a quick-cook bean was hindered by "butterflying" of the bean during the drying or dehydration process. Precooked beans normally split wide open immediately upon exposure to a dehydrating environment. This splitting, known as "butterflying," apparently is caused by a differential rate of drying between the bean skin and cotyledon. The skin dries more rapidly and contracts. The slower-drying cotyledon develops internal vapor pressures of such magnitude that the pressure ruptures the skin and produces the butterflying effect (Feldberg 1956).

One solution is to freeze the beans prior to dehydration. However, blast freezing equipment is relatively expensive. The "butterfly" problem was solved by a process developed by W. Dorsy and S. Strashun (United States Patent 3,290,159, December 6, 1966; assigned to Vacu-Dry Company). This is accomplished by reducing the initial bean drying rate of the precooked beans until the moisture content is below 40 percent. The beans are then rapidly dried to their final low moisture content. The process is useful for producing beans with a variable cooked condition. These beans can be used as "simmer" type beans, or in producing an "instant" type bean which upon rehydration instantly reconstitutes and can be eaten without further cooking.

TABLE 15. SUBJECTIVE COOKING TIMES OF VARIOUS STANDARD AND QUICK-COOKING DRY LEGUMES

Legume	Subjective Cooking Time in Distilled Water: Standard[a] Seedcoat	Standard[a] Cotyledon	Quick-cooking[b] Whole Dry Seed
	---minutes---		
Lentil	20	30	13 (6)
Lima, large	80	27	25 (6)
Lima, baby	65	35	25 (6)
Pinto	50	35	30 (6)
Peas, whole green	50	75	35 (18)
Red kidney	75	45	35 (24)
Red	55	40	35 (24)
Pink	65	40	35 (24)
California small white	80	30	35 (6)
Great Northern	55	40	35 (18)
Blackeye	40	45	45 (18)
Soy	<150 (est.)	180	50 (24)

[a]Prehydrated 16 hours in distilled water at 70°F.
[b]Figures in parentheses indicate soaking times (hr.) in hydration medium at 70°F.

SOURCE: Rockland, 1969.

A process of producing an "instant" or simmer-type cooked bean is described by Noyes (1969). Beans are rehydrated to bring the moisture content up to 50 to 55 percent from their original 10 percent level. The beans are then cooked, preferably in a pressure cooker. The cooking period for instant type beans should be approximately 10 minutes at 13 psi steam pressure (243°F). For "simmer" type beans a shorter cooking period of eight minutes is employed. Beans are then dried in three stages. During the first stage of dehydration the beans are exposed for approximately one-half hour to circulating air at room temperature. This is followed by a half hour of drying at 120°F and a final slow drying of one hour at 130°F. This reduces the bean moisture to 35 to 40 percent or less. The air temperature then is increased to around 150° to 160° F. to bring the moisture rapidly down to around 6 to 10 percent by weight on a dry basis (Noyes 1969).

Instant legume powders were produced by Bakken-Arhema (1966) in a cooperative project between the Western Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture and the Departments of Agricultural Engineering and Food Science, Michigan State University, East Lansing, Michigan. The basic process is to soak the beans at 210°F for 40 minutes, retort, cook them at 230°F for 30 minutes, and drum dry the product, then mill and package it.

Previously, new process development centered around using a wet-heat process either to produce a quick-cook or instant bean product, or to deactivate the anti-nutritional properties of beans. Beginning in the 1970s researchers looked at dry heat methods of processing DEBs. The impetus for researching dry-heat processes was that the wet-heat method was very energy intensive (Dietz and Lusas 1983).

An apparatus was developed in 1970 in which food products were continuously processed into puffed pieces utilizing a heated granular salt bed (Bateson and Harper 1970). It was shown that full-fat soy flour, produced by roasting in a bed of heated salt, was not different from commercially available flour when added to white bread (Harper and Lorenz 1974).

In 1977 Carvalho and others produced instant navy bean powders by roasting dry beans in a bed of salt for 20 seconds at 190°C or 10 seconds at 210°C and then grinding. These heat treatments destroyed 70-80 percent of the trypsin inhibitor activities.

A new particle-to-particle heat exchanger, based on the earlier proven work of Harper, was developed by Food Processes, Inc., Saginaw, Michigan. This roasting innovation allowed the milling of DEBs without requiring them to be precooked and dried. The roasting facilitated the deactivating of trypsin inhibitors and hemagglutinin activity.

This development spawned a new area in product innovation. DEBs could now be milled into a whole bean flour or fractionated into a hull flour, high-protein flour, and a high-starch flour to be used in the food ingredient market. Fractionation of the bean requires pinmilling of the beans followed by an air classification. Dry roasting also produced a less flavored or bland product which is desirable in the food ingredient market. However, this attribute is undesirable when trying to develop full-flavor convenience food products. Much of the work was done cooperatively by Michigan State University and Texas A&M.

Compartmentalization of the protein and starch particles by air classification is possible due to the different density and size of the particles. Air classification has been used to fractionate many cereals as well as soybeans (Stringfellow and Peplinski 1964; Preifer et al., 1960; Stringfellow et al., 1961 and 1971).

Researchers at the Prairie Regional Laboratory, Saskatoon, Canada, pioneered applications of milling and air classification to obtain enriched legume fractions. A commercial method was developed for producing a 60 percent protein concentrate smooth-seeded yellow field pea by pinmilling flour to less than 325-mesh particle size and air classifying (Vose et al., 1976).

Chang and Satterlee (1979) fractionated the bean into high-starch and high-protein flours. In that process, water was used as an extraction medium. Significant energy was consequently used in drying of final products. Wet processes also have major disadvantages, such as the production of waste by-products which contain high amounts of organic material, and the reduction in yield due to losses in wet by-product streams.

Current Technology

Two different processes currently exist that have the potential to produce marketable products from dry edible beans. The first is a dry roasting, milling and fractionation process that would provide the food ingredient market with high fiber, high protein, high starch and whole bean flows. The second, a wet (steam) cooking process, produces a quick-cook or instant-cook bean product. This product, most likely a pinto bean product used in the Mexican ethnic food market, could be marketed to retail consumers, institutional users, and food manufacturers. Descriptions of these processes will be detailed in subsequent sections.

Dry Roasted Edible Bean Flour Fractions

Food research groups at Michigan State University and Texas A&M University have been engaged in a cooperative project sponsored by the United States Department of Agriculture, to develop dry roasted bean flour products.

Commercial use of DEBs in formulated foods has traditionally been limited by the presence of a bitter off-flavor. The dry roasted bean flours developed at Michigan State and Texas A&M possess a bland neutral taste.

Perraut and Ferris (1984) reported that dry bean flour can compete with other protein, starch, and fiber ingredients and provide sufficient returns to attract venture capital. Their findings were based on the following central assumptions:

° The availability of sufficient quantities of quality cull and/or edible split dry beans to lower the overall price of the raw bean output.

° The ability to balance the production and sales of starch with protein and fiber components.

° The ability to overcome any market, institutional or Food and Drug Administration barriers or preconditions.

Justification for Study

Several factors have warranted a new economic analysis of the feasibility of producing dry roasted bean flour fractions. The original study did not include raw material receiving and storage costs, warehouse costs, overhead costs, operating capital requirements, taxes, and insurance costs. The study overstated energy requirements for processing and limited operation to one eight-hour shift per day. Projected revenues were very optimistic. These factors warranted another review of the feasibility of producing food ingredients from dry roasted beans.

Process Description

Whole dry beans are rapidly heated in a solid-to-solid heat exchanger to inactivate antinutritional factors and to stabilize flavor. The roasted beans are then dehulled. The hulls then are ground to produce a high fiber (40 percent) flour. The remaining portion, cotyledons, are then pinmilled to a fine flour. This flour can then be fractionated into high protein (45 percent) and high starch (70 percent) flours by air classification. Alternatively, whole roasted beans may be milled to produce a whole bean flour.

Roasting

The roasting process was developed by Lusas, Aguilera, and Dietz (1980 to 1983) based on the work of Harper (1974 to 1978). The heat exchanger was constructed by Food Processors, Inc. (Saginaw, MI). A schematic of the roasting equipment is shown in Figure 25. The roaster is described in a following excerpt from Deitz and Lusas (1983):

> "It is composed of two metallic rotatable drums. The heat transfer medium is heated by a direct gas flame as it leaves the lower drum. From this drum, the heated medium enters a bucket elevator and is transported to the upper drum, where they are mixed by parallel baffles. Through this mixing action, heat is transferred from the medium to the beans. As the mixture leaves the end of the upper drum, the medium and beans are separated by a screen, with the medium being returned to the lower drum and the processed beans discharged from the system.
>
> The equipment is equipped with controls to regulate the speed of the two drums, the bucket elevator, and the bean inlet screw. Another controlled variable is the angle of each drum, which regulates the retention time in the drums. Temperature of the medium as it leaves the bottom drum is controlled by a combustion safeguard and gas throttling device.
>
> The heat transfer medium employed in this study was 1/16 inch (1.6 mm) diameter type A, 90 percent aluminum oxide ceramic beads (Coors Ceramic Co., Golden City, CO) with a specific gravity of 3.6 g/cm^3."

Dehulling

Dehulling incorporates two processes. First, the roasted beans are cracked through a roller mill to loosen the hulls. Second, the hulls are removed in an aspirator.

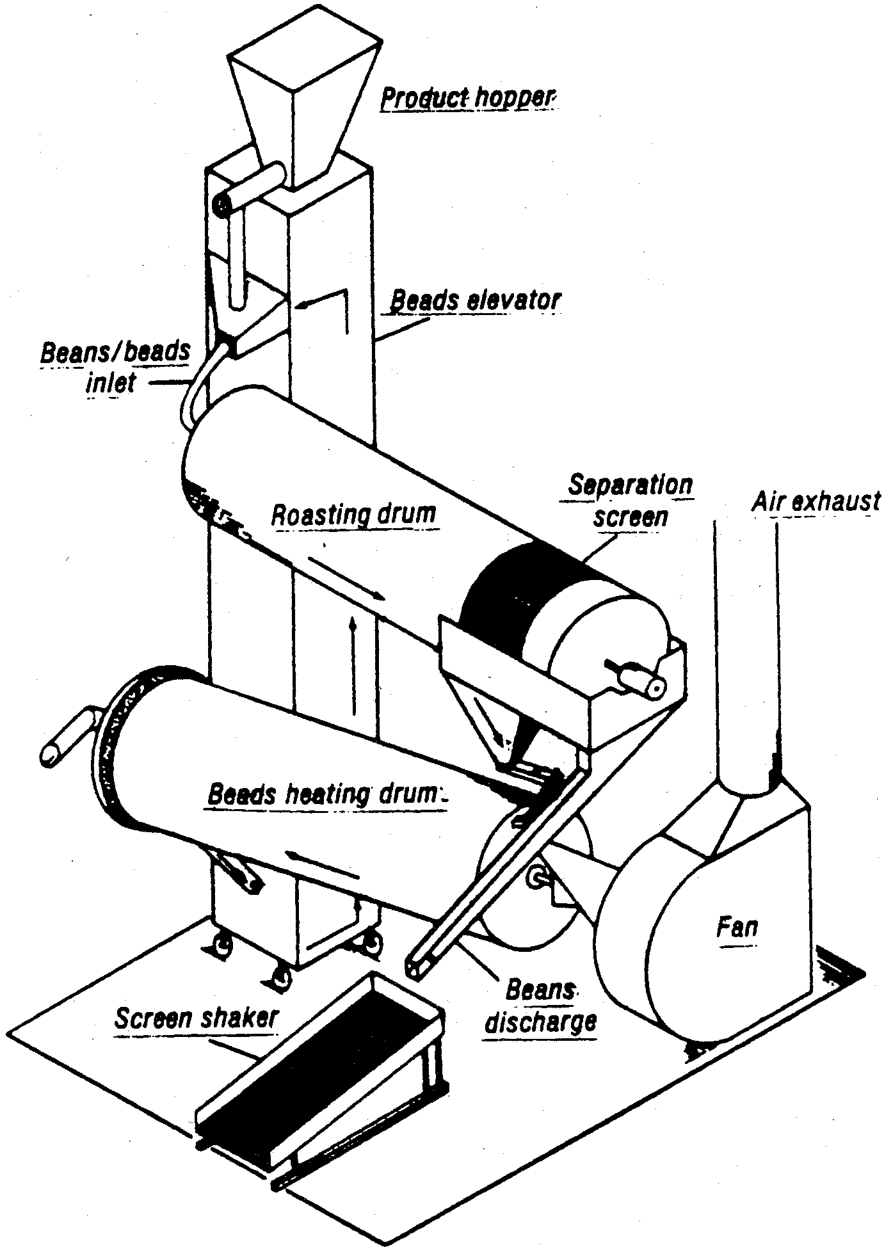

Figure 25. Schematic Drawing of the Solid-To-Solid Heat Exchanger

SOURCE: Dietz and Lusas, 1983.

Pinmilling and Air Classification

Air classification is the process by which particles differing in density and mass are separated in a current of air (Vose 1978). Pinmilling reduces the cracked cotyledons into starch and protein granules. Air classification is then used to separate the denser and larger starch particles from the less dense and finer protein granules. The composition and the degree of separation is dependent upon the fineness of grind and the number of air classifications. An additional pinmilling may be incoporated before additional air classifications.

Product Yields

Product yields depend on the effectiveness of the aspirator in removing hulls without removing significant amounts of cotyledon, on the fineness, on the number of pinmillings, and on the number of air classifications. The process used by Aguilera is schematically presented in Figure 26. Aguilera was able to achieve a yield of 55 percent for a high starch fraction containing 68 percent starch, a 32 percent yield for a high protein fraction containing 41 percent protein, and a 10 percent yield for a high fiber fraction with 35 percent neutral detergent fiber (Table 16).

Dietz and Lusas (1983) produced flour fractions from navy, pinto, and black beans. The process was slightly different than Aguilera's in that it used a second air classification without regrinding (Figure 27). They had difficulty in separating the hull and cotyledon, and this resulted in a sizable amount of cotyledon being incorporated into the hull fraction, reducing the percentage of dieting fiber present. Yields and composition are presented in Table 17.

Potential Uses of Bean Flours

Potential uses of bean flours are summarized by the Michigan State Researchers in Table 18. Whole bean flour can be used as a protein supplement in baked products and as a thickening agent in soups and sauces. The high-fiber fraction (hulls) may be used as a source of dietary fiber in baked products. The high protein fraction can be used as a protein concentrate and/or a water binder in comminuted meats. High starch fraction may be used as a gel structure or thickening agent for puddings, pie fillings, and prepackaged gravies and sauces.

Protein Market

Soybean-based protein products are the primary vegetable protein source. Domestic human consumption was estimated at over 643.9 million pounds in 1984 (Perraut and Ferris 1984). Soy flour and grits are the major soybean-based product accounting for 350.5 million pounds. The annual growth rate for soy flour and grits is greater than 5 percent (Table 19).

The various soybean products would be the primary competition for high protein bean flour. Soy flours and grits are used in baking, protein fortification, meat extenders, cereals, dietary foods, soup mixes and confections. Their use, however, is limited by a characteristic bitter taste. Concentrates are higher in protein and have a less objectionable taste and a greater degree of digestibility. Isolates have higher protein content with no objectionable flavor.

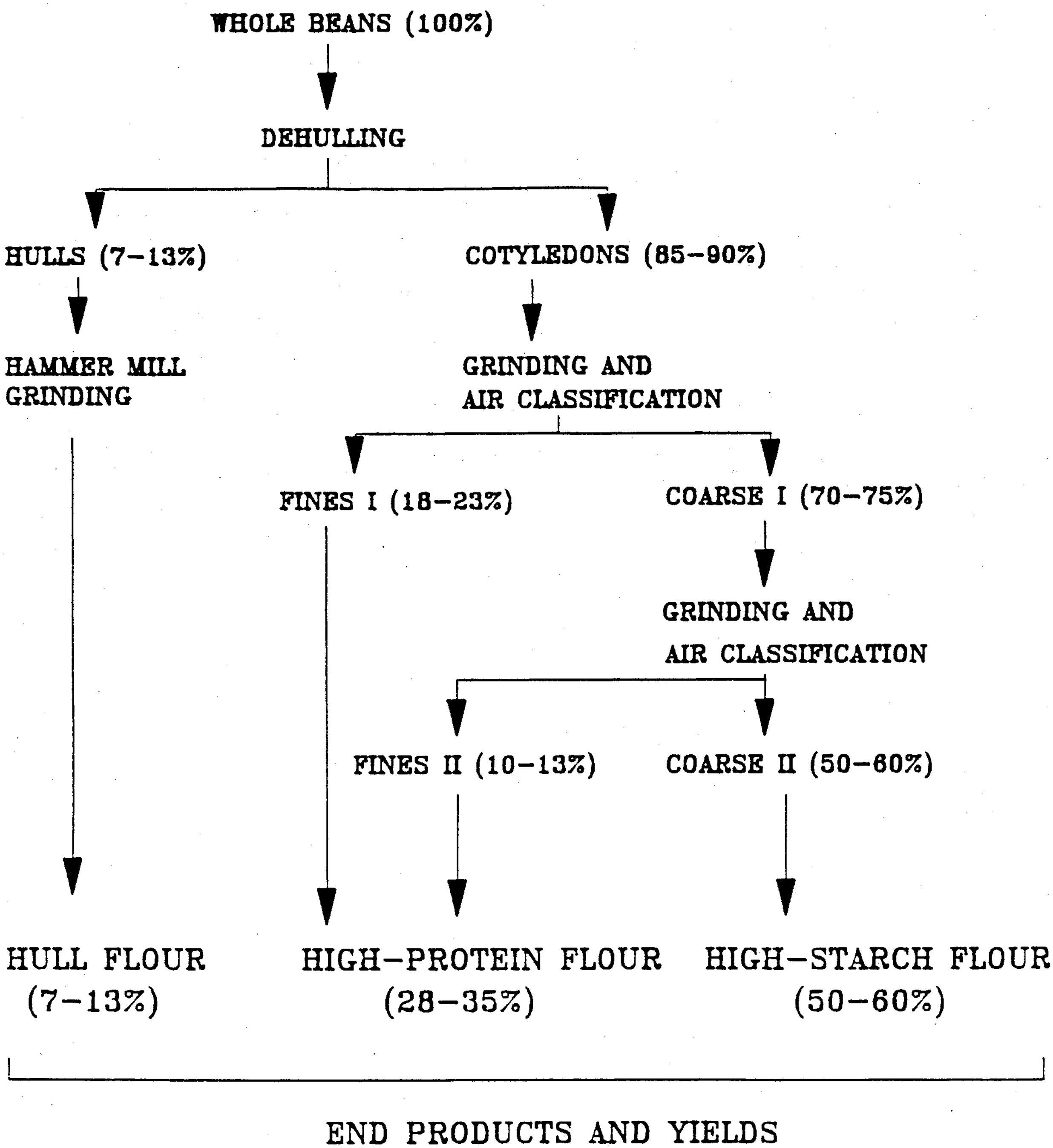

Figure 26. Typical Material Balance For Fractionating Dry Edible Beans

SOURCE: Aguilera, 1981.

TABLE 16. AVERAGE YIELD AND CHEMICAL ANALYSES OF DRY-ROASTED NAVY BEAN FLOUR FRACTIONS

Flour Fractions	Yield (%)	Moisture (%)	Ash (%db)	Protein	ENDF[a]	Starch	Fat
Whole	100	8.92	5.25	25.94	7.58	60.46	1.82
Hull	10	9.03	6.32	18.44	35.43	--	1.01
High protein	32	7.05	4.72	41.31	4.45	31.94	2.49
High starch	55	8.35	2.69	16.12	2.30	67.72	1.02

[a]Enzyme neutral detergent fiber (Robertson and Van Soest, 1977).

SOURCE: Lee et al., 1983.

Researchers at Michigan State have successfully substituted whole bean flour and high protein bean flour in various baked goods. Substitution rates of up to 30 to 40 percent was obtainable before affecting flavor in highly flavored baked goods. Lower levels of substitution were required with less flavored products. Binding and emulsifying properties of the navy bean protein indicate that high protein bean flour could be used in frankfurters at levels comparable to current usage of soy or milk proteins.

Prices of soy protein products are presented in Table 20. Soybean meal is the raw material for the protein products; consequently, prices vary in relationship to soymeal prices.

Starch Market

Corn starch is the primary starch in the market place; it accounts for 95 percent of all food starch ingredients. However, 70 percent of the corn starch produced is destined for corn syrup and sweetner manufacture.

Food manufacturers use starch as a gel and thickening agent in sauces, gravies, puddings, and baking powder. Nonfood industrial uses include use in manufacture of textiles, paper, cosmetics, explosives, and laundry products (Leath et al. 1982).

Starch use in food products is estimated at 800 million pounds annually. Starch is used in an unmodified or modified form; starches are chemically modified to produce specific characteristics. These include controlled swelling, lower viscosity, improved clarity and changes in swelling response to acid, temperature, and pressure (Perraut and Ferris 1984).

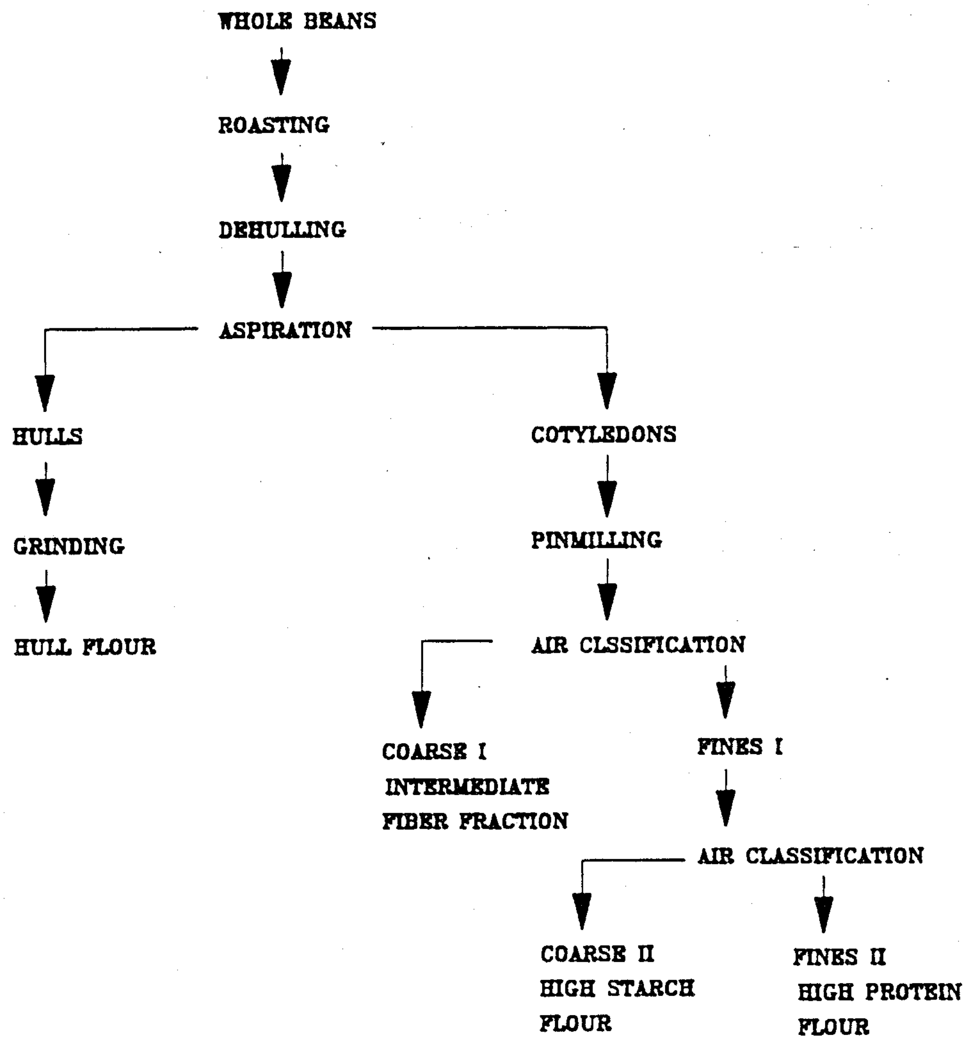

Figure 27. Processing-Flow Diagram, Navy, Pinto, and Black Beans

SOURCE: Dietz and Lusas, 1983.

Bean starches have showed controlled swelling where temperatures of 80 to 82°C are required to initiate changes in viscosity; also no susceptibility to shear was noted (Michigan State University 1984). These characteristics are representative of chemically bonded starches. However, use of bean starch would be limited because of its susceptibility to retrogradation causing severe syneresis in the gels. Thus, high starch bean flour could have the potential to be competitive in the modified corn starch market. Price information covering corn and other starches is presented in Table 21. Other sources of starch include pea, wheat, potato, and tapioca. The pea starch in Table 21 is isolated from the pea in a wet extraction process and thus is a purified starch while bean starch is not.

Starch is also used in the production of extruded products; corn is currently being extruded to produce snack and cereal foods. High starch bean flour, from a functional view, can be extruded. However, the market success of a bean snack product would be questionable at this moment

TABLE 17. PROXIMATE COMPOSITION OF VARIOUS NAVY, PINTO, AND BLACK FLOUR FRACTIONS

Bean Type	Flour Fraction	Yield	Moisture[a]	Dry Basis Ash[a]	Dry Basis Protein[a]	Dry Basis Fat[b]	Dry Basis Fiber[b]	Apparent Starch[c]
		percent						
Navy	Whole-dehulled	--	9.8	4.4	24.3	2.2	4.4	64.6
	Hull	31	9.0	4.9	22.2	1.9	13.4	57.7
	Starch I	17.3	9.6	5.7	26.1	2.4	8.7	57.1
	Starch II	35.7	9.8	3.6	15.5	1.5	1.8	77.6
	Protein	16	9.2	5.4	44.1	3.7	1.8	45.1
Pinto	Whole-dehulled	--	6.2	4.2	24.5	1.2	4.0	66.1
	Hull	25	7.6	4.3	22.8	1.4	11.3	60.2
	Starch I	21	7.1	4.9	27.6	1.8	7.5	58.2
	Starch II	32.9	7.8	3.0	12.2	0.9	1.5	82.5
	Protein	21.1	6.6	6.0	44.2	1.1	4.3	44.3
Black	Whole-dehulled	--	8.4	5.5	27.1	1.3	5.0	61.0
	Hull	20	8.71	6.3	22.5	1.5	13.8	55.8
	Starch I	24.8	8.4	6.3	30.0	2.1	6.4	55.2
	Starch II	34.8	8.1	3.7	12.4	0.8	1.7	81.3
	Protein	20.4	7.3	8.0	45.5	1.2	3.7	41.6

[a]n = 2.
[b]n = 3.
[c]By difference.
SOURCE: Dietz and Lusas, 1983.

TABLE 18. POTENTIAL USES OF BEAN FLOUR FRACTIONS IN FORMULATE FOODS

Flour Fraction	Major Characteristics Contributed to Food	Potential Uses in Foods
Whole bean flour	thickening agent protein supplement	soups, sauces, dips, baked products (doughnuts, cakes, cookies, quick breads) "Master Mix"
High fiber (hulls)	dietary fiber water binding	baked products
High protein	water binding (improved nutritional quality) protein concentrate	comminuted meats (franks, sausages, meat loaves) high protein baked products (substituted at low levels for wheat flour)
High starch	gel structure thickening agent	puddings pie fillings prepackaged gravies & sauces

SOURCE: Michigan State University, Department of Food Science and Human Nutrition, 1986.

TABLE 19. SOYBEAN PROTEIN PRODUCTS: CONSUMPTION AND ANNUAL GROWTH RATES, 1982

Product +	1982 Consumption	Protein Content	Growth Rate
	-million lbs.-	------------percent	------------
Flours and grits	350.5	.50	5.4
Concentrates	79.4	.70	5.2
Isolates	90.4	.90	5.2
Textured flours	94.8	.50	6.4
Textured concentrates	8.8	.70	6.4

SOURCE: Perraut and Ferris (1984).

Fiber Market

Studies have shown that bean hulls are feasible ingredients for high-fiber baked goods. Substitution levels of 10 percent or less produced products of equal quality to controls with no added fiber. Substitution rates in excess of 10 percent were possible in certain variety breads. Use of bean hull flours in wheat bread at a 10 percent level was acceptable provided that 0.5 percent of sodium stearyl lactylate was included (Michigan State University 1986).

TABLE 20. SOYBEAN PROTEIN PRODUCT PRICES 1987

Product	Price Dollars/lb.
Flours and grits	.12-.16
Concentrates	.45-.65
Textured flours	.30
Textured concentrates	.55

SOURCE: Industry Sources, 1987.

TABLE 21. STARCHES: CONTENT AND PRICES OF STARCH USED FOR PROCESSED FOODS

Product	Starch Content	Price
	---percent----	--$/lb.--
Unmodified corn starch	99+	.10-.15
Modified corn starch	99+	.11-.19
Pea flour-whole	57	.16
Pea starch	99+	.29
Unmodified wheat starch	99+	.16
Modified wheat starch	99+	.24

SOURCE: Industry Sources, 1987.

The fiber market is a growth market. The increased public awareness of the benefits of dietary fiber in the diet has helped the demand for high-fiber food products; fiber is also used in pharmaceuticals, diet foods, diet drinks and breakfast cereals. The roasted high-fiber bean flour is fairly bland and thus flavor should not be a critical factor in its adoption by industry. Several fiber sources and prices are presented in Table 22.

Economic Analysis of Roasted Dry Bean Flour Fractions

The economic feasibility analysis of a plant producing dry roasted edible bean flour fractions will be presented in four sections: 1) model plant characteristics, 2) cost analysis, 3) revenue analysis, and 4) economic profitability.

Model Plant Characteristics and Construction Costs

Two basic plants were modeled. Each base plant also had three operational levels: 8, 16, and 24 hours of daily process. The two basic hourly processing capacities were 2,500 and 5,000 kilograms (5,512 and 11,025 pounds). Annual production capabilities ranged from 13.2 million pounds to 79.4 million pounds, based on 300 processing days. This essentially represents the range of market potential that Perraut and Ferris estimated. The hourly capacities are the same as the Perraut and Ferris modeled plant. Plants were modeled after Aguilera's process which incorporates a second milling and air classification of the first coarse starch fraction produced in the initial air classification. The only significant capital cost difference

TABLE 22. DIETARY FIBER SOURCES, CONTENT, AND PRICES

Product	Fiber Content Crude	Fiber Content Dietary	Price
	------percent-------		-$/lb.-
Corn bran-roasted	27	80-90	.55
Pea hull flour	37	56	.32-.56
Cellulose	--	99	.45-.60
Soybean hulls	24	65	.55
Oat	30	70-80	.55
Barley	22	50	.55
Wheat bran-roasted	10	45	.32

SOURCE: Industry Sources, 1987.

for a basic plant with different operating levels is the added storage requirement for both raw and finished product.

Total construction and equipment costs were $2.24 million and $3.61 million (Table 23). Storage requirements for raw material were based on a three-week inventory of raw material. Warehousing requirements were estimated for a three-week inventory of finished product with usable warehouse space of 50 percent (finished product stored two pallets high and 1,500 pounds per pallet). A 3.5 percent material loss was also considered; the material loss is primarily due to moisture losses during roasting. Installation costs were estimated at 33 percent of the cost of processing equipment. Engineering cost was estimated at 7.5 percent of all buildings, equipment, and installation costs. Land costs were $20,000 per acre, based on recent industrial land sales.

Cost Analysis

A summary of costs for base plants operating 24 hours per day, 300 days per year, is presented in Table 24. Total annual costs were $3,471,544 and $5,991,124. This resulted in a per unit processing cost of $.193 and $.166 per kilogram and $.087 and $.075 per pound of finished product.

TABLE 23. ESTIMATED CONSTRUCTION COSTS OF MODEL DRY ROASTED EDIBLE BEAN MILLING PLANTS, NORTH DAKOTA, 1987

Item	Plant Size	
	2,500 kg/hr.	5,000 kg/hr.
	dollars	
Receiving		
Scale	75,000	75,000
Storage	79,380	158,760
Conveying	100,000	100,000
Total Receiving	254,380	333,760
Processing		
Building	225,000	281,250
Roaster	30,000	60,000
Cooler	20,000	20,000
Cracker/roller	18,000	21,000
Aspirator	11,000	11,000
Hammermill	6,500	10,500
Pinmills	290,000	460,000
Air classifiers	320,000	640,000
Bagging lines (3)	90,000	90,000
Conveying	40,000	50,000
Air compressor	10,000	15,000
Control panel	20,000	20,000
Installation	282,315	461,175
Total Processing	1,362,815	2,139,925
Warehouse	380,367	760,734
Engineering	149,817	242,581
Land	40,000	55,000
Land Preparation	30,000	36,000
Forklift	23,000	46,000
Total	623,184	1,140,315
Grand Total	2,240,379	3,614,001

Depreciation

Annual depreciation expenses were $220,038 and $355,901, assuming a 10-year life expectancy. Actual life of the plant may be longer; however, plant obsolescence due to changes in technology must be considered. No salvage value was assumed.

TABLE 24. SUMMARY OF ANNUAL COSTS FOR MODEL DRY ROASTED EDIBLE BEAN MILLING PLANTS, NORTH DAKOTA, 1987

Item	Plant Size	
	2,500 kg/hr.	5,000 kg/hr.
	--------------dollars--------------	
Fixed Costs		
Annual depreciation	220,038	355,901
Interest on plant investment	140,583	226,779
Interest on net working capital	308,566	605,657
Property taxes	39,319	63,426
Property insurance	28,156	50,364
Premise liability	1,897	2,544
Building maintenance	13,694	24,015
General and administrative overhead	374,499	615,344
Total Fixed Cost	1,126,753	1,944,028
Variable Cost		
Labor	654,000	877,200
Fringe benefits	196,200	263,160
Selling and marketing	555,362	1,110,725
Natural gas	143,927	287,855
Electricity-energy charge	210,438	381,024
Electricity-demand charge	70,146	127,008
Repair and maintenance	63,210	97,110
Packaging and shipping supplies	308,705	617,410
Trucking	138,915	277,830
Product liability insurance	3,888	7,775
Total Variable Cost	2,344,791	4,047,096
Total Annual Cost	3,471,544	5,991,124
Per Unit Total Cost (kilogram)	.193	.166
Per Unit Total Cost (pound)	.087	.075

Interest

An interest rate of 12.55 percent, the 1976 to 1985 average interest rate for United States domestic corporate Baa bonds, was charged on investment and working capital requirements. Interest costs charged on average plant investment were $140,583 and $226,779. Interest on net working capital was estimated at $308,566 and $605,657. Required working capital was estimated at $2,458,691 and $4,802,788. Assumptions to calculate net working capital requirements were an 18-day inventory of both raw material and finished products; an average account receivable of 35.1 days; and an average account payable, excluding raw material, of 17.55 days. These were industry averages for flour manufacturers (Robert Morris Associates 1986).

Property Taxes

Property tax was estimated at $351.81 per $1,000 of taxable valuation. Taxable value was 10 percent of assessed value and assessed value was calculated at 50 percent of full and fair market value (North Dakota Tax Department 1985). Full and fair market value was estimated at the total initial investment in buildings and plant equipment. The tax rate of $351.84 was calculated as the average of Fargo, Jamestown, and Grand Forks, ND rates.

Insurance

Three different insurance costs were estimated: property, premise, and product liability. Property insurance was estimated at $5 per thousand for concrete structures and their contents, $10 per thousand for steel structures and their contents. Premise liability was estimated at .29 per $100 of manufacturing payroll. Product liability insurance was calculated at $35 per $1,000 of sales. All insurance rates were obtained from insurance companies that insured flour manufacturing firms.

Building Maintenance

Maintenance is required on buildings regardless of the level of output. An annual cost of 2 percent of initial building costs was used to estimate maintenance costs.

General and Administrative Overhead

General and administrative costs include salary expense of the chief executive officer, secretarial expenses, travel, auditing services, legal fees, telephone, office supplies, postage, and miscellaneous expenses. Office expenses, either ownership or leased office cost, are also included. These costs were estimated at 20 percent of all other operational expenses excluding depreciation and raw product costs. The estimate was derived from an analysis of annual statement reports of various food processing firms.

Labor and Fringe Benefits

Total personnel required for the small plant is nine people per shift plus one extra worker during the day shift for product receiving. Personnel requirements for the large plant are 13 people per shift plus an additional worker for product receiving during one shift. Personnel requirements and wage rates are presented in Table 25. Wage rates were estimated from similar occupations as reported by the North Dakota Job Service (1985). Fringe benefits were estimated at 30 percent of wages.

TABLE 25. PERSONNEL REQUIREMENTS AND WAGE RATES FOR MODEL DRY ROASTED EDIBLE BEAN MILLING PLANTS, NORTH DAKOTA, 1987

Department	Plant Size		
	Small	Large	Wage Rates
	------number------		--$/hr.--
Product receiving	1	1	8.5
Plant supervisor	1	1	16
Plant operators	2	3	10
Warehouse supervisor	1	1	11
Warehouse and shipping	3	6	7
Lab technician	1	1	13/8.5[b]
Total Per Shift	9	13	
Total[a]	25	37	

[a]Product receiving worker is only required during one shift per day.
[b]Head lab technician, one shift, wage is $13, others $8.5.

Selling and Marketing Expenses

Selling and marketing expenses were budgeted at 5 percent of sales. This figure was comparable to that experienced by many wheat flour manufacturers. A new firm with a new product could expect to incur greater selling costs to gain market entry.

Utilities

Energy is required for roasting and milling the beans. Pinmilling is more energy intensive than conventional milling. The natural gas requirement for roasting was estimated at two cubic feet per kilogram based on an energy audit by Aguilera during a pilot run (1981). Electrical requirements were based on the electrical horsepower requirements of the processing equipment and the assumption of a full-load operation. Thus, these estimates are considered upper limits. Estimates were .433 and .392 kilowatts per kilogram for the small and large plants. Energy rates used were $.398 per CCF(100 cubic feet) of natural gas and $.027 per kilowatt for electrical energy. The electrical demand charge (the cost of supplying peak energy usage) was estimated at one-third of the energy charge for a 24-hour operation, two-thirds for a 16 hour per day operation, and equal to the energy charge if operating only at 8 hours per day (Northern States Power Company 1987).

Repairs and Maintenance

Repair and maintenance costs were based on 6 percent of initial equipment cost for continuous round-the-clock operation. When operating only an eight-hour shift, the cost would be 2 percent of initial equipment costs. Repairs are a function of operating time.

Packaging and Shipping

Bag and pallet costs were estimated at $.81 per 100 pounds.

Trucking Cost

Trucking costs are incurred in the process of moving beans from county elevators to the processing plant. Estimated hauling distances would be between 40 and 100 miles with an estimated cost of $.35 per 100 pounds used.

Revenue Analysis

Determining the potential revenue to be generated from bean flour fractions is difficult. Previous sections discussed competition and the prices of competing products as an aid in better understanding the market. The range of potential prices of each of the flour fractions and a composite price were estimated (Table 26). Fiber prices ranged from a low of $.32 to a high of $.55 per pound. Fiber represents only 10 percent of the end products and thus provides a minimal contribution to the overall composite price. The starch fraction represents the lowest priced component and is also the major product from a yield standpoint. Starch prices ranged from $.10 to $.19 per pound. Because bean starch has some of the same characteristics as modified corn starch, a marketing advantage exists in that it does not need to be labeled as a chemically modified starch. Hence, bean starch flour may be preferred in certain markets where the term modified is not desired; the health and natural food markets would be examples. Potential prices for the bean protein fraction could range from $.14 to $.50 per pound. Prices of $.14 per pound were typical of soy flours. High protein bean flour should command a premium as it does not possess a bitter flavor typical of soy flours. Textured soy flours are priced in the area of $.30 a pound. Although high protein bean flour is not textured, it might penetrate markets that demand a bland product. Textured soy products do not possess the bitter flavor of untexturized products. Soy concentrates are generally priced higher, at $.45 to $.65 per pound. Characteristics of soy concentrates include a nonbitter flavor and good water and fat absorption. High protein bean flour would not be able to compete with soy concentrates on a protein basis (70 percent versus 44 percent protein), but a potential does exist for it to compete on a functional basis. Net composite prices range from $.13 to $.33 per pound. It is unlikely that a composite price of $.33 per pound could be obtained. Achieving a high composite price would require penetration of high priced markets and the sale of the entire production balance sold at the high price level.

TABLE 26. POTENTIAL MARKET PRICES OF DRY EDIBLE BEAN FRACTIONS, 1987

Bean Fraction	Price Estimates Low	Midpoint	High	Approximate Yield
	-------dollars/pound-------			-----percent-----
Fiber	.32	.435	.55	10.0
Starch	.10	.145	.19	55.0
Protein	.14	.345	.55	31.5
Composite Price	.13	.23	.33	
Total Yield				96.5[a]

[a]Total does not add to 100 percent due to a moisture loss during the roasting process.

Economic Profitability

The analytical method used to determine economic profitability was the internal rate of return (IRR). IRR is usually thought of as the rate of return the project (investment) earns during the investment's planning horizon. The IRR methodology is superior to other analytical methods because it takes the time value of money into consideration and it allows incorporation of time lags between initial investment and operation of the plant at designed capacity levels.

IRRs are calculated for both small and large plants utilizing whole navy and pinto beans as a raw material source under different price levels of finished product. IRRs were also calculated under scenarios where cull beans were used as a source of raw material.

The processing plants realized a positive return under only the high market price scenario (Tables 27 and 28). Under all other pricing levels including a medium-high market price, IRRs were negative. Acceptable[2] IRRs were observed using pinto beans as a raw material source; however, one must be cautioned that to obtain that level of return, each flour product must be sold at the top of the market price range and sales of each different fraction must be equal to their yield levels. Those conditions are not realistic, and the conclusion drawn was that producing food ingredient fractions from whole beans was not economically feasible.

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[2]An acceptable IRR is defined as one that is high enough to attract investors or to reward risk taking in a new business venture.

TABLE 27. INTERNAL RATE OF RETURN FOR MODEL DRY ROASTED EDIBLE BEAN MILLING PLANTS UTILIZING NAVY BEANS, NORTH DAKOTA, 1987

Price Level	Plant Size	
	Small	Large
	------------percent------------	
High	11	25
Medium high	<-100	<-100
Medium	<-100	<-100
Low	<-100	<-100

Cull Beans As a Raw Material

Edible cull beans are priced significantly lower than top quality beans. Edible culls consist primarily of small, discolored, and split beans. Market prices have generally been 50 to 60 percent of No. 2 beans. Use of culls could reduce raw material cost by 40 percent if culls were used exclusively.

Significant limitations exist in the use of edible cull beans. The primary limitation is supply. It was estimated that on the average only 2 percent of production results in edible culls. Average production of edible culls between 1981 and 1985 is estimated at only 7.4 million pounds from

TABLE 28. INTERNAL RATE OF RETURN FOR MODEL DRY ROASTED EDIBLE BEAN MILLING PLANTS UTILIZING PINTO BEANS, NORTH DAKOTA, 1987

Price Level	Plant Size	
	Small	Large
	------------percent------------	
High	39	66
Medium high	- 3	15
Medium	<-100	<-100
Low	<-100	<-100

Minnesota and North Dakota assuming a 2 percent cull rate. This represents only 56 percent of the raw material requirement for a small DEB processing plant operating one shift per day.

Consequently, the use of cull beans to reduce raw material costs would only be viable for a small DEB processing plant operating either one or two shifts per day. IRRs for the small-sized plant operating one and two shifts per day were estimated (Table 29). The resulting displacement of whole beans by edible culls would be 50 and 25 percent, respectively. The use of culls to produce dry edible bean fractions did not significantly improve profitability. Acceptable IRRs occurred only under the very optimistic scenario of high market prices for end products. A conclusion that the lower cost of cull beans was insufficient to result in an economically feasible operation must be reached.

There are other factors that would reduce some of the cost savings of using culls in addition to limited supplies of cull beans. These factors include added collection costs, increased variation of raw material composition and quality, unstable supply, and potential technical processing problems due to nonuniform particle sizes. It would also be naive to believe that the prices of edible culls would remain the same. There currently exists a market for edible navy culls to Japan and edible pinto culls by canners of refried beans. A substantial increase in demand by a dry bean milling plant would result in the narrowing of the price discount for edible culls.

TABLE 29. INTERNAL RATE OF RETURN FOR SMALL MODEL DRY ROASTED EDIBLE BEAN MILLING PLANT UTILIZING CULL BEANS, NORTH DAKOTA, 1987

Price Level	Operations: 8 Hrs./Day & 50% Culls	Operations: 16 Hrs./day & 25% Culls
	percent	
High	24 to 44	28 to 56
Medium high	-8 to 16	<-100 to 17
Medium	<-100	<-100
Low	<-100	<-100

Dehydrated Precooked Bean Products

Two firms, Gilroy Foods and Basic American Foods, produce a precooked dehydrated bean product. The product is marketed as a quick-cook pinto bean product to the Mexican restaurant and/or ethnic food manufacturers. The precooked products are used as a base for many bean dishes.

The process to produce a precooked bean product is relatively simple but energy intensive. Dry pinto beans are rehydrated from 10 to 15 percent moisture to 55 percent moisture, cooked utilizing either a hot water or steam method, dried to 10 percent moisture, and milled.

The finished product can be rehydrated and cooked in 15 minutes or less, offering a definite advantage over preparing whole beans when they need to be soaked, cooked for a period generally in excess of one hour, and then mashed to be used as a base for many Mexican dishes.

Noyes (1969) described a process where the beans are rehydrated in soaking tanks containing cold running water for at least 5 to 6 hours. The beans are then cooked in an atmospheric steam blancher with a residence time between 15 and 25 minutes. Noyes also stated that the beans could be processed in a pressure cooker for 10 minutes at 13 psi steam at 243°F. Gilroy Foods uses a similar process to the one described by Noyes; however, exact processing information is held confidential. It is speculated that Basic American Foods also use some type of a wet or steam cooking process.

The key variables in the process are the specifics regarding rehydration requirements, steam process times and pressures, and steam consumption requirements.

Potential Markets

The potential market for a quick-cook dehydrated product is primarily the pinto bean market. Pintos have traditionally been sold in the raw dry package form. The market in navy beans is limited in that 90 percent of production is already being processed by canners. Pinto beans, unlike navy beans, have experienced a stable consumer demand. Population growth and the increased popularity of Mexican ethnic foods will increase the demand for convenience pinto bean products.

The most easily identifiable group of consumers would be the Mexican restaurant trade. The Mexican restaurant industry has shown tremendous growth over the past years, with Mexican franchise restaurants increasing from 1,030 in 1973 to over 3,000 restaurants in 1983, a 251 percent increase (Figure 28). Total sales of Mexican franchise restaurants have grown significantly (Figure 29); increases in total sales were not only a result of more restaurants but also an increase in average sales (Figure 30). Total sales increased from $138 million in 1973 to over $1.5 billion in 1983, with sales per establishment increasing from $134,000 in 1973 to over $400,000 in 1983.

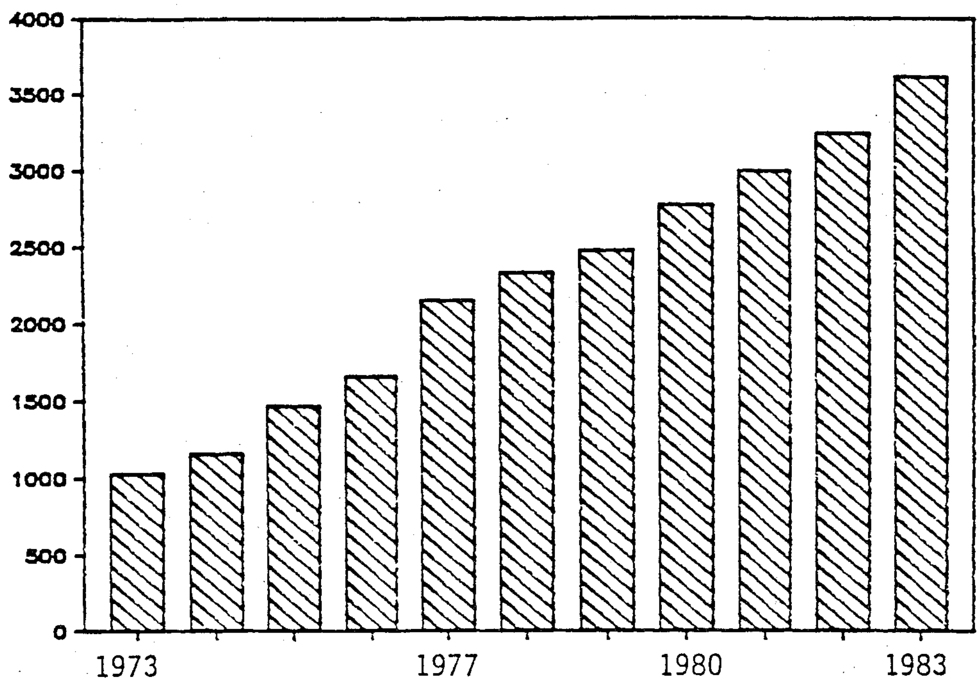

Figure 28. Number of Mexican Franchise Restaurants, 1973-1983

SOURCE: National Restaurant Association.

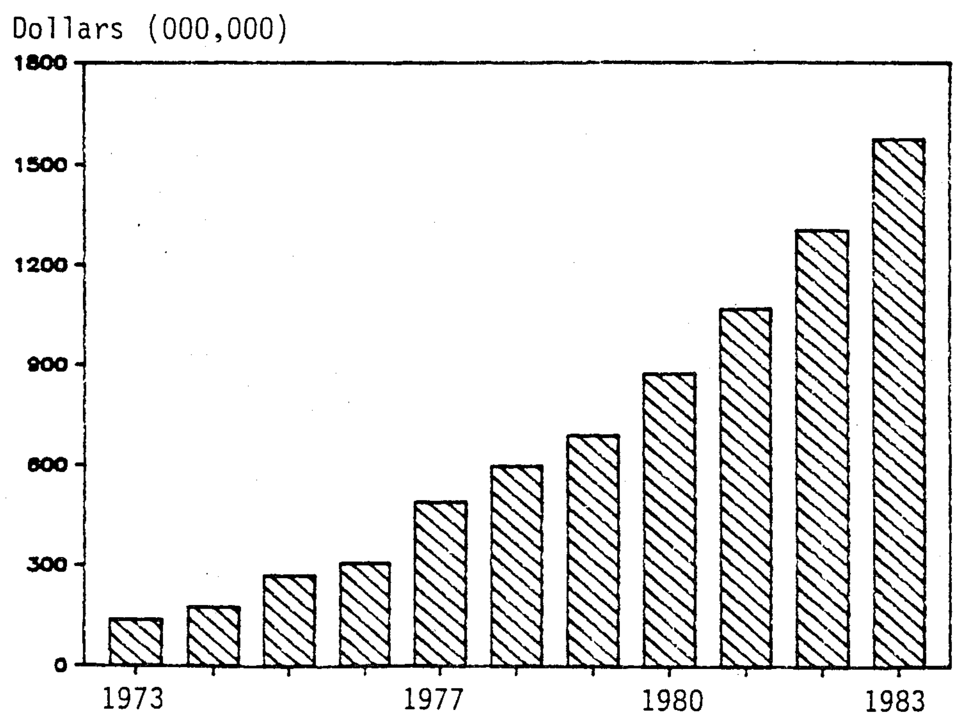

Figure 29. Total Annual Sales of Mexican Franchise Restaurants, 1973-1983

SOURCE: National Restaurant Association.

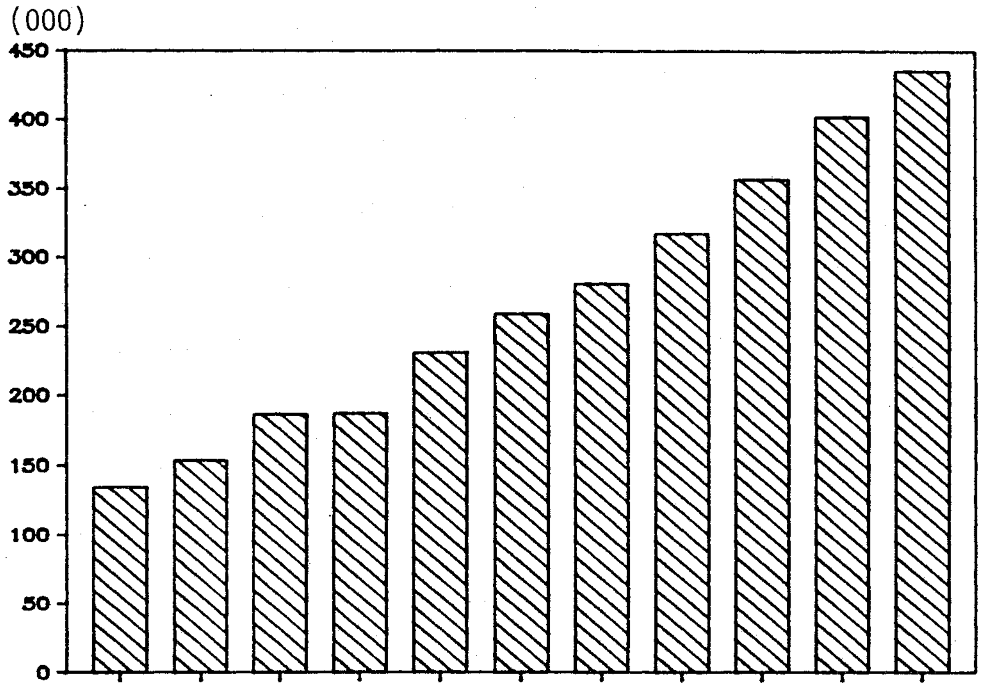

Figure 30. Average Annual Sales Per Mexican Franchise Restaurant, 1972-1983

SOURCE: National Restaurant Association, 1983.

Survey Results

Managers of Mexican restaurants were surveyed[3] regarding their perceptions on trends in consumption of pinto beans at the restaurant level. They were also asked to rate the importance of different characteristics in the marketability of new convenience bean products. They were asked the question, "On an individual restaurant basis, is the consumption of dry edible beans increasing, constant, or decreasing?" In response, 37.5 percent said it was increasing, 60 percent that it was constant, and 2.5 percent that it was decreasing.

When describing changes in customers' preference for entrees that included beans as an ingredient or a side dish, 40 percent of the managers responded with the selection of increasing preference, 60 percent responded with no change in preference, and no one responded with a decreasing preference. Results of a question regarding managers' opinions on the

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[3]1987 mail survey conducted by the Department of Agricultural Economics, North Dakota State University, Fargo, 55 respondents nationwide out of a total of 193 surveyed.

characteristics of a convenience bean product are presented in Table 30. The characteristics deemed most important were elimination of foreign material, product uniformity, and reduction in cooking time. Elimination of the mashing procedure was also deemed important but not as important as the previously mentioned characteristics. Elimination of the soaking process was deemed important by 39 percent of the respondents, but 43 percent felt it to be unimportant.

Elimination of foreign material was deemed very important. This is a result of customer dissatisfaction and subsequent loss of revenue due to refunding of meals. Customer dissatisfaction due to foreign material was reported by 73.9 percent of the respondents; 69.7 percent also stated that they subsequently refunded meals of those dissatisfied. One respondent also reported litigation by a customer due to injury from a foreign object.

The potential for successful marketing of a precooked reconstitutable bean product is promising. Seventy-three percent of the respondents indicated an interest in a quick-cooking reconstitutable bean product. Results of the survey and the recent market entry of Gilroy Foods and Basic American Foods into the convenience pinto bean market reinforces this statement. Marketing success will depend on the product being price competitive with alternative products and on quality being comparable to beans prepared in the traditional manner.

TABLE 30. MANAGERS' RESPONSES TO THE IMPORTANCE OF SPECIFIC CHARACTERISTICS OF NEW CONVENIENCE BEAN PRODUCTS FOR MEXICAN RESTAURANTS

Item	Important	Undecided	Unimportant
	----------	percent	----------
Reduction in cooking time	68	12	20
Elimination of mashing procedure	55	18	27
Elimination of the soaking process	39	16	43
Product uniformity	75	16	9
Elimination of all foreign material (stones, dirt, etc.)	95	5	0
Elimination of the flatulence factor in beans	41	30	30

SOURCE: 1987 mail survey conducted by the Department of Agricultural Economics, NDSU, Fargo, ND.

Economic Analysis

The economic feasibility analysis of a North Dakota based quick-cook pinto bean processing plant will be presented in four sections: 1) model plant characteristics, 2) cost analysis, 3) revenue analysis, and 4) economic profitability.

Model Plant Characteristics and Construction Costs

A plant was modeled to process 5,000 pounds per hour. Annual capacity would be 120,000 cwt., 240,000 cwt, and 360,000 cwt. annually for 8-, 16-, and 24-hour daily operation. Annual operation was estimated at 300 days. The plant operating at full capacity would consume approximately 25 percent of North Dakota's production, based on 1983 to 1985 production data.

This process essentially consists of rehydrating the beans in a blancher to 55 percent moisture, steam cooking the beans, then putting them through a drying operation and a milling operation. The residence times for beans in the blancher is estimated at 20 minutes at 180°F, with a cooking time of 12 minutes at a pressure of 18 psi and 280°F. The cooking process is similar to the one described by Noyes; however, one industry specialist advised a longer cooking time of 20 minutes. A 20-minute cooking time would reduce the capacity to 3,000 pounds an hour. Effects of reduced capacity were analyzed in the economic profitability section.

Total plant building and equipment costs ranged from $1,278,014 to $1,567,171, based on daily operation time (Table 31). Installation cost was estimated at 33 percent of the processing equipment. Engineering fees were estimated at 7.5 percent of total building, equipment, and installation costs. Raw material storage and warehouse requirements for finished products were based on a three-week inventory for both.

Cost Analysis

A summary of operating costs for the model plant operating 8-, 10-, and 24-hours per day is presented in Table 32. Total processing costs per pound of finished products were $.29, $.28, and $.27.

Depreciation

Annual depreciation expenses were $124,568, $138,643, and $152,717 for three operating time periods. Depreciation was estimated on the basis of a 10-year planning horizon. Actual life of the plant may be longer, but plant obsolescense due to changes in technology must also be considered. A zero salvage value was assumed.

TABLE 31. ESTIMATED BUILDING AND EQUIPMENT COST FOR MODEL PRECOOK PINTO BEAN PROCESSING PLANTS, NORTH DAKOTA, 1987

Item	Designed Daily Operation 8 Hours	16 Hours	24 Hours
	-------------dollars-------------		
Receiving			
Scale	75,000	75,000	75,000
Storage	24,000	48,000	72,000
Conveying	100,000	100,000	100,000
Total Receiving	199,000	223,000	247,000
Processing			
Building	225,000	225,000	225,000
Blancher	20,000	20,000	20,000
Cooker	75,000	75,000	75,000
Dryer	165,000	165,000	165,000
Roller mills	50,000	50,000	50,000
Packaging Lines	55,000	55,000	55,000
Air compressor	10,000	10,000	10,000
Control panel	20,000	20,000	20,000
Conveyor	40,000	40,000	40,000
Installation	143,500	143,500	143,500
Total Processing	803,500	803,500	803,500
Warehouse	106,924	213,848	320,772
Engineering	83,210	93,030	102,849
Land	32,330	34,886	40,000
Land preparation	30,000	30,000	30,000
Forklift	23,000	23,000	23,000
Total	275,465	394,764	516,621
Grand Total	1,278,014	1,421,314	1,567,171

Interest

An interest rate of 12.55 percent, the 1976 to 1985 average interest rate for United States domestic corporate Baa bonds, was used. Interest on average plant investment was $79,876; $88,832; and $97,948. Assumptions for net working capital are an 18-day inventory of both raw and finished product. Price of raw product was estimated at $.20 per pound and the investment in finished product was the sum of raw material and processing costs. An average account receivable of 35.1 days and an average account payable, excluding raw material, of 17.55 days were taken into account. These were cited as averages

TABLE 32. SUMMARY OF ANNUAL COSTS FOR MODEL PRECOOK PINTO BEAN PROCESSING PLANTS, NORTH DAKOTA, 1987

Item	Designed Daily Operation 8 Hours	16 Hours	24 Hours
	-------------	dollars	--------------
Annual depreciation	124,568	138,643	152,717
Interest on plant investment	79,876	88,832	97,948
Interest on net working capital	110,237	219,047	327,859
Property taxes	22,429	24,944	27,503
Property insurance	8,910	10,950	12,990
Premise liability	525	960	1,395
Building maintenance	7,118	9,736	12,355
General and administration overhead	263,795	511,259	758,732
Total Fixed Costs	617,458	1,004,371	1,391,502
Labor	181,200	331,200	481,200
Fringe benefits	54,360	99,360	144,360
Selling and marketing	985,150	1,970,300	2,955,450
Natural gas	842,685	1,685,371	2,528,056
Electricity-energy charge	9,720	19,440	29,160
Electricity-demand charge	9,720	9,720	9,720
Water	48,000	96,000	144,000
Packaging and shipping supplies	320,487	640,975	961,462
Trucking	42,000	84,000	126,000
Product liability insurance	2,298	4,597	6,896
Repairs and maintenance	14,770	29,540	44,310
Total Variable Costs	2,510,390	4,974,876	7,430,614
Total Annual Cost	3,127,848	5,979,247	8,822,116
Processing cost per pound of finished product	.2905	.2774	.2731

for the industry by Robert Morris and Associates (1986). Net working capital requirements were $918,641; $1,825,399; and $2,732,163. Interest costs on net working capital came to $110,237, $219,047, and $327,859.

Property Taxes

Property taxes were estimated at $351.81 per $1,000 of taxable valuation. Taxable value was 10 percent of assessed value, and assessed value was calculated at 50 percent of full and fair market value (North Dakota Tax Department). The tax rate was calculated as the average rate of Fargo, Jamestown, and Grand Forks, North Dakota.

Insurance

Three different insurance costs were estimated: property, premise, and product liability. Property insurance was estimated at $5 per $1,000 for concrete structures and their contents and $10 per $1,000 for steel structures and their contents. Premise liability was estimated at $.29 per $100 of manufacturing payroll. Product liability was calculated at $.35 per $1,000 of sales. All insurance rates were obtained from insurance companies that handled insurance coverage for food processing firms.

Building Maintenance

Maintenance is required on buildings regardless of the level of output. An annual cost of 2 percent of initial building cost was used to estimate maintenance costs.

General and Administrative Overhead

General and administrative costs include the salary expense of the chief executive officer, secretarial expense, travel, auditing services, legal fees, telephone, office supplies, postage, and miscellaneous expenses. Office expenses, either ownership or leasing costs, were also included. These costs were estimated at 20 percent of all other operational expenses excluding depreciation and raw product costs. The estimate was derived from an analysis of annual financial statement reports of various food manufacturing firms.

Labor and Fringe Benefits

Total personnel required for operation of the plant was estimated at eight per shift. One extra worker is required during the day shift for raw product receiving. Personnel requirements and wage rates are presented in Table 33. Wage rates were estimated from similar occupations as reported by the North Dakota Job Service (1985). Fringe benefits were estimated at 30 percent of labor.

Utilities

Production of quick-cook bean products utilizing a steam process is very energy intensive. The primary energy usage is in the production of steam for the steam cooker. Steam requirements were estimated at 10 pounds of steam per pound of raw product, and water usage for blanching was estimated at .8 gallons per pound of raw product. Moisture content of beans is approximately 55 percent exiting the steam cooker. Drying the beans to a moisture content of 10 percent requires the removal of one pound of water for each pound of finished product. Consequently, the drying operation is very energy intensive. Electrical energy requirements were based on the required horsepower to operate the processing equipment. This process may overstate energy requirements slightly. Natural gas cost was $.39695 per CCF (100 cubic

TABLE 33. PERSONNEL REQUIREMENTS AND WAGE RATES FOR MODEL PRECOOK PINTO BEAN PROCESSING PLANT, NORTH DAKOTA, 1987

Department	Employees	Wage Rates
Product receiving	1	$ 8.50
Plant supervisor	1	16.00
Plant operators	2	10.00
Warehouse supervisor	1	11.00
Warehouse and shipping	2	7.00
Lab technician	1	13.00/8.50[b]
Total per shift	8	

[a]Product receiving worker is only required during day shift.
[b]Head lab technician one shift at $13, other lab technicians at $8.50.

feet) of natural gas and electrical energy $.027 per kilowatt. An electrical demand charge was estimated as equal to the electrical energy cost when operating 8 hours per day, one-half the energy cost when operation is 16 hours per day, and one-third the energy cost if a 24-hour per day operation (Northern States Power Company 1987). Water costs, including sewage, were estimated at $2 per thousand gallons.

Repairs and Maintenance

Repairs and maintenance costs were based on 6 percent of initial equipment cost for round-the-clock operation. Repairs and maintenance are proportional to operating time. A plant operating 8 hours per day would only incur one-third of the cost of a plant operating 24 hours per day.

Packaging and Shipping

Bag and pallet costs were estimated at $.0298 per pound. These costs are considerably higher than those for the dry bean flour plants because it was assumed that the products would be packaged in 5-pound rather than 50-pound bags.

Selling and Marketing Expenses

Selling and marketing expenses were estimated as 15 percent of sales. Marketing cost for manufacturers of food products for food service establishments was estimated as 12.3 percent of sales (Bailey 1972). This rate, although dated, was comparable to current manufacturers' cost. A new firm with a new product would in all probability incur a higher cost. Bailey estimated selling-related costs to be 4 percent and market-support costs at 8.3 percent of net sales. Selling-related costs include sales management, outside salesmen, inside salesmen, field services, compensation to agents or brokers, and other selling-related costs. Market-support cost includes market administration and planning, advertising and sales promotion, marketing research, pricing, and estimating and quoting.

Trucking Costs

Trucking costs are incurred in the process of moving raw material and pinto beans from country elevators to the processing plant. A cost estimate of $.35 per 100 pounds was used based on a hauling distance ranging between 40 and 100 miles.

Revenue Analysis

Convenience food products, in general, command a premium price; convenience bean products are no exception. Three convenience or quick-cook pinto bean products currently exist. These are canned whole pinto beans, canned refried beans, and a reconstitutable dry refried bean mix. Prices of these products were investigated and estimated for southwestern United States. Southwestern locations were used because of their strong pinto bean consumption. To gain sufficient sales, a North Dakota based plant must be price competitive in the southwest regions. Market prices of various pinto bean products are presented in Table 34. Wholesale prices are adjusted for wholesale margins and moisture differentials in determining a price on a per pound of dry matter basis. Wholesale margins were estimated at 17 percent (Robert Morris Associates 1986). In general, processed beans were priced at 200 percent or more of the unprocessed prices. Products that included flavorings, canned refried beans, and the precooked refried bean mix, were at a premium over nonflavored products, canned whole beans, and precooked pinto bean flours.

Quick-cook barley products of the Quaker Oats Company are priced at $.26 per pound or 45 percent over their standard product. Thus, potential prices for precooked pinto bean products could range from a high of $.88 per pound to a low of $.46 per pound based on a 10 percent moisture level. The $.88 figure is based on Gilroy's prices and the low of $.46 per pound is based on a 45 percent premium over dry packaged beans. Economic theory suggests that as the supply of a normal good increases, price will decrease. Thus, with the recent entry of Basic American Foods in the market place and the added output from a potential North Dakota plant, the existing high premium for precooked bean products would decrease.

TABLE 34. ESTIMATED PRICES FOR VARIOUS PINTO BEAN PRODUCTS, 1987

Item	Wholesale Price	Estimated Delivered Price Southwest U. S.	Dry Matter Content	Price Per Pound of Dry Matter
	$/lb.		-percent--	---$/lb.----
Dry packaged beans[a]	.3 -.36	.29-.34	85-90	.32-.38
Canned whole beans	.27-.34	.22-.28	20-25	.88-1.12
Canned refried beans	.29-.41	.24-.34	20-25	.96-1.36
Precooked pinto bean flour	.88	.88	90	.98
Precooked refried bean mix	1.37	1.14	90	1.27

[a]Wholesale margins on dry packaged beans estimated at 5 percent.

It is unlikely that in the long run, given sufficient market growth of precooked products, the $.88 price would be maintained. It also would be unlikely that prices would drop to $.46 per pound given the existing premiums for precooked products.

Economic Profitability

The analytical method used to determine economic profitability is the internal rate of return (IRR). (See page 72 for an explanation of the IRR methodology).

Analysis is done under two basic scenarios. These were with output capacities of 5,000 and 3,000 pounds per hour. This was done to consider the impact of a longer cooking process, 20 minutes versus 12 minutes, if required to produce a satisfactory product. Under each basic scenario, the IRR will be estimated under various assumptions regarding market prices and annual sales volume during the planning horizon.

IRRs for the precook bean processing plant are presented in Table 35. It was assumed that market prices would range from $.565 to $.775 per pound delivered to southwestern United States. Adjusting for a transportation cost of $.06 per pound resulted in estimates of $.505, $.610, and $.715 per pound for low, midpoint, and high market prices. IRRs were estimated on the basis of 300 annual operational days; three different operational levels of one, two, and three shifts per day (8-, 10-, and 24-hours per day); and two planning horizons of 10 and 15 years.

IRRs are presented in Table 35 for hourly capacities of 5,000 pounds. IRRs ranged from 13 percent to over 150 percent for the 5,000 pound per hour plant. The IRR is very dependent on market price, and to a lesser extent, operational levels. The increase in the IRR at higher operational levels occurs because per unit fixed costs are decreased as production increases. However, increased production did not raise the return significantly. Generally the increase in return was between 1 and 3 percentage points. This is true because the process is very energy intensive and; therefore, a large portion of the cost of production is variable. Increasing the planning horizon from 10 to 15 years increased the IRR marginally.

IRRs for the plant operating at an hourly production rate of 3,000 pounds are presented in Table 36. IRRs of return are significantly lower than those under an hourly capacity of 5,000 pounds. Negative returns result under the low price and one shift per day operating-level scenario. Attractive returns were still estimated for the middle-price scenarios for all operational levels. The previously estimated IRRs were based on the assumption that sales volume was constant throughout the planning horizon. Realistically, this is a very optimistic assumption. In a very large and price-competitive market, it might be possible if the plant represented only a small share of the market. However, in a smaller market with a new product, it takes time to develop sales volume. Tables 37 and 38 present IRRs for plants operating at 5,000 and 3,000 pounds hourly with sales volume in year one estimated at 33 percent of normal and increasing annually at a rate of 15 percent until reaching full capacity. IRRs were decreased substantially under the more conservative sales volume forecast. However, if the middle level of prices could be maintained, attractive rates of return existed for the plant operating at both 5,000 and 3,000 pounds hourly. Only when prices were at the low level or operational levels of one shift per day did the return become less than 20 percent when processing 5,000 pounds per hour. When operating at only 3,000 pounds per hour, the middle range of prices must be maintained to preserve attractive rates of return.

TABLE 35. INTERNAL RATE OF RETURN FOR PRECOOK PINTO BEAN PROCESSING PLANTS, 5,000 POUND HOURLY CAPACITY, NORTH DAKOTA, 1987

	Planning Horizon					
	10 Years			15 Years		
	Product Price Levels			Product Price Levels		
Operational Level	Low	Medium	High	Low	Medium	High
	IRR percent					
One shift per day	13	61	104	16	62	105
Two shifts per day	25	86	143	27	87	144
Three shifts per day	30	99	164	32	99	164

TABLE 36. INTERNAL RATE OF RETURN FOR PRECOOK PINTO BEAN PROCESSING PLANTS, 3,000 POUND HOURLY CAPACITY, NORTH DAKOTA, 1987

	Planning Horizon					
	10 Years			15 Years		
	Product Price Levels			Product Price Levels		
Operational Level	Low	Medium	High	Low	Medium	High
	IRR percent					
One shift per day	-11	36	69	-3	37	69
Two shifts per day	3	58	105	8	59	105
Three shifts per day	9	71	126	13	72	126

In summary, a precook processing plant is economically profitable with a return high enough to be attractive to potential investors. This was true when prices were maintained at the medium level or higher. Low or negative rates of return existed only under low prices and less than optimal sales and operational levels.

Competitive Position of a North Dakota Plant

Pinto bean consumption is not evenly distributed across the country. Major consumption areas are the southern and southwestern regions of the United States. As a result, differential prices exist between the producing areas. North Dakota pinto bean prices are historically about $1 per cwt.

TABLE 37. INTERNAL RATE OF RETURN FOR PRECOOK PINTO BEAN PROCESSING PLANTS UNDER ALTERNATIVE ANNUAL SALES VOLUME, HOURLY CAPACITY 5,000 POUNDS, NORTH DAKOTA, 1987

	Planning Horizon					
	10 Years			15 Years		
	Product Price Levels			Product Price Levels		
Operational Level	Low	Medium	High	Low	Medium	High
	IRR percent					
One shift per day	-4	23	40	4	27	42
Two shifts per day	2	32	53	10	35	54
Three shifts per day	5	36	59	12	38	60

TABLE 38. INTERNAL RATE OF RETURN FOR PRECOOK PINTO BEAN PROCESSING PLANTS UNDER ALTERNATIVE ANNUAL SALES VOLUME, HOURLY CAPACITY 3,000 POUNDS, NORTH DAKOTA, 1987

Operational Level	Planning Horizon: 10 Years, Product Price Levels: Low	Medium	High	15 Years, Product Price Levels: Low	Medium	High
	IRR percent					
One shift per day	-9	11	27	-9	16	30
Two shifts per day	-12	20	40	-2	25	42
Three shifts per day	-9	25	46	1	28	48

less than Colorado's prices. The price differential may be less or greater depending on different supply and demand conditions at a given time.

Recognizing that the Southwest is the major consumption area for pinto beans, the price differential can be explained by the additional transportation cost from North Dakota. Bulk DEB shipping rates from Fargo, ND, and Sterling, CO, to selected locations in the Southwest are presented in Table 39. The price differential between North Dakota and Colorado can easily be explained by the rail rate structure.

TABLE 39. SELECTED DRY EDIBLE BEAN RAIL RATES FROM NORTH DAKOTA AND COLORADO TO LOCATIONS IN THE SOUTHWEST

Destination	Origin: Fargo, ND	Origin: Sterling, CO	Differential
	$/cwt.		
Dallas, TX	2.43	1.43	1.00
San Antonio, TX	2.76	1.46	1.30
El Paso, TX	2.92	1.90	1.02
Phoenix, AZ	2.96	1.91	1.05
San Francisco, CA	3.51	2.79	.73

SOURCE: Burlington Northern Railroad, 1986.

Pinto bean shipments to major processors are primarily by rail. It is estimated from industry sources that between 75 and 85 percent of North Dakota pinto bean shipments are by rail.

A precook processing facility in North Dakota would not likely utilize the railroad to ship its products. Distribution would be by truck to distribution centers across the country. Trucking costs are higher than rail costs resulting in a disadvantaged position for a North Dakota plant.

. Trucking would be the primary mode of transportation because of the smaller quantities shipped. Distribution will be to more destinations (population centers in the United States) rather than to a small number of canners and dry packagers. Many final destinations are not easily accessable by rail.

The geographical market penetration areas of a North Dakota based processing plant relative to existing precook processors (Gilroy Foods, Gilroy, CA; and Basic American Foods, Pocatello, ID) are presented in Figure 31. The market areas were determined by least-cost product movements from producing areas to consumption markets using a linear programming model. The least-cost movements incorporate regional pricing differences between producing areas, transportation (rail and truck) from production areas to processing locations, and cost of shipping by truck from processing locations to consumption markets.

North Dakota has a locational advantage over both California and Idaho in shipping products to the East and Southeast. It can penetrate Texas and the western parts of Colorado and Wyoming. However, it would not be able to penetrate the southwestern parts of the country on an equal cost basis. Gilroy Foods, Gilroy, CA, has a transportation advantage in serving southern California. Basic American Foods of Pocatello, ID, is able to compete on an equal cost basis in the Northwest and the states of New Mexico and Arizona.

The market penetration area of a North Dakota based plant relative to existing and potential processors of precooked bean products is presented in Figure 32. Potential processing locations include Colorado because this state already is a major producer of pinto beans. Other locations are El Paso, TX; San Antonio, TX; and Phoenix, AZ; these locations were selected because they are located in major consumption areas.

After the inclusion of potential processors, North Dakota markets have not changed significantly. Only Denver, CO, of the four potential processing locations, has a market area. A Denver location would be able to compete with a North Dakota location in serving western Texas, Arizona, Colorado, and Wyoming.

Economic Impact

The economic impacts resulting from the construction and operation of a precook bean processing plant in North Dakota can be measured in terms of several key economic variables. Numerous direct, indirect, and induced impacts would occur within the state. These include increased levels of

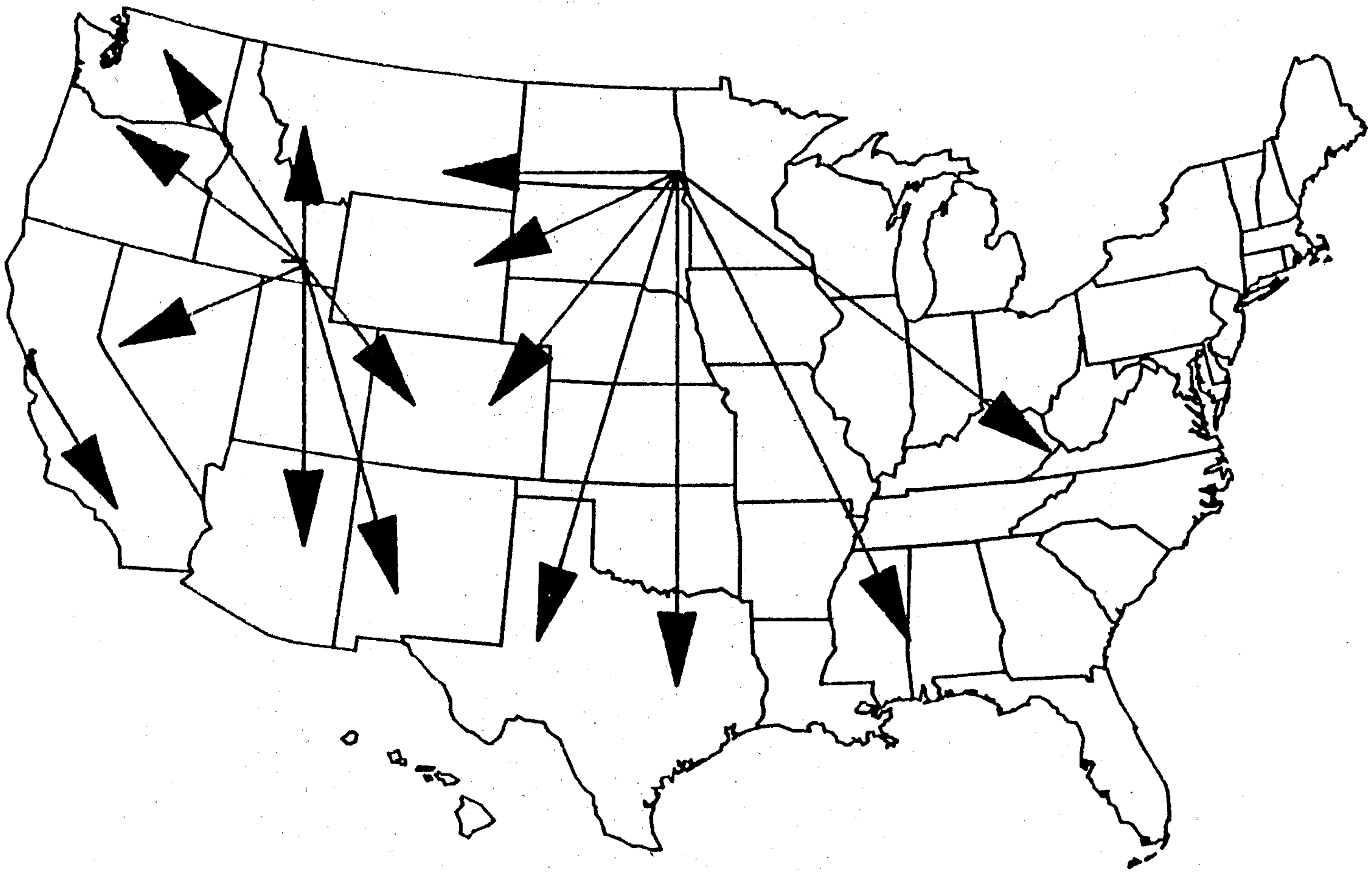

Figure 31. Least Cost Market Flows of Precooked Pinto Bean Products, Existing Processors

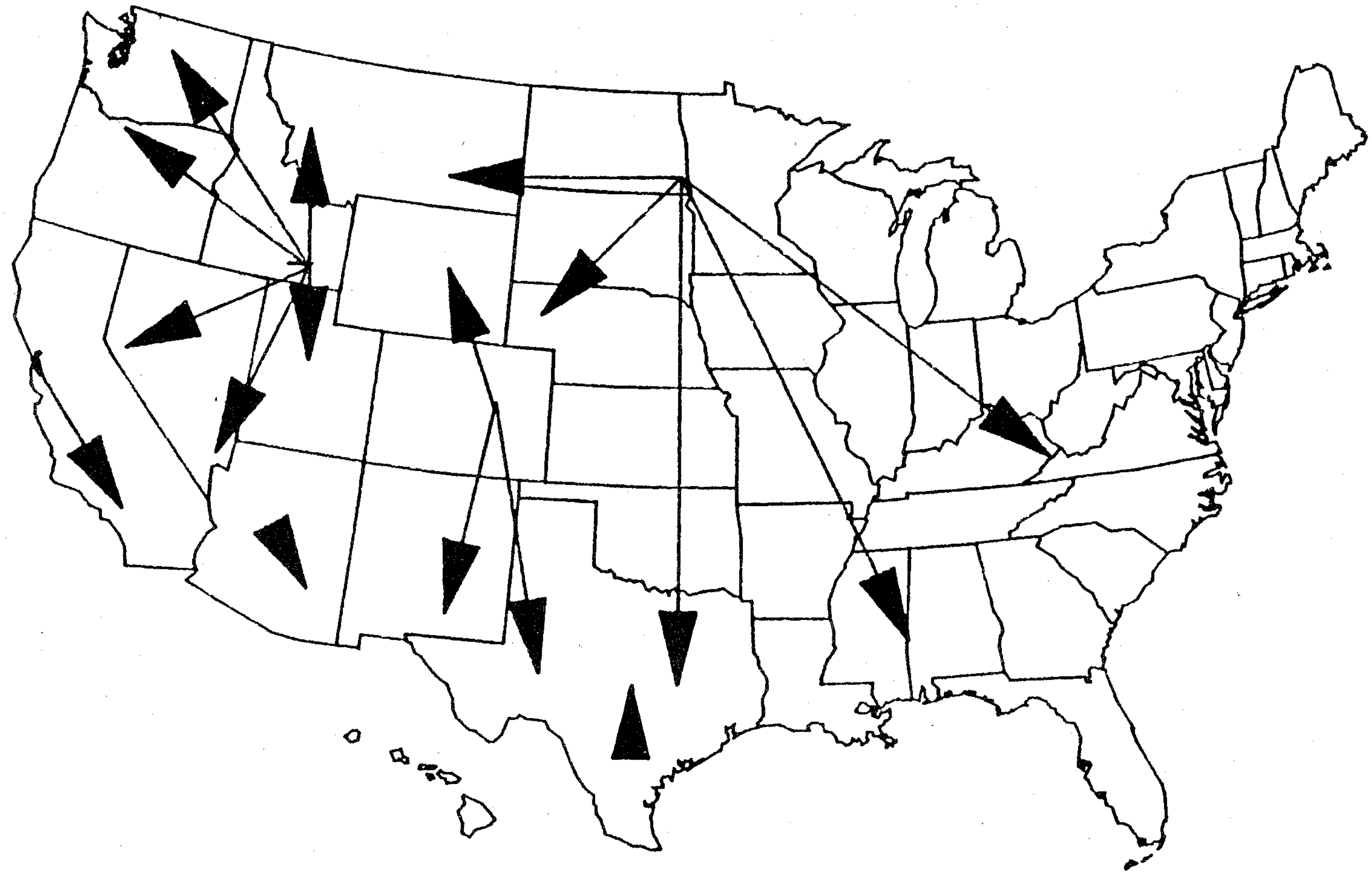

Figure 32. Least Cost Market Flows of Precooked Pinto Bean Product, Existing and Potential Processors and a North Dakota facility

business activity, retail sales, and personal income. Additional tax revenue would also be generated.

The analysis was based on the plant operating 24 hours per day and 300 processing days per year. All impacts will be reported as occurring in North Dakota since a specific location is not specified. Both construction and operational impacts will be analyzed. The construction impact refers to the "one time" business activity generated as a result of the construction of the facility. Economic impacts from the operation of the plant would result each year the plant was in operation. These impacts are annually recurring, but were determined for one year based on the expected annual expenditures that would result from a bean processing plant operation. Economic impact results are reported in 1987 dollars.

Local Expenditures

Local expenditures during the construction phase totaled $1.1 million. Direct construction expenditures were $618,000; retail trade expenditures $386,000; and the professional and social service sector $103,000 (Table 40).

TABLE 40. ESTIMATED LOCAL CONSTRUCTION AND OPERATION PHASE EXPENDITURES FOR MODEL PRECOOK PINTO BEAN PROCESSING PLANT, NORTH DAKOTA, 1987

Sector	Item	
	Construction	Operational
	----------thousand dollars----------	
Construction	618	--
Transportation	--	126
Commercial and public utilities	--	2,710
Retail	386	1,113
Fire	--	21
Business and personal services	--	951
Professional and social services	103	--
Households	--	929
Total	1,107	5,850

Expenditures during the operational phase were distributed among six sectors of the state economy. The commercial and public utilities received the largest expenditures ($2.7 million) followed by the retail sector with over $1 million, business and personal services sector with $1 million, and the household sector with $0.9 million in expenditures. The household sector represents wage and salaries from operation of the plant.

Total Business Activity

Applying construction and operational phase expenditures to the multipliers provided estimates of personal income, retail trade, and total business sector activity (Coon 1986). Retail trade associated with the construction of the plant totaled $815,000; and $3,792,000 in annual retail trade activity associated with plant operations.

Personal income attributable to construction of the plant was estimated at $640,000. Operations generated annual personal income of $4,851,000. Total business activity associated with construction of the facility was $2,670,000 and $15,786,000 annually from operations (Table 41).

TABLE 41. ESTIMATED PERSONAL INCOME, RETAIL TRADE ACTIVITY, AND TOTAL BUSINESS ACTIVITY RESULTING FROM THE CONSTRUCTION AND OPERATION OF THE MODEL PRECOOK PINTO BEAN PROCESSING PLANT, NORTH DAKOTA, 1987

Item	Personal Income	Retail Sales	Total Business Activity
	-----------------thousand dollars-----------------		
Construction phase	640	815	2,670
Operational phase	4,851	3,792	15,786

Tax Collections

Estimated total tax revenues resulting from the construction and operation of the plant are presented in Table 42. Construction generated $33,000 in sales tax, $13,000 in North Dakota personal income tax and $6,000 in North Dakota corporate income tax. Operations generated $154,000 of sales tax, $102,000 in North Dakota income tax, and $31,000 in North Dakota corporate income tax annually.

TABLE 42. ESTIMATED TAX REVENUES RESULTING FROM CONSTRUCTION AND OPERATION OF THE MODEL PRECOOK PINTO BEAN PROCESSING PLANT, NORTH DAKOTA, 1987

Item	Sales Tax	Personal Income Tax	Corporate Income Tax
	------------------thousand dollars------------------		
Construction phase	33	13	6
Operational phase	154	102	31

Summary and Conclusions

The primary objective of this study was to determine the overall feasibility of a North Dakota based bean processing plant. Factors taken into consideration were local production, competing products, plant processing costs, transportation costs, raw material costs, and expected end-product prices. Two technologically feasible processes were investigated. One process was a dry roasting and milling process that would produce protein, starch, and fiber products for the food ingredient market. The other process, a steam-cooking process, produces a precooked or quick-cook convenience full-flavored bean product.

The dry roasting process produced high starch, high protein, and high fiber products for the food manufacturing industry. Although technologically feasible, this process was not economically feasible. In summary, the value of whole beans exceed the sum of the values associated with its starch, protein, and fiber fractions. Under a very optimistic revenue assumption, the model bean processing plant generated a positive rate of return; however, the high level of revenue was determined to be unrealistic. The potential use of cull beans as a means of lowering raw material cost was also investigated. A major limitation is a limited and variable supply of edible culls. Partial replacement of whole beans by edible culls did not sufficiently reduce cost to make the plant economically feasible.

The production of full-flavored precooked pinto beans was a much more viable option than producing food ingredient products. Internal rates of returns under moderate revenue estimates exceeded 50 percent. The impact of lower than expected processing volumes was also determined. Internal rates of return exceeded 20 percent for the plant regardless of operating one, two, or three shifts per day.

A North Dakota based precooked pinto bean processing plant possesses a locational advantage over other existing and potential processing locations in the distribution of their product to eastern, central, and southern regions of the country. A North Dakota plant would have a disadvantage in shipping to the Southwest. However, given the high value of the product, there is sufficient margin to allow penetration of the Southwest market.

Economic impacts of the precooked pinto bean plant were also investigated. A bean processing plant operating at full capacity would generate $5.9 million in local expenditures annually. These local expenditures would, in turn, generate over $15 million in overall business activity.

Appendix

APPENDIX TABLE 1. PINTO BEAN PRODUCTION BY STATE, 1972-1985

State	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	------------	------------	------------	------------	------------	------------	1,000 cwt.	------------	------------	------------	------------	------------	------------	------------
Colorado	1648	1443	1527	1798	1663	1243	1628	1659	2131	2650	1977	1662	2204	2948
Idaho	1096	706	868	1170	1177	785	1138	1114	1629	2421	1228	553	1147	820
Kansas	110	88	130	152	150	162	192	170	336	935	280	126	204	272
Michigan	203	113	69	114	116	65	89	112	850	348	120	28	30	64
Minnesota	225	256	263	276	240	221	218	205	421	598	247	100	202	182
Montana	178	152	148	174	147	91	109	137	144	188	119	35	132	43
Nebraska	578	451	622	804	665	597	652	704	1020	1782	666	433	882	990
North Dakota	918	985	542	1117	1043	944	966	1158	2248	3570	1596	1020	1500	1534
Utah	52	68	46	71	51	2	24	32	42	60	46	41	54	40
Washington	162	55	142	302	150	91	259	306	498	643	221	78	214	199
Wyoming	423	305	401	389	390	316	363	454	689	834	480	296	717	452
U.S. Total	5613	4622	4758	6367	5792	4517	5638	6051	10008	14029	6980	4372	7286	7544

SOURCE: Bean Market Summary, AMS, USDA, 1977-1985.

APPENDIX TABLE 2. NAVY BEAN PRODUCTION BY STATE, 1972-1985

State	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	1,000 cwt.													
Michigan	6300	4640	6274	3987	4665	4844	4974	5260	4827	4070	6497	3750	3591	4355
Minnesota	150	242	417	92	118	175	360	351	486	610	600	270	415	543
North Dakota			46	61	63	150	270	247	404	870	840	598	960	1451
U.S. Total	6450	4882	6737	4140	4846	5169	5604	5858	5717	5550	7937	4618	4966	6349

SOURCE: Bean Market Summary, AMS, USDA, 1977-1985.

APPENDIX TABLE 3. GREAT NORTHERN BEAN PRODUCTION BY STATE, 1972-1985

State	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	1,000 cwt.													
Idaho	321	509	527	313	420	387	513	459	368	427	352	192	230	146
Minnesota		2			4									
Montana	9	10	6	2	3	3	3	2			10			
Nebraska	1092	1147	1460	1056	1275	1140	1280	1456	1700	2211	2332	1720	2132	1356
North Dakota	11	21	15	2	5	9	3	3						
Wyoming	82	87	80	36	60	64	64	78	44	48	42	28	42	29
U.S. Total	1515	1776	2088	1409	1767	1603	1863	1998	2112	2686	2736	1940	2404	1531

SOURCE: Bean Market Summary, AMS, USDA, 1977-1985.

APPENDIX TABLE 4. SMALL RED BEAN PRODUCTION BY STATE, 1972-1985

State	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	1,000 cwt.													
Idaho	199	179	250	182	240	189	213	206	258	214	235	147	177	220
Minnesota	1			4					18					
Washington	171	139	197	308	197	116	153	300	370	396	254	155	168	286
U.S. Total	371	318	447	494	437	305	366	506	646	610	489	302	345	506

SOURCE: Bean Market Summary, AMS, USDA, 1977-1985.

APPENDIX TABLE 5. PINK BEAN PRODUCTION BY STATE, 1972-1985

State	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	1,000 cwt.													
California	108	78	202	206	193	144	204	250	700	700	220	188	186	208
Idaho	399	545	727	809	705	542	415	515	942	1034	587	429	583	540
Minnesota	29	71	6	8										
Montana										30	10		20	14
Nebraska	40	66	63	60	40	30	15							
Washington	48	44	62	71	52	37	53	52	108	177	55	22	52	32
U.S. Total	624	804	1060	1154	990	753	687	817	1750	1941	872	639	841	794

SOURCE: Bean Market Summary, AMS, USDA, 1977-1985.

APPENDIX TABLE 6. BLACK TURTLE SOUP BEAN PRODUCTION BY STATE, 1981-1985

State	1981	1982	1983	1984	1985
	1,000 cwt.				
Michigan	1990	140	30	35	165
New York	254	96	18	75	72
U.S. Total	2244	236	48	110	237

SOURCE: Bean Market Summary, AMS, USDA, 1984-1985.

APPENDIX TABLE 7. SMALL WHITE BEAN PRODUCTION BY STATE, 1981-1985

State	1981	1982	1983	1984	1985
	1,000 cwt.				
California	150	110	34	43	0
Idaho			74	227	140
Michigan			180	170	125
Nebraska					90
Washington	162	126	93	240	180
U.S. Total	312	236	381	680	535

SOURCE: Bean Market Summary, AMS, USDA, 1984-1985.

APPENDIX TABLE 8. RED KIDNEY BEAN PRODUCTION BY STATE, 1981-1985

State	1981	1982	1983	1984	1985
	1,000 cwt.				
California	830	865	400	746	710
Idaho	13	41	16	34	40
Michigan	335	450	207	260	398
Minnesota	39	90	80	80	139
Nebraska	32	182	35		
New York	293	408	259	261	205
U.S. Total	1542	2036	997	1381	1492

SOURCE: Bean Market Summary, AMS, USDA, 1984-1985.

APPENDIX TABLE 9. CRANBERRY, LARGE LIMA, BABY LIMA, BLACKEYE, AND GARBONZO BEAN PRODUCTION BY STATE, 1981-1985

Bean Class	State[a]	1981	1982	1983	1984	1985
		1,000 cwt.				
Cranberry	Michigan	320	420	285	185	261
Large Lima	California	639	580	463	648	912
Baby Lima	California	661	530	472	546	640
Blackeye	California	875	1050	623	930	775
Garbonzo	California	50	60	47.	19	16

[a]States exclusive producer, thus state totals are also U.S. totals

SOURCE: Bean Market Summary, AMS, USDA, 1984-1985.

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