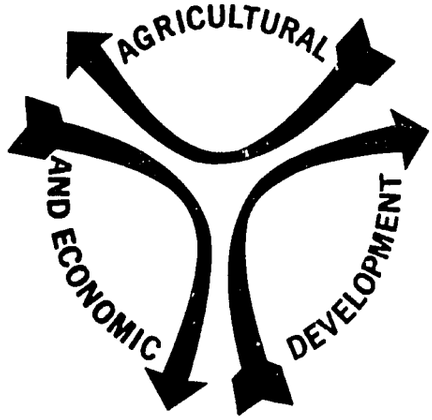
AN ANALYSIS OF COSTS INCURRED AND PRICES CHARGED FOR FOOD SHIPMENTS UNDER PUBLIC LAW 480



CENTER FOR AGRICULTURAL AND ECONOMIC DEVELOPMENT

IOWA STATE UNIVERSITY

AMES IOWA

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AN ANALYSIS OF COSTS INCURRED AND PRICES CHARGED FOR FOOD SHIPMENTS UNDER PUBLIC LAW 480

by

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Important interrelationships exist between domestic agricultural policies and opportunities and public costs of international aid in the form of food. Since their outset, U.S. public policies for agriculture have been of developmental nature. Up to 1930, the entire thrust of U.S. agricultural policies was developmental in nature. They supposed that greater farm income might be best attained through greater yields and production. The developmental elements of early policies were reflected in programs which increased the supplies of physical and knowledge resources and kept their prices low.

As a consequence of these programs, the nation has been able to produce more food than can be absorbed by domestic consumers and international trade at prices acceptable to the farm public. To attain conditions which still allowed technological development of agriculture but diverted consequences of gains to consumers (through lower outlays for food) at a sacrifice to farmers (through reduced farm income), supply control programs have been in effect over a large proportion of the last 40 years. Acreage withheld from crop production averaged around 55 million acres over the last decade. But even with these land retirement and supply control programs, the nation has been able to produce crop outputs exceeding domestic and foreign demand at support price levels. This capacity and the restrained level of supply control attained has thus allowed a large proportion of U.S. international aid to be in the form of food commodities. Shipment of food commodities under P.L. 480 were high throughout the 1960's; for wheat, averaging nearly a third of annual production.

Without P.L. 480 wheat, feed grain and cotton exports, an increased amount of land would have had to be retired during the 1960's if the same level of domestic prices had been maintained. Hence, the cessation of P.L. 480 food shipments would not necessarily reduce the costs of domestic farm programs by a corresponding amount. Cessation of exports under these programs, with domestic prices maintained at the same level, would require offsetting public expenditures for a larger land retirement program.

In other words, the choice may not be between (a) a land retirement program and P.L. 480 shipments of the magnitudes over the past decade, or (b) a land retirement program of this magnitude and no P.L. 480 shipments. Rather it may be a choice between the first and a larger land retirement program to offset cessation of publicly assisted food exports and maintain prices. Under the latter set of choices, the public costs of food aid then may be marginal; since part or all of the funds to support this international activity might (or would) be needed for larger land retirement and supply control programs.

The study reported in this manuscript has been made accordingly. Its objective is to measure the public costs of programs relating to

domestic agriculture when outlays are for varying levels and mixes of land retirement and publicly assisted exports, and when supply control is implemented through different types of land retirement programs. Dr. Mayer also has indicated the potential costs at which food could be provided recipient countries under different levels of P.L. 480 exports and various alternatives in type of land retirement programs.

The results of this study indicate the need for further analysis of interrelationships in domestic farm programs, food aid and public costs. Hence, we expect to conduct further analyses of trade-offs in magnitude of food aid programs and domestic supply control and pricing programs.

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Executive Director

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Introduction

The capacity of U.S. Agriculture to produce quantities of major grain commodities in excess of domestic and commercial export demand has been evident to agricultural interest for several decades. Efforts to remove this persistent problem have focused on two alternative types of programs. One set of programs attempted to shift the aggregate supply curve of farm commodities to the left through restricting the land input on thousands of individual farms. The second set of programs focused on shifting the aggregate demand curve to the right through programs to increase the quantities of food utilized by million of individual consumers, both at home and abroad. These two sets of programs have been carried forward together as a means of relieving the pressures on the agricultural sector to adapt its resource base to the new technological plateau on which farming operations rest. Programs of supply control have received the most attention in recent years (and the most public funds). But large amounts of public funds have also been expended on programs of export food distribution.

Programs of enlarging exports of major crops under special kinds of financing were officially initiated in 1954 under the Agricultural Trade Development and Assistance Act (Public Law 480, 83rd Congress). P.L. 480 programs provided that surplus farm commodities could be sold to foreign countries under special terms, or in some cases, simply donated. Under the special terms provision, commodities were provided to countries for payment in their own currency. Under the donation provision, supplies of food commodities could be given to victims of disaster. Provision was also made for food supplies to move through welfare

organizations to persons otherwise unable to fill their need for food. A later addition to the program allowed sale of commodities for long term credit at low interest rates and with eventual payment in dollars.

The introduction of export promotion programs in the 1950's grew out of price and income difficulties in the agricultural sector. Partly, these problems were a carryover of the enlarged production base of the World War II period as well as a result of the sharp decline in export markets after the Korean conflict. But besides these two sources of imbalance, the agricultural sector achieved a rapid growth in productivity after 1950. By 1959, few disagreed with Cochrane when he pointed out that, "...the aggregate output of agriculture is outdistancing a very rapid rate of population growth in the United States by more than one-half of one percent per year. And where the income elasticity of raw farm products approaches zero, as in the United States, this imbalance... properly measures the additional pressure of supply on demand each year, hence measures the increased downward pressure on farm prices (or, under price supports, the widening of annual rate of surplus).[1/] The downward pressures on farm prices resulted in a major emphasis on two policy alternatives: increased shipments of farm commodities to foreign markets and reduced acreages of land for major crops. Demand expansion programs were initiated in 1954 to increase exports to nations recuperating from the effects of World War II and the Korean Conflict; land retirement programs were instituted in 1956 to reduce total acreages of crops and slow growth in aggregate output.

1/ Willard W. Cochrane. "Farm Technology, Foreign Surplus Disposal and Domestic Supply Control." Journal of Farm Economic Vol. XLI, No. 5 December, 1959, p. 886.

Long-Term Trends in Agricultural Trade

Placed in the perspective of a century of world trade, the decade after P.L. 480 was initiated has brought some startling changes in total shipments of agricultural commodities between countries. After P.L. 480 programs started in 1956, both U.S. exports and world trade in agricultural commodities increased considerably. In the next decade, world trade in wheat doubled and the proportion of world wheat exports supplied by the U.S. increased from 33.5 to 38.5 percent (Table 1). Feed grains (corn, barley, and oats) also followed a similar trend; world trade more than doubled over the period and the proportion shipped by the United States rose from 30.3 percent to 47.5 percent.

Besides the more recent changes in agricultural trade, some substantial shifts in individual country food situations also occurred over the last century. At one period of history, India accounted for 10 percent of the world trade in wheat. This has dwindled and today that nation is an importer of this commodity. Another historical feature of agricultural trade has been the change in exports of wheat from Russia. After 1917, exports of wheat nearly ended and only recently have they shown a tendency to increase. A similar trend is evident with feed grains. Exports dropped sharply after 1917 and only in recent years has Russia increased its share of feed grain exports. A downward trend is also evident in farm exports from the Danube countries (which include most of Western and Eastern Europe). Exports of both wheat and feed grains from these countries have dropped over the last century.

Besides the United States, two remaining nations -- Argentina and Australia -- export sizeable quantities of wheat and feed grains.

Table 1 . Percentage distribution of annual world exports (Gross) of wheat and feed grains 1854-58 to 1962-66.

Country	1854-58	1884-88	1909-13	1924-28	1934-38	1952-56	1962-66
Wheat							
	Percent						
United States.....	24.9	35.8	14.5	22.1	8.0	33.5	38.5
Canada.....	6.4	1.2	12.6	35.2	27.9	31.3	23.4
Russia.....	12.0	25.3	22.3	2.1	4.2	2.6	6.4
Danube Countries..	9.8	18.6	15.8	4.2	7.6	1.1	2.2
Argentina.....	...	1.4	13.2	16.8	19.3	8.8	7.4
Australia.....	...	2.4	6.9	10.6	16.4	9.8	11.4
India.....	3.2	10.1	7.1	2.1	1.6	...	...
Other.....	43.7	5.2	7.6	6.9	15.0	12.9	10.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Metric tons (000's)	2,544	9,500	19,696	23,852	17,332	27,142	55,489
Feed Grains							
	Percent						
United States.....	16.8	20.3	9.2	10.0	7.8	30.3	47.5
Canada.....	2.6	4.0	1.9	7.9	3.2	20.2	2.9
Russia.....	16.8	36.4	36.2	3.7	3.1	2.6	4.8
Danube Countries..	26.9	24.4	17.3	15.8	11.1	3.2	4.4
Argentina.....	...	3.7	23.2	44.9	53.3	14.2	11.4
Australia.....	...	...	...	0.2	0.6	5.0	2.3
Other.....	36.9	11.2	12.2	17.5	20.9	24.5	26.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Metric tons corn	535	2,590	6,800	8,452	10,049	5,386	22,745
Metric tons barley	350	1,910	5,536	3,541	2,655	5,900	6,933
Metric tons oats (000's)	272	1,414	3,041	1,658	878	1,511	1,429
Total (000)	1,157	5,914	15,377	13,651	13,582	12,797	31,107

Source: Data for 1854-58 to 1952-56 are from Robert M. Stern, "A Century of Food Exports," in Foreign Agricultural Trade, Selected Readings, Iowa State University Press. Ames, Iowa. 1966; data for 1962-66 are from FAO, Trade Yearbook, Rome, 1967.

Australia has more recently become a major wheat exporter and in recent years has ranked third in the world. While agricultural exports from the U.S. have increased since the initiation of P.L. 480, it is also true that as early as 1885, the United States provided one-fourth of world wheat exports and one-fifth of world feed grains exports. Only during 1934-38 did U.S. wheat shipments fall below 10 percent of total world trade indicating the severe effects of economic conditions on trade between nations. However, world feed grain trade during this period remained fairly stable.

Food Production and Land Use

The favorable level of exports from the U.S. indicates that total agricultural production has far exceeded domestic needs. That favorable record has largely resulted from two factors: A supply of land resources which has been relatively elastic even at constant or declining commodity prices, and the continuous introduction of various kinds of yield-increasing technologies which doubled production per crop acre between 1910 and 1960. Over the decade 1952-56 and 1962-66, yields increased at such a rapid rate that major crop acreages could be reduced by 43 million acres (Table 3) and still have total farm production rise by 15 percent. Production per acre increased 28 percent over the decade.

The reduction in harvested crop acreage under government programs resulted largely from overproduction of a few specific crops. Wheat acreage in the early 1950's totaled over 70 million acres as high prices held over from World War II encouraged enlarged plantings. By 1962-66, acreage quotas had reduced harvested wheat acreage by some 10 million acres although total production continued to climb.

Table 2. Acreages, yields, and production of major crops in United States with export acreages and prices received by producers. [1/]

	1854-58	1884-88	1909-13	1924-28	1934-38	1952-56	1962-66
				All Crops			
Harvested Acreage.....	n.a.	n.a.	329	359	334	341	298
Export Acreage.....	n.a.	n.a.	36	50	22	42	72
Crop Failure Acreage..	n.a.	n.a.	10	14	33	15	8
Production/Acre [2/].....	n.a.	n.a.	69	69	64	90	118
Total Production [1/].....	n.a.	n.a.	64	72	68	95	110
				Wheat			
Harvested Acreage.....	n.a.	36.3	48.1	56.1	55.4	58.1	47.5
Export Acreage.....	n.a.	5.8	3.7	8.9	2.2	15.4	27.1
Yield/Acre.....	n.a.	13.2	14.2	14.7	12.9	18.6	25.9
Total Production.....	n.a.	479.9	681.7	826.4	715.6	1,080.4	1,231.0
Price/bushel [3/].....	n.a.	.73	.87	1.20	.65	2.04	1.63
				Cotton			
Harvested Acreage.....	n.a.	18.3	33.0	41.8	28.4	20.4	13.4
Export Acreage.....	n.a.	5.7	11.2	12.2	6.7	2.7	4.0
Yield/Acre.....	n.a.	.36	.39	.36	.45	.72	1.04
Total Production.....	3.1	6.6	13.0	15.0	12.7	14.7	14.0
Price/Pound.....	n.a.	8.52	12.01	18.29	10.26	32.91	29.14
				Feed Grains [4/]			
Harvested Acreage.....	n.a.	168.6	145.4	150.9	140.8	128.5	88.4
Yield/Acre.....	n.a.	.40	.65	.52	.54	.93	1.53
Total Production.....	n.a.	66.8	94.9	77.9	75.4	119.4	135.6
Price/Ton.....	n.a.	13.68	22.24	36.16	23.72	48.93	40.83

Source: United States Bureau of the Census. Historical Statistics of the United States, Colonial Times to 1957, a statistical abstract supplement, Washington, D. C. 1960; and the Statistical Abstract 1964-68 issues.

1/ Acreages are million acres, yields per acre are bushels for wheat, pounds for cotton and tons for feed grains, total production is million bushels for wheat, million bales for cotton and million tons for feed grains.

2/ Simple 5 year average of published production index, 1957-59 = 100.

3/ Weighted 5 year average.

4/ Corn, oats and barley; grain sorghum is not included.

Wheat was not the only crop to feel the effects of increased yields and reduced acreages during the 1950's. Feed grains yields also rose consistently. By 1962-66, yields of feed grain were 75 percent above a decade earlier. Acreages were reduced from 128 million acres in 1952-56 to 88.4 million acres by 1962-66.

As with wheat and feed grains, cotton acreage in the United States also tapered off after World War II. By 1962-66, only 13.4 million acres of cotton were harvested in the United States. Production of cotton remained relatively constant and in 1962-66, 14.0 million bales were harvested. Cotton prices trended upward for most of this period. In recent years, government programs reduced the market price and substituted direct government payments to maintain total revenue per bale of cotton.

From a historical perspective, total crop acreage in the United States trended downward over the last several decades. Harvested acreage of all crops reached a high of 359 million acres in the period 1924-28 with production from 50 million acres entering export markets. Total acres of harvested crops tapered off during the 1934-38 period as a result of weather and severe economic conditions. But the decline in total harvested acres of crops in this period was only temporary and large increases took place during World War II. Crop acreages remained large through 1954 as the Korean Conflict provided demand for most commodities. Export acreage totaled 42 million acres between 1952-56 with prices for major commodities at record levels.

The decade after the Korean Conflict saw a rapid decline in acreages harvested. Total crop acreage harvested fell below 300 million acres, a twentieth century low. Wheat acreage totaled 47.5 million acres,

feed grains 88.4 million acres, and cotton 13.4 million acres, a total of 149 million acres in the period 1962-66. Between 1924-28 and 1962-66, these crops used nearly a hundred million acres less cropland, falling from 248.8 million acres to 149.3 million acres. Fortunately, for entrepreneurs with large investments in farmland, other crops expanded some, notably soybeans and grain sorghum, and government programs removed large acreages of cropland from potential production. Instead of a large reduction in land prices as might have been expected, land prices continued to climb throughout most of this period.

Land Diversion and Government Export Programs

While land diversion programs removed a large amount of potential production after 1956 (Table 3) a significant part of the remaining production was moved into foreign markets under P.L. 480 programs. Some production also went into domestic programs of supplementing diet of low income families. But a much larger portion was shipped into foreign markets under P.L. 480 programs.

Wheat has been the major crop exported under government programs of special financing (Table 4). Over 40 percent of U.S. wheat production moved under government programs in some years since the inception of P.L. 480. A much smaller proportion of feed grains, less than 3 percent in most years, moved under these programs. Primarily this small proportion results because most feed grains are used domestically, less than 15 percent of feed grains production is exported. Over 50 percent of the wheat crop has been exported in some recent years.

The history of land diversion and export programs point up that supply reduction and demand expansion represent two alternative methods

Table 3. Cropland diversion under specified programs, 1956-68.

Year	Total	Program						
		Wheat[1/]	Feed Grains	Cotton	Acreage Reserve	Conservation Reserve	Cropland Conversion	Cropland Adjustment
				(million acres)				
1956	13.6	---	---	---	12.2	1.4	---	---
1957	27.8	---	---	---	21.4	6.4	---	---
1958	27.1	---	---	---	17.2	9.9	---	---
1959	22.5	---	---	---	---	25.5	---	---
1960	28.7	---	---	---	---	28.7	---	---
1961	53.7	---	25.2	---	---	28.5	---	---
1962	64.7	10.7	28.2	---	---	25.8	---	---
1963	56.1	7.2	24.5	---	---	24.3	0.1	---
1964	55.5	5.1	32.4	0.5	---	17.4	0.1	---
1965	57.4	7.2	34.8	1.0	---	14.0	0.4	---
1966	63.3	8.3	34.7	4.6	---	13.3	0.4	2.0
1967	40.8	---	20.3	4.9	---	11.0	0.6	4.0
1968	47.8	---	31.0	3.0	---	9.2	0.6	4.0

Source: United States Department of Agriculture. Agricultural Statistics 1968.

1/ Wheat acreage diversion is voluntary diversion only and does not include required diversion for participation in price support programs. In 1968, required diversion is estimated to total million acres.

Table 4. Exports of major cereals under P.L. 480 programs, 1954-67.

Year Beginning July	Sales for Foreign Currency or Long-term Dollar Credit	Disaster Relief, Foreign Donations and Other Assistance	Barter	Total P.L.480 Shipments	Total Production[1]	Percent P.L.480 Exports of Production
			WHEAT[2]			
1954	23,802	16,954	46,459	87,215	983,900	8.86
1955	94,347	14,652	66,716	175,715	937,094	18.75
1956	200,536	23,924	87,086	311,546	1,005,397	30.99
1957	179,023	31,688	9,807	220,518	955,740	23.07
1958	227,914	31,732	20,062	279,708	1,457,435	19.19
1959	300,648	32,827	25,662	359,137	1,117,735	32.13
1960	327,214	61,499	34,090	422,803	1,354,709	31.21
1961	386,396	63,316	41,337	491,049	1,232,359	39.85
1962	413,065	58,721	6,493	478,279	1,091,958	43.80
1963	400,102	69,076	35,167	504,345	1,146,821	43.98
1964	500,633	55,932	12,441	569,006	1,283,371	44.34
1965	459,675	65,957	45,522	571,154	1,315,613	43.41
1966	253,535	51,739	67,351	372,625	1,311,702	28.41
1967	331,534	13,828	80,352	425,714	1,522,382	27.96
			FEED GRAIN[3]			
1954	153	87	529	769	114,073	0.67
1955	551	46	3,493	4,090	120,846	3.38
1956	805	295	2,318	3,418	119,308	2.86
1957	1,110	434	359	1,903	132,424	1.44
1958	1,401	362	590	2,353	144,121	1.63
1959	1,375	373	1,101	2,849	149,605	1.90
1960	1,031	578	957	2,566	155,618	1.65
1961	1,038	840	1,193	3,071	140,626	2.18
1962	840	451	741	2,032	142,899	1.42
1963	995	501	277	1,773	156,432	1.13
1964	861	451	385	1,697	134,200	1.26
1965	1,659	452	236	2,347	157,400	1.49
1966	3,500	412	426	4,638	157,600	2.64
1967	1,758	485	659	2,902	175,100	1.66

1/ Calendar year.

2/ Thousand bushels.

3/ Includes corn, oats, barley and grain sorghum in thousand tons.

of handling excess production capacity of U.S. agriculture. The U.S. has developed two specific set of programs, one to remove excess land resources from agricultural production, and a second to absorb the commodities produced in excess of domestic and commercial export demand. Together these two programs have jointly managed to slow the outflow of resources from the agricultural industry brought on by rapid introduction of new innovations. As was pointed out in 1966, "what the U.S. has today is not surplus production but reserve acreage. This reserve acreage can be returned to production as needed -- to produce for U.S. use, commercial exports, and food assistance exports".[1/] These various programs provide the agricultural sector with insurance against large economic fluctuations. They represent an attempt by society to offset some of the harsh economic and social losses to farmers growing out of the private and public creation of yield-increasing innovations which greatly increase potential production in agriculture, place downward pressure on prices received by producers and reduce the need for labor in agriculture.

Costs of Supply Control and Demand Expansion Programs

Costs of programs to restrain production and increase demand have increased substantially since their inception. In the first full year of operation of P.L. 480, this program had a total cost of $430.9 million for purchase, shipment and distribution of commodities in recipient countries (Table 5). This cost doubled in the second year of

1/ United States Department of Agriculture. The New Food Aid Program. Washington, D.C. November, 1966

Table 5. Gross cost of financing programs carried out under the Agricultural Trade Development and Assistance Act of 1954 through Dec. 31, 1967.

Year beginning July 1	Title I		Title II—Donations		Title III	Total
	Sales for foreign currencies	Long-term credit sales for dollars	Famine and other emergency relief	Voluntary agency programs	Bartered materials for supplemental stockpile	
	(millions of dollars)					
1954	129.5	-	86.9	214.5	-	430.9
1955	624.2	-	93.6	271.2	-	989.0
1956	1,396.4	-	124.9	234.1	217.3	1,972.7
1957	1,144.7	-	121.4	254.3	83.9	1,604.3
1958	1,113.3	-	97.9	178.7	314.7	1,704.6
1959	1,308.0	-	95.5	130.8	192.4	1,726.7
1960	1,557.3	-	198.6	169.3	200.5	2,125.7
1961	1,606.1	29.0	241.9	191.7	193.3	2,262.0
1962	1,739.4	80.3	215.6	238.8	99.7	2,373.8
1963	1,636.2	65.1	228.2	341.6	37.7	2,308.8
1964	1,505.8	211.0	147.2	174.6	40.6	2,079.2
1965	1,287.8	274.6	222.5	148.3	25.8	1,959.0
1966	1,067.8	221.7	335.9	34.2	32.5	1,692.1
1967	312.6	123.3	120.0	-	10.3	566.2
1968						

operation and again the next year. It reached a high in 1962 when total outlays were $2,373.8 million but tapered off after that.

Land use and price support programs also increased sharply after the initial years of operation. In 1956, these programs had a total cost of $554 million (Table 6) with over half being spent on conservation and price support programs. After 1956, costs for these programs rose, as the Soil Bank Program was expanded to restrain total crop production. As acres retired increased in 1957, total costs doubled, reaching over $1 billion. While this trend was temporarily reversed in 1959 and 1960, it resumed after 1961 and reached $2 billion by 1964 and $3.5 billion by 1968. For this level of expenditure, some 50 million acres of cropland were held out of production; other acres of cropland were improved through conservation practices and farmers receive price supports in the form of direct payments on portions of the remaining production.

Together, program costs for price support, supply control and export expansion totaled nearly $50 billion during the period 1956 to 1968. On the benefit side these programs assisted U.S. agriculture in the structural adjustment problems growing out of the introduction of labor-saving output-increasing innovations and provided supplies of food to less fortunate people in other nations of the world. Society, through various kinds of government programs, placed limits on the amount and rate of structural adjustment required of the agricultural sector and as a mutually beneficial policy, set up programs to supplement diets of millions of less fortunate human beings. The combination of programs used indicates that both supply reduction and demand expansion are feasible alternatives for dealing with the welfare and food producing capacity of the agricultural sector.

Table 6. Government payments to farmers under various land use and price support programs, 1954-68.

Calendar Year	Conservation program	Sugar Act	Wool program	Soil bank program	Feed grain program	Wheat program	Cotton	Total[1/]
				(million dollars)				
1954	217	40	-	-	-	-	-	257
1955	188	41	-	-	-	-	-	229
1956	220	37	54	243	-	-	-	554
1957	230	32	53	700	-	-	-	1,016
1958	214	44	14	815	-	-	-	1,089
1959	228	44	82	323	-	-	-	682
1960	217	50	51	370	-	-	-	693
1961	230	45	56	334	772	42	-	1,484
1962	224	54	54	304[2/]	841	253	-	1,736
1963	222	57	37	304[2/]	843	215	-	1,686
1964	227	67	25	199	1,163	483	39	2,169
1965	215	64	18	160	1,391	525	70	2,452
1966	220	60	34	145	1,293	679	773	3,266[4/]
1967	226	62	29	129	865	731	932	3,071[4/]
1968[5/]	215	64	66	114	1,366	747	787	3,452[4/]

1/ Includes Great Plains conservation payments since 1958.

2/ Includes land-use adjustment program and cropland conversion and Appalachia programs.

3/ Includes cropland adjustment program.

4/ Preliminary.

Methodology for Estimating Net Costs of U.S. Food Aid

This study develops a model to measure the net cost of food shipments under P.L.480. The model simulates the production-marketing and exportation of food shipments within the conditions now existing in the agricultural sector. These conditions include the two major alternatives open to policy makers described previously. One alternative is the lowering of total production from agriculture through various supply control programs. The second alternative is to provide a quantity of agricultural output for shipment under government programs. Each alternative policy has a set of costs associated with it. The objective of this model and analysis is to place these alternative policies and their costs in relationship to each other and develop a perspective for planning a future set of policy elements for the nation.

The U.S. has for some years given sizeable amounts of aid to other nations, both in the form of monetary resources and aid-in-kind. In 1966, 30.7 percent of U.S. aid was shipments of food commodities under P.L. 480 programs (Table 7). Technically, these shipments were sales for local currency or long term credit but the preponderance of evidence is that a sizeable portion of such shipments will eventually turn out to be a form of economic aid. Even for that portion for which repayment is likely, the pricing policy should reflect the long term ability of nations to repay and the realistic U.S. government cost of such aid.

At least in the near future, the policy alternatives open to the U.S. government are limited. Through a long series of public decisions, the nation has specified a set of public programs to maintain the social

Table 7. United States Economic Assistance to other regions of the world, by kinds during Fiscal Year 1966[a/]

Region	Total Economic Assistance	Kind of Economic Assistance				Percent Region of Total Assistance	Percent P.L.480 of Total Assistance
		Loans	Grants	P.L.480	Other[b/]		
	million dollars					Percent	
Near East-South Asia	1,474.5	548.2	74.2	823.9	28.2	26.2	55.9
Latin America	1,387.7	505.4	142.0	202.2	538.1	24.7	14.6
East Asia[c/]	1,264.9	76.6	761.5	292.6	134.2	22.5	23.1
Africa	388.3	88.9	80.6	141.8	77.0	6.9	36.5
Europe	468.0	-.3	-.2	205.4	263.1	8.3	43.9
Other	631.8	0	266.2	60.1	305.5	11.2	9.5
Total	5,615.2	1,218.8	1,324.2	1,726.0	1,346.1	100.0	30.7

Source: Agency for International Development. Proposed Foreign Aid Program FY 1968. U.S. Govt. Printing Office. Washington, D.C. May 1967. Tables No. 1 and No. 2.

a/ Does not include military aid which totaled $1,046 million in 1966 (Statistical abstract of the United States, 89th edition, 1968).

b/ Includes Export-Import Bank long term loans; Peace Corps, supplementary contribution to the Inter-American Development Bank and the International Development Association; and other miscellaneous programs.

c/ Includes Vietnam.

welfare of our agricultural sector and assure the nation of an abundant supply of food. To achieve this purpose, a large acreage of land is retired under government programs for temporary periods of time. Two possible alternatives exist for this land: it can be used to produce for non-commercial export markets or it can continually be retired from production under government programs. In the past, a combination of these programs was adopted based partially on available government revenue and partially on the magnitude of food needs in other countries.

To measure the net cost of food shipments under the two alternative use of land and other resources, (retirement or subsidized exports), a linear programming model was developed to simulate resource use of the agricultural sector and the purchase and shipment of agricultural commodities under P.L.480 programs. The major resource restraint in the model is cropland, since this resource forms a basic input in the crop production process and has been used as the major mechanism for controlling the aggregate supply of agricultural commodities. Through government programs for agriculture, the supply of cropland for individual farms and for the nation has become institutionalized. Production units have specific allotments for production of certain crops. When the available base or national allotment for certain crops has resulted in over production at supported price levels, the government has purchased excess acres of allotment from the producer to reduce aggregate production.

Concepts included in the model

The institutionalization of the supply of land resources in the past several decades has in effect placed a two-way restraint on the total

land resources available for major crops. One restraint arises because available cropland is limited for any given level of technology. This restraint takes the form

$$x_1 + x_2 + \ldots + x_n \leq L, \tag{1}$$

where x_i represents the amount of land used in the production of crop i; (i=1,...,n). Thus, land use in the production of crops cannot exceed total available cropland, L. Under conditions where land resources required for crop production are less than total land available, the inequality of this restraint holds and excess land resources remain idle.

With the institutionalization of land use in the United States, excess land resources are no longer forced by the market to lie idle but are removed from production under government programs. This new type of relationship in resource use must be accounted for in a model for evaluating use of land resources. An additional land using activity must be defined so that

$$x_1 + x_2 + \ldots + x_n + r = L \tag{2}$$

where $x_1, x_2, \ldots, x_n$ denotes acres of crops, and r is retirement of acres of cropland under government programs. These activities must use all cropland available. If all land is required for production to meet potential demand, then retirement activities remain at zero level. However, if potential production exceeds demand, then retirement activities absorb the excess cropland.

Whether cropland is used for production of a crop or is retired under a government program, there are costs associated with its use.

These costs may be expressed in a cost function,

$$C = \Sigma c_i x_i + c_j r_j \tag{3}$$

which specifies that retiring each unit of cropland under the j-th program costs c_j, and each unit used for the i-th crop costs c_i. To derive a net cost of using cropland for production of the i-th crop, Equation (2) can be solved for r and substituted into Equation (3) giving

$$C = \Sigma c_i x_i + c_j (L - \Sigma x_i), \tag{4}$$

and total cost becomes a function of the total supply of land and total acres of crop production. Equation (4) can be rearranged as

$$C = \Sigma (c_i - c_j) x_i + c_j L, \tag{5}$$

which denotes that the cost of each unit of x_i is the cost of crop production, c_i, less the cost of retiring the same cropland, c_j. Thus the net cost of producing an acre of crop is

$$NC = c_i - c_j. \tag{6}$$

The net cost per unit of production may be found by dividing Equation (6) by the yield per acre of the i-th crop.

The concept of net cost outlined above is an integral part of the linear programming model for this study.[1/] As used, it represents a means of estimating the net cost of using marginal units of cropland for supplying food to other nations under P.L.480 as opposed to retiring the cropland from production under government programs. Further it provides a basis for developing pricing policies for future food sales under the Food Aid Act of 1966.

1/ For a complete description of the mathematical model used see Appendix A.

Model Parameters

Several sets of parameters are estimated for the model. These include (1) output coefficients for each crop production activity for each of the 150 production areas, (2) cost coefficients for each activity in the model including crop production, land retirement, commodity substitutions, inland transportation and international shipping, (3) cropland restraints for each region and crop included in the analysis, and (4) domestic and export demand levels for each commodity. A short explanation of each set of parameters will provide a background from which to evaluate the later analytical results.

Output Coefficients. Output coefficients are estimated for each major crop activity for each of the production areas in which the crop is acclimated. The coefficients representing yields per acre are estimated for 1970 using linear equations on post 1948 time series data for each state. To derive yield estimates for each of the 150 production areas, state yield estimates are adjusted by indexes of region to state ratios of yields to reflect variation among production areas within each particular state. These estimates of yields for each crop production area are used for both activities which satisfy domestic and commercial export demand and for those activities which provide commodities for P.L. 480 programs.

Activity Costs. Activity costs are estimated for each activity included in the model. For crop production activities, per acre costs of production are estimated for each crop in each production region.

The formulation used is

$$c_{ij} = pm_{ij} + lr_{ij} + fs_{ij}\, w_{ij} + io_{ij} + dq_{ij} \qquad (18)$$

where c_{ij} is production cost per acre for the j-th crop in the i-th production area, and

pm is power and machinery costs

lr is labor requirement costs

fs is fertilizer and seed costs

w is irrigation costs for water, if any

io is interest costs on operating capital, and

dq is drying and storage costs.

All costs are measured in 1966 prices and reflect no allowance for inflationary factors which may have occurred through the projection year 1970.

For commodity substitution activities, costs are based on factors involved in using wheat as a feed instead of as a food grain. The adjustments in enterprise operation necessary to shift from feeding coarse grains to feeding wheat have an economic cost because of differences in allowable portions of wheat and coarse grains in rations. Further, government programs maintain a cost differential between wheat and coarse grains. Activity costs for wheat-feed grain transfers reflect these considerations.

Activity costs for transporting wheat, feed grains and soybeans between the 31 demand regions are based on railroad rates for transporting agricultural commodities between destinations. Data were obtained from

several sources.[1/] No costs are estimated for transportation of cotton since most cotton is ginned within the demand region where produced.

Cropland Restraints. Cropland restraints are based on historical harvested acreages of the crops included in the model -- wheat, feed grains (including corn, oats, barley and grain sorghum), soybeans, and cotton. These restraints are based on acreages harvested over the period 1952-54 when crop acreages were at recent maximums. Since 1952-54, production of one or more of these crops has been restricted by government programs and total acreages have been at a lower level. Acres no longer required have been retired under government programs but remain available for production of crops if control programs are terminated. The acreage base for wheat, feed grains, soybeans and cotton totals 241.1 million acres. As was evident from Table 3, a sizeable proportion of this base has been retired from production in recent years.

Commodity Demands. Total demand for the specified commodities includes domestic demand, commercial export demand and shipments under government programs. Domestic demand is estimated for 1970 based on domestic population size and average per capita consumption levels for direct consumption demand. For feed grains and oilmeals, a derived demand is estimated based on demand for livestock and livestock products and historical trends in feed conversion rates. Demand for domestic consumption of each commodity is constant throughout the analysis.

Sources include: Ulrey, Ivon W. The Economics of Farm Products Transportation, Marketing Research Report No. 843, Economic Research Service, United States Department of Agriculture. Washington, D.C., 1969, Skold Melvin D. Programming Regional Adjustments in Grain Production to Meet Changing Demands. Unpublished Ph.D. Thesis, Iowa State University Library, Ames, Iowa 1963; and Wright, Bruce H. (private communications) Iowa State University, Ames, Iowa 1968.

Commercial export demand is estimated for 1970 based on trends of recent years. Commercial exports are defined as unassisted sales as well as those with government assistance in the form of (a) extension of credit and credit guarantees for relatively short periods, (b) sales of government-owned commodities at less than domestic market prices, and (c) export payments in cash or in kind.

Noncommercial export demand which includes P.L. 480 programs is the major variable in the model. Demand from this source for each commodity -- wheat, feed grains and cotton -- is varied from a zero level of shipments to a level in excess of past or expected levels of shipment. As each commodity is considered, demand levels for the other two commodities are set near recent levels. For example, when demand levels for wheat under P.L. 480 programs are varied from zero to 525 million bushels, demand for feed grains under these programs is set at 3.0 million tons and cotton at 2.0 million bales.

Demand levels for each of the commodities included in the model are specified in Table 8. Average commodity utilization levels are provided for the 1966-68 marketing years and projected for the 1970 marketing year

Analytical Procedure

The model developed for this study uses linear equations to express all relationships. The model includes activities which simulate the processes of crop production - government purchase - storage and shipment of commodities under P.L. 480 programs. A considerable number of governmental decisions are required before the eventual shipment of commodities to recipient countries under P.L. 480 programs (See Figure 1). In the

Table 8 . Demand levels specified for Domestic use, Commercial Export, and varying levels of food aid under P.L. 480.

Commodity (Million)	1966-68 Marketing Year			Projected 1970 Marketing Year								
	Domestic Use	Commercial Exports	Other Exports 1/	Domestic Use	Commercial Exports	Level of P.L. 480 Exports						
						0	1	2	3	4	5	6	7
Wheat (bu.)	585 2/	301	433	591 2/	300	0	75	150	225	300	375	450	525
Feed Grains (tons)	144.6	19.2	2.1	145.4	22.0	0	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Cotton (bales)	8.9	1.6	2.3	9.1	1.5	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0
Oilmeals 3/ (tons)	22.8	10.0	4/	24.1	12.2	a 4/	a	a	a	a	a	a	a

1/ Includes exports under P.L. 480, programs for barter and other exports financed by the U.S. Government.

2/ Does not include feed for wheat.

3/ Includes both soybeans and cottonseed.

4/ Oilmeals exports under P.L. 480 are included with commercial exports.

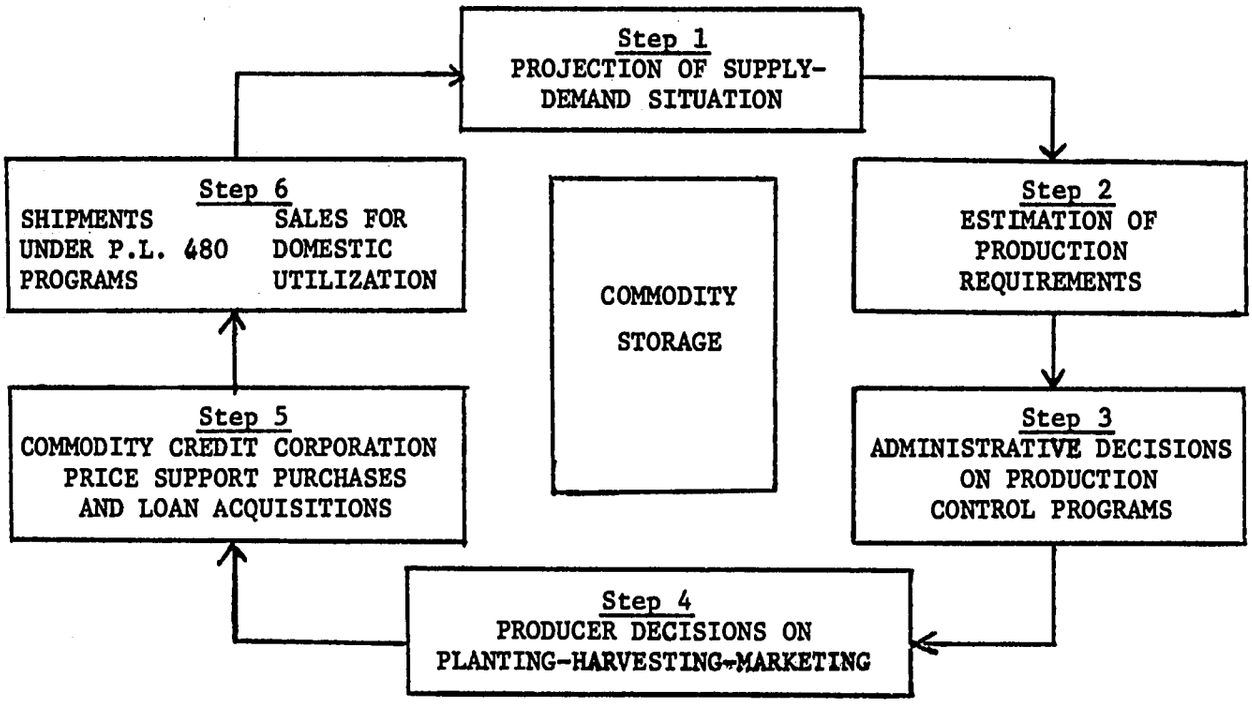

Figure 1. Public policy processes for management of food and fiber supplies

model, decisions in Steps 1 through 3 of Figure 1 are prespecified while Steps 4 through 6 are internal to the model. In Step 6, sales for domestic utilization are assumed to be zero; shipments under P.L. 480 are specified for discrete intervals as noted previously in Table 8.

Methodologically, the model uses parametric programming to vary both demand levels for P.L. 480 shipments and activity costs for commodity purchase under government price support programs. Initially, P.L. 480 demands are set at zero level for the specified commodity. After finding the optimal combination of activities for that shipment level, the P.L. 480 demand vector is increased by a discrete interval. At each specified increase, estimates are derived of the per unit net cost of providing the marginal unit of the commodity to the recipient country. This per unit cost measures the net cost of using cropland and other resources to produce the commodity for the market established by P.L. 480 programs, as compared to retiring the cropland (with other resources remaining idle) under government land retirement programs. Per unit costs for wheat, feed grains and cotton are estimated over a wide range of shipment levels.

One of the major difficulties encountered with the model was to simulate the purchase of commodities by the government at support prices (Step 5 in Figure 1). The usual minimum cost linear programming model selects activities to satisfy a given level of demand based on the criterion of least-cost. As demand is increased, the cost for providing the marginal unit also increases. With this type of model, costs for supplying an increasing amount of a commodity for export would normally rise as more marginal production areas provide the additional units of production.

But in reality the process by which commodities become available for shipment under P.L. 480 programs caused the costs for marginal and average units to be equal. That is, the price support mechanism which results in commodities becoming available through the Commodity Credit Corporation for food aid programs sets a constant price for all units, 1, 2, ..., n. To simulate this constant purchase price in the model, parametric cost programming is used to vary cost elements on shipping activities as the quantity of commodities shipped under P.L. 480 programs increases. This process is shown in Figure 2 where the total cost (tc) of procurement and shipment of commodities under P.L.480 is broken down into variable costs for producing each unit, a return to fixed factors used in production, and costs for transportation, storage and shipping. The dotted line defines the support price (sp) for each commodity. In the model, the cost coefficients on the shipping activities are adjusted with each increase in quantity to simulate the difference between pc and tc. In this manner, a constant cost is simulated for producing, storing and shipping a unit of the j-th commodity as follows:

$$c_j Z_j + c_{rj} S_{rj} = tc_{rj} \qquad (19)$$

where tc is the total cost for all activities required to deliver a unit of the j-th commodity to the r-th recipient country. As the element c_j increases for producing the j-th crop for export under P.L. 480, the cost element c_{rj} is reduced in magnitude, thus holding tc_{rj} constant. Total costs (tc) are taken from actual costs of operating P.L. 480 programs in the 1966-68 period. These data are given in Table 9 along with quantities shipped under P.L. 480 programs for 1966-68.

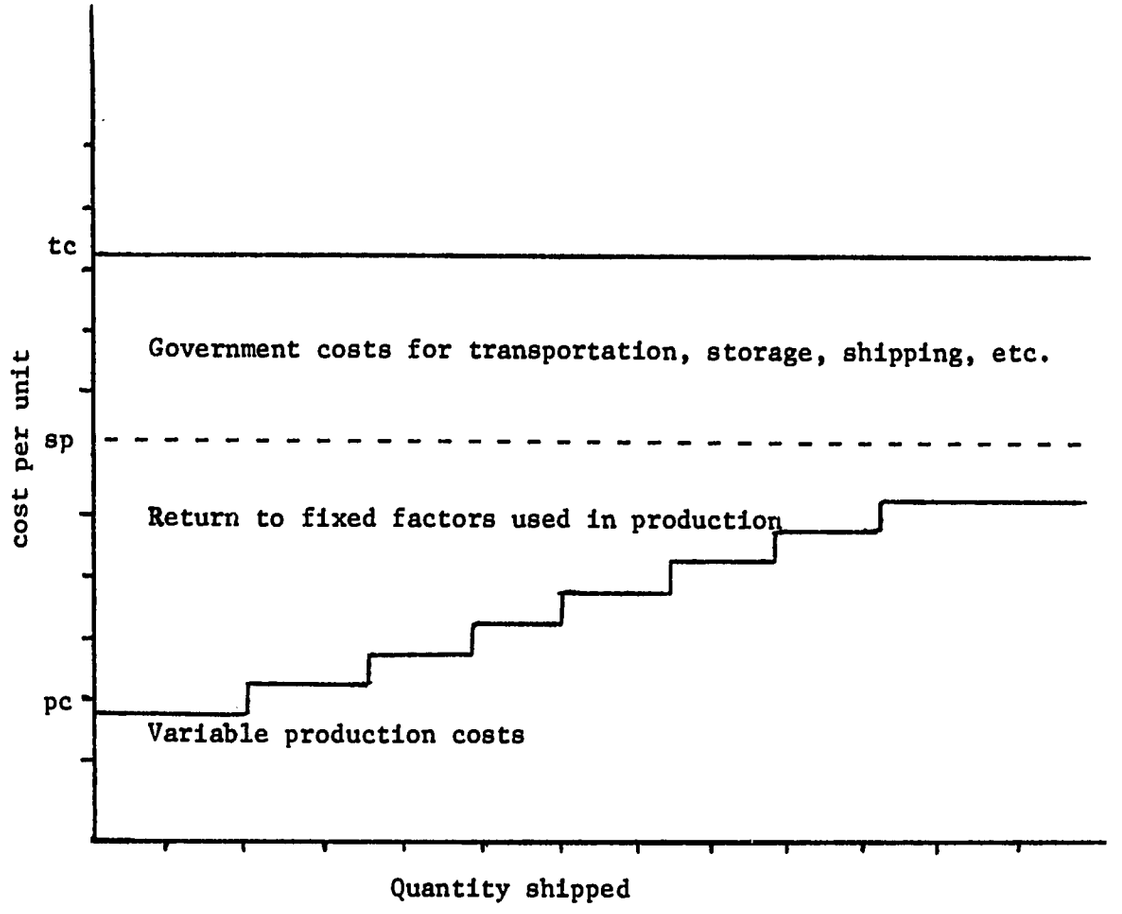

Figure 2. Simulated cost estimates of P.L. 480 shipments

Table 9. Quantities pf major commodities and costs incurred for purchase and shipment of commodities under P.L. 480 programs for the fiscal years, 1966-68.

Commodity and Fiscal Year	Total Quantity Shipped 1/	Costs incurred for: Commodity Purchase	Ocean Transportation	Export Payment	Other Costs	Total Costs
Wheat	(Thousand bushels)		(Thousand Dollars)			
1968	362,987	597,202	83,885	16,611	---	697,698
1967	273,269	511,525	8,392	43,181	48,016	611,114
1966	485,075	803,714	99,847	214,694	150,166	1,268,421
3-Yr. Ave.						
Quantity	373,403	636,843	63,977	91,404	65,995	858,219
Cost/Bu.	---	$1.71	.17	.24	.18	2.30
Feed Grains	(Thousand Tons)					
1968	1,952	95,758	8,607	---	---	104,365
1967	3,844	195,715	29,579	---	91,168	316,462
1966	2,007	101,910	11,723	---	4,803	118,432
3-Yr. Ave.						
Quantity	2,598	130,997	16,620	---	31,958	179,573
Cost/Bu.	---	$1.41	.18	---	.34	1.93
Cotton	(Bales)					
1968	955,212	119,591	980	---	---	120,572
1967	1,189,482	142,774	1,618	2,153	759	147,304
1966	625,745	78,283	553	13,940	10,422	103,198
3-Yr. Ave.						
Quantity	922,556	113,436	1,049	5,359	3,723	123,568
Cost/lb.	---	$0.246	0.002	0.012	0.008	0.268

1/ Includes sales for foreign currency, sales for dollars on credit terms and disposition under Title II except commodities in prepared form (rolled oats, rolled wheat, etc.). The costs for the latter items are not included in the totals given.

As described above the parametric programming techniques used in conjunction with the model provide two types of simultaneous variation: one variation allows a discrete change in the quantities of the food aid demand vector; the second variation allows for a discrete change in the shipping cost vector. The practical significance is that this combination of changes in the model allow simulation of real world conditions for production, government purchase and eventual shipment of commodities to overseas destinations under P.L. 480 programs.

Recipient Countries

Countries included in the study were chosen based on past records of receiving food aid under P.L. 480 programs and on their location throughout the world. An effort was made to establish a recipient country in all major areas of the world (See Figure 3). The analysis assumes that as food shipments are expanded, each of the countries receives a fixed proportion of each increment based on the programmed quantities of wheat, feed grains and cotton under agreements signed with these countries in the period 1966-68. For example, an average of 323 million bushels of wheat were programmed for shipment under Title I of P.L. 480 during 1966-68 (Table 10). In distributing the incremental quantities, the proportion received by each nation during this period was held constant. For wheat India receives 52.6 percent and Pakistan 10.6 percent. For feed grains, India and Pakistan receive 62.0 and 6.4 percent respectively. Cotton programmed for shipment under Title I of P.L. 480 was distributed somewhat differently. Korea was scheduled to receive 30.0 percent with India receiving 24.0 percent. Taiwan received

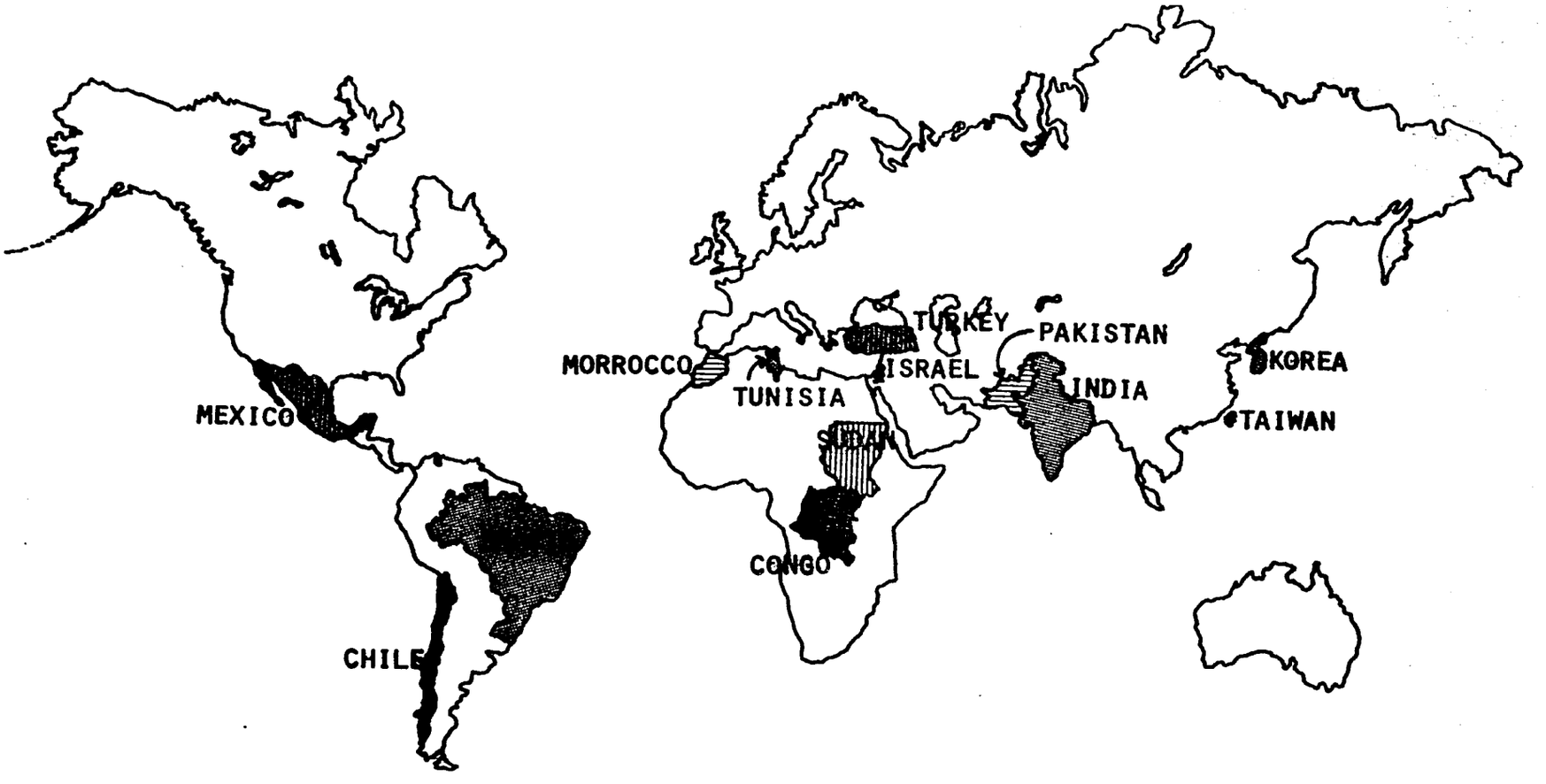

Figure 3. Location of major recipient countries under P.L. 480 programs.

Table 10 . Average quantities of commodities programmed under agreements for calendar years 1966-68 and percent received by the specified countries under Title I, P.L. 480.[1/]

Country	WHEAT		FEED GRAINS[2/]		COTTON	
	1966-68 Average	Percent	1966-68 Average	Percent	1966-68 Average	Percent
	(Thousand bushels)		(Thousand bushels)		(Thousand bushels)	
All Countries	323,149	100.0	91,752	100.0	1,012.3	100.0
Congo	1,498	0.5	341	0.4	22.3	2.2
Morrocco	8,308	2.6	---	---	12.9	1.3
Sudan	3,488	1.1	---	---	---	---
Tunisia	2,204	0.7	1,583	1.7	7.7	0.8
India	170,075	52.6	56,907	62.0	243.3	24.0
Pakistan	34,405	10.6	5,905	6.4	7.7	0.8
Korea	11,204	3.5	1,088	1.2	303.3	30.0
Taiwan	---	---	---	---	66.7	6.6
Brazil	24,496	7.6	---	---	---	---
Chile	1,470	0.5	984	1.1	30.0	3.0
Mexico	---	---	---	---	---	---
Others	66,002	20.4	24,945	27.2	318.4	31.4

Source: The While House. Annual Report on P.L. 480 for 1966, 1967 and 1968.

1/ Includes Title I and Title IV shipments for 1966.

2/ Feed grains include the following quantities (1,000 bu.):

	1966-68 Average
Corn	22,933
Barley	1,239
Oats	23
Grain Sorghum	67,557
Total	91,752

6.6 percent of these shipments. Altogether, an average of 91.8 million bushels of feed grains and 1.0 million bales of cotton were programmed under P.L. 480 programs in each year between 1966 and 1968.

One country was included in the analysis even though no commodities were programmed during the period 1966-68. Mexico was included to provide an estimate of the price differential resulting from international shipping costs for feed grains. Mexico has received a small amount of feed grains under P.L. 480 programs since their inception in 1954.[1/]

Estimated Costs of Individual Commodities for P.L. 480 Programs

The estimated cost of providing quantities of wheat, feed grains and cotton to each specified country is reported in the following sections. These estimated net costs take into account the "savings" which result from no longer retiring the cropland which is used to produce for shipment under P.L. 480 programs and is based on the concept of net opportunity cost.[2/] As explained previously, under present political realities the net cost of crop production per-acre on marginal acres is total cost less the cost of retiring the acre under a government program. As more acres are retired, the cost of retiring cropland increases and the net cost of using the cropland for producing the commodity decreases if production costs are stable. As net cost of using cropland decreases the estimated

1/ For quantities shipped to each country, see the Annual Report on Public Law 480 published annually by The White House since 1964 and semi-annually between 1954 and 1964.

2/ For an explanation of the concept of opportunity cost in the linear programming framework, see Earl O. Heady and Wilfred Chandler, Linear Programming Methods. Iowa State University Press, Ames, Iowa 1958. pp. 21-26.

costs for providing units of food commodities for P.L. 480 programs also decrease as is shown later. These estimated costs include all activities necessary to provide a unit of each commodity to a specified country. Per unit costs are derived for the marginal unit of production -- that unit which is produced after domestic and commercial export demand is satisfied. Each set of costs is based on the assumption that a particular type of land retirement program is used to control aggregate production. The type of land retirement program is important because differences exist between programs for costs of retiring an acre of cropland. Three types of land retirement programs are considered.

Net Costs with Long Range Land Retirement, No Restrictions

The per unit cost of wheat, feed grains and cotton for P.L. 480 programs is estimated first under a food aid program where wheat shipments vary from zero to 7.0 million bales, and a land retirement program retires cropland from production for an extended period of time with the location of acres retired based on comparative advantage; no restriction is placed on the number or proportion of acres retired in any production area.[1/] Acres are retired in the most marginal areas of production with the program payment based on the estimated net return above all costs of crop production except land taxes.

1/ Limitations on the amount of land retirement in any production area have been shown to have considerable effect both on the total cost of retiring cropland and on the rural communities affected by the program. The latter grows out of the tendency for marginal cropland to be concentrated in particular areas, i.e., the Great Plains, and the Southeastern states. For an analysis of this effect, see Earl O. Heady and Norman K. Whittlesey, A Programming Analysis of Interregional Competition and Surplus Capacity or American Agriculture in the United States in 1980. Research Bulletin 538, Iowa State University of Science and Technology, July, 1965, Ames, Iowa.

Net costs per unit of each commodity under this type of land retirement program are specified in Table 11. At the initial level, 75 million bushels of wheat are shipped under P.L. 480 programs with an estimated net cost of $1.40 per bushel. As shipments expand, the cost per bushel rises. The cause of this increase is somewhat complex. As we pointed out earlier, the total government cost of purchase and shipment of a unit of a commodity is maintained at a constant level by the model. To hold this cost constant, the differential between the support price and production costs is reduced as the cost of producing a unit increases (See Figure 3). Consequently, since this cost is constant, the variation in cost results from the change in cost per acre of land retirement. As each additional acre is returned to production for shipment under P.L. 480 programs, the number of acres of cropland retired is decreased. But of greater importance, each consecutive acre brought back into production has a lower net return and consequently a smaller cost for retiring it from production.[1/] Hence, the increasing cost of each additional unit shipped under P.L. 480 results because the "savings" from removing this cropland from the government land retirement program diminishes. As this value declines, the net cost of each unit of food shipped increases.

The net cost of providing wheat in this economic environment rises to $2.01 when 525 million bushels of wheat are shipped compared to a gross CCC cost of $2.30 per bushel for the wheat shipped under P.L. 480

1/ The cost per acre of land retired increases as more and more acres are retired since more productive cropland must be brought into the program with each increase. In reverse order, as crop production is expanded, the retirement cost per acre of land returned to production will decline. The "savings" from this source will decline, increasing the net cost per unit of food aid.

Table 11. Estimated net total cost per unit for commodities provided to recipient countries under P.L. 480 programs assuming the United States employs a long-range land retirement program with no limits on retirement in any production area.

Recipient Country or Area	Level of P.L. 480 Shipments[1]							
	0	1	2	3	4	5	6	7
				Wheat Per Bushel				
Average.....	0	1.40	1.60	1.71	1.74	1.80	1.89	2.01
Brazil.....	0	1.33	1.53	1.64	1.67	1.73	1.82	1.96
Morrocco.....	0	1.35	1.55	1.66	1.69	1.75	1.84	1.98
India-Pakistan...	0	1.41	1.61	1.72	1.75	1.81	1.90	2.04
Turkey.....	0	1.40	1.60	1.70	1.73	1.79	1.88	2.03
Korea.....	0	1.38	1.58	1.69	1.72	1.78	1.87	2.01
				Feed Grains Per Bushel[2]				
Average.....	0	1.57	1.58	1.59	1.61	1.67	1.68	1.68
Mexico.....	0	1.42	1.44	1.44	1.46	1.52	1.53	1.53
Chile.....	0	1.58	1.59	1.60	1.62	1.68	1.69	1.69
Tunisia.....	0	1.51	1.53	1.53	1.55	1.61	1.62	1.62
Sudan.....	0	1.61	1.63	1.63	1.66	1.72	1.72	1.73
India-Pakistan...	0	1.58	1.59	1.60	1.62	1.68	1.69	1.69
Isreal.....	0	1.52	1.54	1.54	1.57	1.63	1.64	1.64
Korea.....	0	1.54	1.56	1.56	1.58	1.64	1.65	1.65
				Cotton Per Pound				
Average.....	0	20.0	20.6	20.6	21.5	22.2	22.8	25.5
Chile.....	0	20.1	20.6	20.6	21.5	22.2	22.8	25.5
Congo.....	0	20.1	20.7	20.7	21.6	22.3	22.9	25.6
India-Pakistan...	0	20.1	20.6	20.7	21.5	22.2	22.8	25.6
Korea-Taiwan.....	0	20.0	20.6	20.6	21.5	22.2	22.8	25.5

1/ Quantities are (mil. bu. wheat; mil. tons feed grains; mil. bales cotton):

Wheat	0	75	150	225	300	375	425	525
Feed Grains	0	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Cotton	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0

2/ Feed grain price is per bushel of corn or equivalent nutritive value of other feed grain.

programs during 1966-68 (Table 9). The increase from $1.40 at 75 million bushels of wheat to $2.01 at 525 million bushels indicates the magnitude of decrease in land retirement costs as shipments of wheat are increased. The differential of $0.90 per bushel ($2.30 - $1.40) between gross and net costs at the low level of shipments indicates that each bushel of wheat not produced by retiring cropland would cost this amount of government expenditure. For an average acre with a projected yield of 30 bushels per acre, this implies that retiring an acre of cropland would cost $27.00. At the maximum level of wheat shipments, the differential is $0.29 per bushel ($2.30 - $2.01). Assuming the same level of yield, the estimated cost of land retirement is only $8.70 per acre indicating more marginal acres are retired at the larger level of production.

The net cost of feed grains is estimated at $1.57 per bushel of corn when 1.5 million tons are shipped and rises to $1.68 when a total of 10.5 million tons are shipped.[1/] This cost compares to an average total CCC cost of $1.93 per bushel incurred for feed grains shipped for the years 1966-68. The small change in net cost per bushel of feed grains implies that the cost of land retirement remains relatively constant over this magnitude of change in acreages harvested. One reason for this is the relatively small size of feed grains shipments. Even at the maximum level, 10.5 million tons, less than 6 percent of total feed grain production would be exported under P.L. 480 programs. This amount of feed grains would use only slightly more than 5 million acres of cropland if the average yield is 2.0 tons per

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1/ Feed grains prices are measured in terms of corn although other kinds of feed grains are also shipped.

The net cost of cotton ranges from $0.20 per pound for 1.0 million bales of cotton to $0.25 per pound for 7.0 million bales. This compares an average cost of $0.268 per pound for shipments from 1966 through 1968. The greater rise in cost per pound of cotton than for feed grains indicates that the cost of land retirement in cotton areas fluctuates more than it does in feed grain areas. Also, the 7.0 million bales level of cotton shipments represents 40 percent of total production. This level is well in excess of recent levels of cotton exports under P.L. 480 programs. It would require that nearly all land available for cotton be returned to production. At that point, almost no savings would occur from reduced land retirement and hence the cost of cotton per pound of lint approaches the gross cost of these shipments.

Net Costs with Long Range Land Retirement, with Restrictions

A second type of government program examined would ship the same quantities of wheat, feed grains and cottonlint with this limitation placed on the land retirement program: No more than 50 percent of total cropland can be retired in any production region. Acres retired are spread over more production area; land with a higher net return from crop production (and a higher cost for retirement) is retired. Consequently, the cost of retirement increases but this results in a decrease (compared to the previous program) in cost per unit for P.L. 480 programs.

Estimates of net cost per unit of wheat, feed grains and cotton are specified in Table 12 for this type of land retirement program. The net cost of wheat is $1.29 per bushel (compared to $1.40 with the previous program) with shipments of 75 million bushels. As shipments expand, the cost per bushel increases and reaches $1.71 at 525 million bushels. The

Table 12. Estimated net total cost per unit of commodities provided to specified countries under P.L. 480 programs assuming the United States employs a long-range land retirement program with a 50 percent limit on retirement in any production area.

Recipient Country or Area	Level of P.L. 480 Shipments[1/]							
	0	1	2	3	4	5	6	7
				Wheat Per Bushel				
Average.....	0	1.29	1.34	1.47	1.59	1.59	1.61	1.71
Brazil.....	0	1.22	1.27	1.40	1.52	1.52	1.54	1.63
Morrocco.....	0	1.24	1.29	1.42	1.54	1.54	1.56	1.66
India-Pakistan...	0	1.30	1.35	1.48	1.60	1.60	1.62	1.72
Turkey.....	0	1.29	1.34	1.47	1.59	1.59	1.61	1.70
Korea.....	0	1.28	1.32	1.45	1.57	1.57	1.59	1.69
				Feed Grains Per Bushel[2/]				
Average.....	0	1.43	1.46	1.48	1.49	1.56	1.56	1.57
Mexico.....	0	1.28	1.32	1.33	1.34	1.41	1.41	1.42
Chile.....	0	1.44	1.47	1.49	1.50	1.57	1.57	1.58
Tunisia.....	0	1.37	1.40	1.42	1.43	1.50	1.50	1.51
Sudan.....	0	1.48	1.51	1.52	1.53	1.61	1.61	1.61
India-Pakistan...	0	1.44	1.47	1.49	1.50	1.57	1.57	1.58
Isreal.....	0	1.39	1.42	1.44	1.44	1.52	1.52	1.52
Korea.....	0	1.40	1.43	1.45	1.46	1.53	1.53	1.54
				Cotton Per Pound				
Average.....	0	18.9	20.0	20.0	20.6	20.6	21.4	23.4
Chile.....	0	18.9	20.1	20.1	20.7	20.7	21.4	23.5
Congo.....	0	19.0	20.1	20.1	20.7	20.7	21.5	23.5
India-Pakistan...	0	18.9	20.1	20.1	20.7	20.7	21.4	23.5
Korea-Taiwan.....	0	18.9	20.0	20.0	20.6	20.6	21.4	23.4

1/ Quantities are (mil. bu. wheat; mil. tons feed grains; mil. bales cotton):

Wheat	0	75	150	225	300	375	425	525
Feed Grains	0	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Cotton	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0

2/ Feed grain price is per bushel of corn or equivalent nutritive value of other feed grain.

individual country estimates point up the location aspect of cost; shipments to Brazil have an estimated cost of $1.22 per bushel when shipments are 75 million bushels and increase to $1.63 at the maximum level considered. Shipments to India-Pakistan are the most costly considered, ranging from $1.30 to $1.72 per bushel. These differences are due to the estimated transportation cost differentials of shipping to alternative countries.

Feed grain costs are lower than the previous model, varying on average from $1.43 per bushel to $1.57 per bushel. Feed grain shipments vary from 1.5 to 10.5 million tons. Mexico has the lowest cost for shipments while the Sudan has the highest cost per bushel provided. Again these cost differences are due to the estimated cost differentials for international transportation.

Costs for cotton for this type of program rise from $0.189 per pound to $0.234 per pound. Cotton costs are somewhat different from either wheat or feed grains in that transportation and other costs are a smaller proportion of total costs. Wheat costs under P.L. 480 programs in 1966-68 were broken down into 74.3 percent commodity purchase and 25.7 percent transportation and other costs. Feed grains costs were similar with commodity purchase accounting for 73.1 percent of total costs per unit. Cotton has a lower proportion of costs for transportation and other items, however. For cotton 91.8 percent of all costs in 1966-68 were for commodity purchase with only 8.2 percent for transportation, export payments and other costs. The lower costs for cotton for these other items primarily result because support prices for cotton are competitive with world market prices and hence only minor export payments are required.

Costs for transportation for all commodities have been reduced because "an amendment to Public Law 480 signed October 8, 1964, included a provision climinating local currency financing of ocean transportation in U.S. flag vessels. Now only the differential between U.S. and foreign flag rates is paid by CCC where commodities are required to be transported in U.S. veseels."[1/] As a result of these changes there is a smaller differential in price among different countries receiving commodities under P.L. 480 programs.

Net Costs with Annual Land Retirement-Direct Payment Type Programs

The final program of commodity shipments considered is based on land retirement programs which individually retire cropland from wheat, feed grains and cotton on an annual basis with direct payments to producers on a portion of production as an incentive to participate. This type program is similar to those in effect for feed grains since 1961 and for other crops after 1965-66. Costs per acre for retirement of cropland are based on actual data from these programs; costs are higher than for previous programs. These higher costs result primarily because under an annual program, producers still retain all factors of production necessary to operate their firm at full capacity. Retaining these factors of production results in producers incurring costs for depreciation and underemployed labor. Payments for land retirement must cover these costs to gain participation of producers. Hence the payment per acre for this

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1/ The annual report of the President on activities carried out under Public Law 480, 83rd Congress, as amended, during the period January 1 through December 1964. 89th Congress, 1st Session, House Document 130. Washington, D.C. 1965.

type of program will be larger than for a long range program where excess factors of production can be sold and excess labor employed in other pursuits.

Costs for shipping wheat and other commodities to recipient countries under P.L. 480 programs with this type of program are given in Table 13. The initial 75 million bushels of wheat are estimated to costs $0.08 per bushel under this type of program. Costs rise with shipments between 75 and 150 million bushels, reaching $0.50 per bushel. At the maximum level considered, 525 million bushels, the net cost per bushel is $1.31. These data indicate that the net cost of wheat shipments under P.L. 480 programs is relatively low when measured against the high cost of retiring land under the type of programs used to control production and maintain returns to producers of wheat in recent years. Likewise, these costs indicate that shipments of wheat have a mucher lower net cost than gross costs incurred by CCC would suggest. While the gross cost for each bushel of wheat shipped under P.L. 480 in 1966-68 was $2.30, there is a clear indication that retiring all of these same acres would have cost nearly as much had these shipments not been made, particularly for the initial 100 million bushels. At the average level of shipment for 1966-68, 373.4 million bushels, the average net cost is estimated at $1.13 per bushel, approximately 49 percent of the gross cost of shipments.

Estimated costs for feed grain shipments with annual land retirement programs are lower than either program previously considered, although not as significantly as wheat. At an initial level of 1.5 million

Table 13. Estimated net total cost per unit for commodities provided to recipient countries under P.L. 480 programs assumming the United States employs annual land retirement-direct payment type programs for wheat, feed grains and cotton.

Recipient Country or Area	Level of P.L. 480 Shipments[1/]							
	0	1	2	3	4	5	6	7
				Wheat Per Bushel				
Average.....	0	.08	.50	.87	1.05	1.13	1.27	1.31
Brazil.....	0	.00	.42	.79	.97	1.05	1.19	1.23
Morrocco.....	0	.02	.44	.81	.99	1.07	1.21	1.25
India-Pakistan..	0	.09	.51	.89	1.06	1.14	1.28	1.32
Turkey.....	0	.05	.54	.84	1.02	1.10	1.24	1.28
Korea.....	0	.05	.57	.84	1.02	1.10	1.24	1.28
				Feed Grains Per Bushel[2/]				
Average.....	0	1.08	1.10	1.15	1.17	1.32	1.34	1.34
Mexico.....	0	.93	.95	1.01	1.03	1.17	1.19	1.19
Chile.....	0	1.09	1.10	1.16	1.18	1.32	1.34	1.34
Tunisia.....	0	1.02	1.04	1.10	1.12	1.26	1.28	1.28
Sudan.....	0	1.13	1.14	1.20	1.22	1.36	1.38	1.38
India-Pakistan..	0	1.09	1.11	1.16	1.18	1.33	1.35	1.35
Isreal.....	0	1.04	1.05	1.11	1.13	1.27	1.29	1.29
Korea.....	0	1.05	1.07	1.12	1.14	1.29	1.31	1.31
				Cotton Per Pound				
Average.....	0	13.8	16.8	17.2	17.2	17.7	18.2	19.2
Chile.....	0	13.8	16.8	17.2	17.2	17.7	18.2	19.2
Congo.....	0	13.8	16.8	17.2	17.3	17.8	18.2	19.2
India-Pakistan..	0	13.8	16.8	17.2	17.2	17.7	18.2	19.2
Korea-Taiwan....	0	13.7	16.7	17.1	17.2	17.7	18.2	19.1

1/ Quantities are (mil. bu. wheat; mil. tons feed grains; mil. bales cotton):

Wheat	0	75	150	225	300	375	425	525
Feed Grains	0	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Cotton	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0

2/ Feed grain price is per bushel of corn or equivalent nutritive value of other feed grain.

tons, the cost is estimated at $1.08 per bushel, approximately 75 percent of the previous program. As shipments increase, costs per bushel increase, reaching $1.34 per bushel at 10.5 million tons of feed grains.

The net cost of cotton shipped under P.L. 480 programs is also lower for this type program. Cotton costs at 1.0 million bales are estimated to be 13.8 cents per pound of cottonlint, which is 73 percent of the previous program cost. As shipments expand, costs increase and reach 19.2 cents per pound of lint at 7.0 million bales.

The estimated costs for all commodities considered with this type of land retirement program are considerably lower than for the previous programs. These lower costs result from the higher costs for retiring land with annual retirement programs.[1/]

Guidelines for Pricing P.L. 480 Commodities

The estimated per unit cost of P.L. 480 shipments specified above for each alternative land retirement program is based on actual costs incurred for commodities programmed under these programs during 1966-68. These costs are subject to change over time due to changes in price support levels, proportion of international transportation costs borne by the Commodity Credit Corporation, and world prices of these commodities. The latter prices determine to a large extent the level of export subsidy

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1/ For a discription of the changes in quantities of cropland used and retired at each level of shipment for the three types of land retirement programs, see Appendix B of the report.

necessary to make these commodities competitive in world markets. Since these costs are specific to a past period, an attempt is made to make these estimated costs more applicable to future pricing of P.L. 480 commodities.

To develop this type of guideline for pricing of future shipments, the estimated net average cost for commodities for each alternative land retirement program is compared with the gross CCC costs for the period 1966-68. This ratio,

$$\frac{\text{Estimated Net Cost}}{\text{Gross CCC Cost}}(100) = \text{Pricing Coefficient} \qquad (20)$$

provides an estimate of the percent of gross costs to be charged for P.L. 480 shipments given (1) the type of land retirement program actually in use at a particular time, and (2) the actual CCC costs of food aid commodities.

In Table 14, the Pricing Coefficients (PC) are summarized for the three types of land retirement programs examined. The PC vary according to the level of shipment, the particular commodity shipped and the land retirement program. For wheat, the PC varies from 3.5 with an annual land retirement program and a shipment of 75 million bushels of wheat, to 87.4 with a long range retirement program and 525 million bushels. The PC for annual programs are considerably lower for all levels of wheat shipments than for other programs. This result is expected given the lower estimated costs of commodities for this type program (Table 13).

The Pricing Coefficients for feed grains and cotton are generally higher than for wheat for a similar shipment level and land retirement program. These results suggest, given the criteria and political realities

Table 14. Estimated proportion net opportunity cost is of gross CCC costs for shipments of wheat, feed grains and cotton during 1966-68, under alternative supply control programs 1/

Type of Land Retirement Program	Level of P.L. 480 Shipments 2/						
	1	2	3	4	5	6	7
				WHEAT			
Long Range Retirement No Restrictions	60.9	69.6	74.3	75.7	78.3	82.2	87.4
Long Range Retirement 50% Restrictions	56.1	58.3	63.9	69.1	69.1	70.0	74.3
Annual Land Retirement Direct Payments	3.5	21.7	37.8	45.7	49.1	55.2	57.0
				FEED GRAINS			
Long Range Retirement No Restrictions	81.3	81.9	82.4	83.4	86.5	87.0	87.0
Long Range Retirement 50% Restrictions	74.1	75.6	76.7	77.2	80.8	80.8	81.3
Annual Land Retirement Direct Payments	56.0	57.0	59.6	60.6	68.4	69.4	69.4
				COTTON			
Long Range Retirement No Restrictions	74.6	76.9	76.9	80.2	82.8	85.1	95.1
Long Range Retirement 50% Restrictions	70.5	74.6	74.6	76.9	76.9	79.8	87.3
Annual Land Retirement Direct Payments	51.5	62.7	64.2	64.2	66.0	67.9	71.6

1/ Gross CCC costs in 1966-68 are $2.30 per bushel of wheat, $1.93 per bushel of feed grains, and 26.8 cents per pound of cotton (Table 9).

2/ Quantities are (mil. bu. wheat; mil. tons feed grains; mil. bales cotton):

Wheat	75	150	225	300	375	425	525
Feed Grains	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Cotton	1.0	2.0	3.0	4.0	5.0	6.0	7.0

explained earlier, that shipments of feed grains are optimally priced if the return is 81.3 percent of the CCC cost when 1.5 million tons are shipped and a long range land retirement program is used to control aggregate production. For the same level of shipment, feed grains shipments priced at 56.0 percent of their CCC cost are optimal if annual programs with direct payments are used to control production. For these respective programs, these percentages rise to 87.0 percent and 69.4 percent of CCC costs at the maximum level of shipments.

The PC for cotton with a 1.0 million bale shipment varies from 74.6 with a long range land retirement program to 51.5 with an annual land retirement program. These coefficients increase to 95.1 with the long range program when 7.0 million bales are shipped and 71.6 when annual programs are used with this level of shipment. During the period 1966-68, an average of 1.0 million bales of cotton were programmed for shipment to recipient countries under P.L. 480 programs.

To conclude this discussion on pricing levels and provide comparisons with actual data, we have calculated the actual levels of cost recovery for commodities programmed for shipment between 1966-68. While data are not available for the individual commodities as we might like, data are available on the proportion of gross CCC costs recovered in contracts signed between 1966 and 1968. To calculate these proportions the export market value of P.L. 480 shipments is compared with the CCC costs of these shipments. These results indicate a sharply rising trend after 1965. From a level of 60.0 percent in 1965, the level of cost recovery rose to 69.5 in 1966, to 80.9 in 1967, and 84.7 in 1968.

To test these recovery rates against those which would exist if the pricing levels derived earlier in this study were uses, we calculated for wheat, feed grains and cotton the level of recovery with the concept of net cost applied to pricing. For these estimates pricing coefficients from Table 14 were weighed with the proportion of wheat, feed grains and cotton actually programmed for shipment in each year between 1966 and 1968.[1/] The following comparisons were derived for the period 1966-68:

	Estimated	Actual
1966	54.9	69.5
1967	50.0	80.9
1968	39.4	84.7

In all cases the proportions derived using the results of this study are well below the actual levels of cost recovery. As costs for land retirement rose in 1967 and 1968, the net costs of potential food shipments declined. Actual recovery rates went up however. These data indicate that in the years specified, the level of pricing was substantially above levels indicated from the analysis in this study.

1/ The procedure used was:

$$\sum_{i-1}^{3} P_{ikt} PC_{ikn} = PC_t$$

where P_{ikt} is the proportion that the i-th crop is of the total value of feed grains, and cotton shipped in the t-th year when the k-th government program is used to control aggregate production, PC_{ikn} is the estimated Pricing Coefficient for the i-th crop assuming the k-th crop assuming the k-th government program is used and the n-th level of commodity is shipped, and PC_t is the estimated avcrage Pricing Coefficient that would have been optimized the pricing of commodities in the t-th year.

Other Considerations in Commodity Pricing For P.L. 480

The foregoing results raise many questions as to the appropriate level of prices to be charged for commodities shipped under P.L. 480 programs. There are of course many considerations involved in deciding upon a set of final prices to be charged. Some of these considerations arise from the standpoint of the supplying nation - for example what quantity of stocks does it have available. This issue was prevalent in the years immediately following the Korean conflict. Large stocks of grain commodities become available as price support programs resulted in large amounts of grain and fiber flowing into government bins. Stocks levels climbed 16.2 percent between 1954 and 1955 and continued rising in 1956 (Table 15). After a temporary drop in 1957, stocks continued to increase and the level of cost recovery of P.L. 480 shipments dropped from 70.1 percent in 1955 to a low of 58.7 percent in 1961.

The pressure to reduce stocks through overseas shipment was clearly noted by John Davis in 1958. He suggested that "the objective most emphasized by the proponents of Public Law 480 in 1954 was the disposal of United States farm surpluses, which at the time were accumulating in the hands of Commodity Credit Corporation at the rate of almost $3 billion per year."[1/] Over the decade after 1954, considerable debate ranged on whether this was in fact the major function of P.L. 480 programs. Given a decade and a half of operation of P.L. 480 programs, it is now possible to observe more closely what relationship has existed between storage

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1/ John H. Davis, Surplus Disposal as a Tool for World Development -- Objectives and Accomplishments. Journal of Farm Economics. Vol. 40. p. 1484.

Table 15. Level of carryover stocks and the proportion of CCC costs recovered in programmed shipments under P.L. 480 programs, 1955-68.

Year	Index of Carryover Stocks 1/	Actual Cost Recovery Coefficients 2/	Year	Index of Carryover Stocks 1/	Actual Cost Recovery Coefficients 2/
	(1954=100)	(percent)		(1954=100)	(percent)
1950	68.7	---	1960	150.1	59.7
1951	51.3	---	1961	162.8	58.7
1952	38.9	---	1962	148.8	63.5
1953	68.8	---	1963	147.0	56.6
1954	100.0	---	1964	143.7	66.2
1955	116.2	70.1	1965	132.4	60.0
1956	130.7	59.7	1966	117.1	69.5
1957	120.7	60.1	1967	93.5	80.9
1958	121.0	65.0	1968	89.9	84.7
1969	146.7	65.1			

Source: Semiannual Report on Public Law 480, 1954-1963; Annual Report on Public Law 480, 1964-1968. Washington, D.C.

1/ The index of carryover stocks of wheat, feed grains and cotton is calculated using the ratio: $\frac{P_{ij}Q_{ij}}{P_{i54}Q_{i54}}$ (100) where i = crops, j = year with 54 = 1954. The price weights (P_{ij}) are average prices received by farmers in 1954.

2/ Calculated as the $\frac{\text{Export market value of P.L. 480 shipments}}{\text{Estimated CCC costs for commodities}}$.

stocks and program operations. This we have done using data in Table 15 and a simple statistical test to find the relationship between them.[1/] In this case the test substantiated that an inverse relationship existed in the past between storage stocks and prices charged. As grain stocks increased, cost recovery decreased and as stocks decreased, cost recovery increased. That this issue was still prevelant in recent policy considerations can be seen by looking at data on cost recovery in the 1966-68 period when large shipments sharply reduced stocks; cost recovery levels rose. There would seem to be considerable question as to the appropriateness of basing pricing of food shipments on stock levels. Food shipments can likelyhave a positive effect on development of recipient countries if it if programmed in a manner designed for this purpose. But using the criterion of storage stock levels does not seem the most useful tool available for this purpose.

This question of development effects of aid policies was further raised after passage of Food Aid Act of 1966. The new act placed a major emphasis on assuring "...a progressive transition from sales for foreign currencies to sales for dollars (or to the extent that transition to sales for dollars under the terms applicable to such sales is not possible, transition to sales for dollars under the terms applicable to such sales is not possible, transition to sales for foreign currencies on creidt terms no less favorable to the United States than those for development loans under section 201 of the Foreign Assistance Act of 1961,

1/ To measure the relationship between carryover stocks and the prices charged recipient countries for these commodities a simple correlation test was used. The correlation coefficient had a value of -.66 which is significant at the .99 probability level.

as amended, and on terms which permit conversion to dollars at the exchange rate applicable to the sales management) at a rate whereby the transition can be completed by December 31, 1971".[1/] For most if not all countries, this change represented a hardening of terms under which P.L. 480 shipments were received and increased difficulty in their long run balance of payment position. For most if not all recipient countries, this hardening of terms may well represent an increased burden of deb repayment which could endanger the whole process of development. This point has been made by another analyst of the f food needs of developing countries. Kreistensen[2/] after reviewing future trade and aid potentials concluded:

> "It appears from the foregoing (analysis) that at least for the next one or two decades to come rising imports of food and fertilizer are likely to be a heavy burden on the balance of payments of a number of developing countries, including some of the most populous ones. At the same time the annual burden of the service of external debts is increasing fast in quite many of the countries."(p. 44).

He then went on to give glum appraisal of future possibilities for these countries as a result of their need for food coupled with their balance of payments problem.

> "... the years ahead may well prove to be a particularly difficult period in many developing countries. Later on it is conceivable that rising productivity and a slower population growth will make the situation easier but there exists a real danger that the whole development process may be jeopardised in the next, say, 10-15 years

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1/ Public Law 480 - 83rd Congress, "Agricultural Trade Development and Assistance Act of 1954", (68 Stat. 454) As amended through July 29, 1968.

2/ Thorkil Kristensen. The Food Problem of Developing Countries. Organization for Economic Cooperation and Development. Paris. December 1967.

> because food imports and debt service will require such a large share of the foreign exchange earnings of many countries that the necessary imports of capital goods for investment will not be possible if there is not an increasing inflow of capital from abroad." (p. 45).

And there would seem to be some possibility that the shift to credit terms with dollar repayments will tend to intensify the problem of debt repayment and even threaten more seriously the development potentials in several recipient countries. To offset this possibility, Kristensen argues,

> "what is needed is more aid at least until exports of the developing countries have risen sufficiently so that they can pay for all their imports, including food. The best solution would be to increase aid in the form of cash substantially in order to enable the receiving countries to decide what they want to buy. If it is easier to provide more aid in the form of food and if the receiving country would import food aid anyway, food aid may however, be one of the best instruments available in the foreseeable future." (P. 52).

It is this view of realities -- that continued food aid is more likely than substantially increased dollar aid -- that leads directly back to questions of food a d pricing. The shift to credit terms with dollar repayments can substantially reduce the aid element in food shipment under P.L. 480. This result may occur at the same time that net costs for this food are quite low because of the annual type supply control program which is employed. This lead to the need to consider food aid is a context including the total policy mix of the U.S. government -- both domestic policies for agriculture and foreign policies with developing nations. In this context there would seem to be considerable room for application of the concepts included in this study.

In addition considerations raised by domestic policy considerations there is also the issues of the value of these shipments

to recipient nations. If these commodities have a high marginal productivity in these countries and hence add considerably to economic growth and development, the charging of full cost prices could be generally justified. But there are some strong views that this is not the case. Schultz concluded the following as early as 1960.[1/]

1. "CCC costs of P.L. 480 products appears to me to have been in the neighborgood of twice the value of these products had they been sold freely in world markets".
2. "Costs of the United States of P.L. 480 products measured in terms of marginal revenue foregone from foreign sales may have been zero provided we treat our farm programs and agricultural production as a constant".
3. "The value of P.L. 480 products to the countries receiving them has been perhaps about 37 cents for each dollar of CCC costs".
4. "Accordingly, under conditions set forth in (2) and (3) above, there is a substantial range for negotiating P.L. 480 transactions, inasmuch as the value to the recipient country is about 37 cents per dollar of CCC costs and the costs to us in earnings foregone may be zero, on the shaky grounds assumptions that we will not improve on our agricultural policies".

Schultz's estimate of the value of P.L. 480 shipments was made during a period of large surpluses when there was fairly general agreement that

1/ Theodore W. Schultz. Value of U.S. Farm Surpluses to Underdeveloped countries. Journal of Farm Economics December 1960. p. 1033.

had these commodities been moved into normal marketing channels, the price depression would have resulted in total revenue at least no larger and perhaps even smaller than with P.L. 480 shipments. But since 1966 surplus stocks have been removed and one can argue that we now must produce a given quantity each year for the P.L. 480 created market. Under these circumstances, it is no longer relevant to levy a zero cost for the commodities to the U.S. Instead, it is now true that the nation is in the position of either having to produce for this market or of having to bid the land away from farmers to keep stocks of farm commodities from increasing. Under these circumstances, the derived results of this study become especially relevant to the pricing of future sales of commodities under P.L. 480.

Summary and Conclusions

The empirical results of this study have shown clearly that the net cost of the U.S. is considerably lower than gross CCC costs would suggest. As estimated, they provide a "lower bound" for pricing future quantities of commodities since of course any lower return would mean that the U.S. could manage its agricultural capacity in a cheaper manner by retiring the land instead of producing and shipping the commodities. By contrast the "upper bound" is established by the gross CCC costs for these commodities and this level of prices would be relevant if the alternative use for the resources were idleness with zero cost or even alternative employment.

Given the empirical results and the pricing considerations outlined above, we can draw up certain conclusions from this study:

1. For the time interval during which the U.S. continues to support a policy of using all its institutionalized land resources either for crop production or for government-supported retirement, the appropriate level of costing for P.L. 480 products is considerably below gross CCC costs. Given the recent three-year extension of annual land retirement programs pricing for food aid programs should be reevaluated.

2. So long as P.L. 480 shipments meet the requirements of being additional to normal commercial imports, the price level for these shipments cannot be said to affect the competitive position of competitor nations and hence no international reaction should arise from the imposition of such a policy.

3. The major benefit of such a policy change will accrue to the recipient nations who will have to accept a reduced amount of long term credit and hence will have to repay a smaller total amount at some future date. The realities are probably such as to indicate that many countries will eventually find these terms to be a heavy burden on limited foreign earnings.

4. Finally, the objective of aid-in-kind should always be kept in mind. Such aid must have as its goal the improvement in the welfare of mankind, both in the short term through consumption of food itself and in the long run through the effects on economic development. To the extent that food shipments represent a larger portion of aid-in-kind and a smaller proportion of commercial sales for credit, the poorer nations may be genuinely helped to improve the lot of their poorer strata of consumers. Perhaps this larger amount of aid will add not only to their welfare but also to our own welfare in the year 2000.

APPENDIX A - THE MODEL

The model used for this study divides the U.S. into 150 crop producing areas and 31 demand regions. Each demand region includes one or more production areas. The following activities are defined for the model:

1. Crop production -- activities are defined for production of wheat, feed grains, soybeans and cotton in each production area to satisfy domestic and commercial export demand in the 31 demand regions; a separate set of activities is defined for production of wheat, feed grains and cotton for export under P.L. 480 programs.
2. Land retirement -- activities are defined for retiring from production cropland in each of the 150 crop production areas not required to satisfy domestic demand, commercial export demand, or shipments of wheat, feed grains or cotton under P.L. 480 programs.
3. Transportation -- activities are defined for inland transportation of wheat, feed grains and soybeans from points of production to point of domestic utilization in each of the 31 demand regions or the port of commercial export.
4. Shifting activities -- activities are defined for shifting wheat from food use to feed use within each of the 31 demand regions.
5. Shipping activities -- activities are defined for shipment of each commodity -- wheat, feed grains and cotton -- from the United States to each recipient country under P.L. 480 programs.

For each of the activities in the model an associated cost is estimated. Together these costs form the total cost function C where

$$C = \sum_{i=1}^{150}\sum_{j=1}^{4} c_{ij}X_{ij} + \sum_{i=1}^{150}\sum_{j=1}^{3} c_{ij}Z_{ij} + \sum_{i=1}^{150}\sum_{k=1}^{3} c_{ik}R_{ik} + \sum_{n=1}^{31}\sum_{\bar{n}=1}^{30}\sum_{j=1}^{3} c_{n\bar{n}j}T_{n\bar{n}j}$$

$$+ \sum_{n=1}^{31} c_{nj}S_{nj} + \sum_{r=1}^{7}\sum_{j=1}^{3} c_{rj}U_{rj} \qquad \text{(A-1)}$$

and X is crop production for domestic and commercial export

Z is crop production for shipment under P.L. 480 programs

R is land retirement under government programs

S is substitution of wheat for feed grains for feed use

T is inland transportation of commodities between demand regions

U is international shipping of food aid commodities, and

c is the per unit cost coefficient for each individual type activity.

The subscripts define the

i-th crop production area,

j-th crop produced within each crop production area,

k-th government program for retiring cropland,

n-th demand region shipping a given commodity to the $\bar{n}$-th region

$(n \neq \bar{n})$, and

r-th recipient country which receives food aid.

Domestic and commercial export demand is included in the models as a set of restraints which must be satisfied by the production activities. Demand for wheat, feed grains and soybeans is specified by the 31 demand regions defined for the United States. Demand for cotton is specified as an

aggregate for the United States. These demands form a set of restraints which require that

$$\sum_{i=1}^{m} a_{ij}X_{ij} - q_n S_n \pm \sum_{n=1}^{31} \sum_{\bar{n}=1}^{30} z_{n\bar{n}j}T_{n\bar{n}j} \geq D_{nj} \qquad \text{(A-2)}$$

(j=1 is wheat, n=1, 2...31)

$$\sum_{i=1}^{m} a_{ij}X_{ij} + q_{nj}S_{nj} \pm \sum_{n=1}^{31} \sum_{\bar{n}=1}^{30} z_{n\bar{n}j}T_{n\bar{n}j} \geq D_{nj} \qquad \text{(A-3)}$$

(j=2 is feed grains, n=1, 2...31)

$$\sum_{i=1}^{m} a_{ij}X_{ij} + \sum_{i=1}^{m} a_{ij}X_{ij} \pm \sum_{n=1}^{31} \sum_{\bar{n}=1}^{30} z_{n\bar{n}j}T_{n\bar{n}j} \geq D_{nj} \qquad \text{(A-4)}$$

(j=3 is soybean, n=1, 2...31)

$$\text{and} \quad \sum_{i=1}^{65} a_{ij}X_{ij} \geq D_j \qquad \text{(A-5)}$$

(j=4 is cotton)

where Equation A-2 expresses total demand for wheat for the n-th demand region,

Equation A-3 expresses total demand for feed grains for the n-th demand region,

Equation A-4 expresses total demand for oilmeals (supplied by both soybeans and cottonseed) for the n-th demand region, and

Equation A-5 expresses total demand for cotton lint.

where

m is the number of crop production areas within the n-th demand region

a is the output coefficient per unit of the j-th crop produced in the i-th region

q is the amount of wheat substituted for feed grains for each unit of the s-th activity

and

z is the quantity of each respective commodity transported between the n demand regions.

A second set of demand restraints define the level of shipments of commodities under P.L. 480 programs. In the model, demand for P.L. 480 shipments is expressed in two parts, one is an intermediate demand for major commodities prior to shipment to overseas destinations, and the second is the final demand of particular recipient countries. The intermediate demand restraints require that

$$\sum_{i=1}^{150} a_{ij} Z_{ij} \geq 0 \qquad \text{(A-6)}$$

where Z_{ij} is production of the j-th commodity in the i-th production area where

j = 1 is wheat

j = 2 is feed grains

j = 4 is cotton lint

These intermediate demands for food aid commodities simulate the storage of commodities by the government. In the model, these demand restraints remain at zero level which in the actual world indicates maintenance of some existing level of carryover stocks -- i.e. inflows equal outflows. The final demand for commodities shipped under P.L. 480 programs is food deficit countries. These final demands are defined as

$$\sum_{i=1}^{150} b_{ij} U_{ij} \geq \sum_{r=1}^{7} D_{rj} \qquad \text{(12)}$$

where D_{rj} is demand for the j^{th} commodity in the r^{th} recipient countries. U_{ij} is international shipment of the j^{th} commodity from the United States

to recipient countries under P.L. 480 programs, and b_{ij} is the activity coefficient. These demand levels are initially set at zero levels for each respective crop under consideration and demand is expanded by discrete quantities in the model. Together with domestic and commercial export demand this completes the set of demands for agricultural commodities in the model.

The remaining restraints in the model are associated with cropland. Two sets of activities in the model, crop production and land retirement, use acres of cropland. In each of the 150 production areas, a restraint exists on the total acres of cropland available for production of major crops or for retirement under government programs. This restraint provides that

$$a_{ij}X_{ij} + a_{ij}Z_{ij} + a_{ik}R_{ik} \leq L_i \qquad \text{(A-7)}$$

where all activities are defined above and the a_{ij} are coefficients expressing the amount of resource L_i required in the i-th region per unit of each crop production process and a_{ik} is similarly the amount required per unit of the k-th land retirement process. There are three types of land retirement processes analyzed in the study. Each is designed to simulate a realistic type of government land retirement program:

1. Annual land retirement -- this set of programs simulates programs of land retirement for each of the major crops, wheat, feed grains and cotton. The distribution of land retired and the cost per acre was based on recent patterns and costs.
2. Long range land retirement -- this program assumes that all cropland in a production area is eligible for retirement under

a single government program. Costs per acre for retiring cropland is the estimated net revenue over cost of production for crops included in each production area.

3. Long range land retirement with restrictions -- this program assumes that retirement programs are limited to one-half of all cropland in any production area. Costs per acre are estimated as above.

Each of these land retirement programs form a set of restraints on crop production for the particular model in which they are used. In the model specifying a retirement program for each of the crops -- wheat, feed grains and cotton -- the restraints in the model restrict crop production in each production area by retiring a prespecified quantity of cropland for each crop. These programs require that

$$a_{ik}R_{ik} \geq K_{ik} \qquad \text{(A-8)}$$

where K is land removed from production in the i-th region under the k-th government program.

The second type of program, long range land retirement, forms two types of restraints in the model in which it is used. When no limitation is placed on the amount of land retired in any production area, the restraint is of the form

$$a_{ik}R_{ik} \leq L_i \qquad \text{(A-9)}$$

whereas in the model in which a restraint of one-half of any production area could be retired, the restraint is

$$a_{ik}R_{ik} \leq .5L_i \qquad \text{(A-10)}$$

One final restraint was added to the model which is unique. That restraint was formed to express the relationship whereby all cropland must either be used for crop production or retired under government programs. This restraint requires that

$$a_{ij}X_{ij} + a_{ij}Z_{ij} + a_{ik}R_{ik} = L_i \qquad \text{(A-11)}$$

thereby causing all cropland in each region to be used by one of the production or nonproduction activities. The decision of which process will use the supply of cropland is based on the associated costs specified in Equation A-1. As costs change for the alternative types of land retirement programs R_{ik}, the optimal combination of activities will also change. But one set of optimal activities is infeasible because of the restraint formed by Equation A-11. That set of activities would be formed when the demand for crop production uses less than the available supply of cropland. Under these conditions the optimal and perhaps "first-best" outcome would be for the model to leave this cropland unused. But equation A-11 will not allow this outcome. Rather the model simulates present political realities whereby land unrequired for crop production does not return to grass or trees but is held in nonuse under government programs. Within these constraints farmers still attempt to form efficient production units to minimize total production costs for the agricultural sectors. Similarly, the model of this study derives an optimum set of activities which will minimize the total cost of production, transporting, shifting and shipping commodities to satisfy the specified levels of domestic and international demand. The constraint specified

in Equation A-11 prevents the attainment of one set of optimum activities and through the use of shadow prices generated by the model provides a measure of the net opportunity costs of commodities produced at the margin.

APPENDIX B - PRODUCTION EFFECTS

Effects on crop production and land retirement of increasing food aid shipments was evaluated as part of this study. The interregional nature of the model provided a means of measuring the regional effects of changing shipments levels under P.L. 480 programs. Both the magnitude and location of crop acreages required for different levels of P.L. 480 shipments was part of the results derived. These additional aspects of these models are discussed below for the different farm programs analyzed.

Production Effects with Unlimited Long-Term Land Retirement

During the period 1966-68 an average of 373 million bushels of wheat was annually exported under P.L. 480 programs. According to data shown in Table B-1, this quantity of wheat (Level 5 = 375 million bushels of wheat) requires 14.1 million acres of cropland for wheat production, using the 1970 level yields of this study. Given the level of domestic demand postulated (591 million bushels) plus 300 million bushels of commercial export demand total wheat acreage necessary is estimated at 56.1 million acres. Of the acreage produced for P.L. 480 programs, nearly 60 percent is located in the Northern Plains. Other major areas include the Corn Belt (2.4 million acres), Southern Plain (2.1 million acres) and the Mountain states (2.3 million acres).

In contrast to the effects of shipping 375 million bushels of wheat, if P.L. 480 shipments were eliminated, total wheat acreage declines to 43.0 million acres. Other alternative levels of shipments would have less severe effects. But all reductions in wheat shipments have a positive effect on land retirement. These estimates suggest that

Table B-1. Acreages of Cropland used for Crop Production or Retired under Government Programs Assuming the U.S. Employs a Long Range Land Retirement Program with no Limits on Retirement in any Production Area.

Crop and Land use[2/]	Level of P.L. 480 Shipment[1/]							
	0	1	2	3	4	5	6	7
Wheat								
Acres Harvested	42,992	46,016	48,511	50,303	53,256	56,143	58,169	59,766
For P.L. 480	0	3,080	5,828	8,663	11,397	14,096	16,214	18,578
Northeast	0	0	0	0	72	72	117	345
Lake States	0	0	24	82	236	518	518	520
Corn Belt	0	0	0	0	64	464	1,727	2,360
N. Plains	0	2,860	4,474	5,667	7,723	9,009	9,009	9,009
Appalachian	0	0	0	43	43	63	63	142
Southeast	0	0	0	0	15	15	29	41
Delta	0	0	100	265	270	270	274	306
S. Plains	0	81	90	627	1,181	1,806	1,912	2,439
Mountain	0	95	843	1,459	1,473	1,473	1,738	2,304
Pacific	0	44	297	320	320	406	827	1,112
Acres Retired	66,625	63,399	60,907	58,718	55,799	52,965	50,481	48,416
Feed Grains								
Acres Harvested	87,169	88,093	88,927	89,597	90,287	91,095	91,907	92,612
For P.L. 480	0	883	1,696	2,366	3,086	3,933	4,745	5,431
Northeast	0	0	0	0	0	0	0	0
Lake States	0	0	0	0	137	433	808	924
Corn Belt	0	504	1,169	1,625	1,969	2,055	2,329	2,794
N. Plains	0	322	398	459	615	1,021	1,103	1,103
Appalachian	0	0	0	0	0	0	17	17
Southeast	0	0	0	0	0	1	11	13
Delta	0	11	19	19	19	19	19	21
S. Plains	0	7	71	152	152	188	188	334
Mountain	0	16	16	88	171	171	199	199
Pacific	0	23	23	23	23	45	71	71
Acres Retired	60,494	59,579	58,718	57,943	57,018	55,974	55,170	54,468

Table continued...

Table B-1. (Continued)

Crop and Land Use[2/]	Level of P.L. 480 Shipments[1/]							
	0	1	2	3	4	5	6	7
Cotton								
Acres Harvested	11,149	12,274	13,579	14,387	15,323	16,296	17,051	17,734
For P.L. 480	0	1,125	2,430	3,238	4,174	5,147	5,903	6,586
Corn Belt	0	0	173	173	173	173	173	173
Appalachian	0	0	0	0	19	386	423	452
Southeast	0	50	329	329	338	383	610	857
Delta	0	396	398	642	718	1,227	1,330	1,399
S. Plains	0	656	1,507	2,071	2,903	2,928	3,169	3,169
Mountain	0	23	23	23	23	23	171	171
Pacific	0	0	0	0	0	27	27	365
Acres Retired	60,205	59,365	58,345	57,781	57,227	56,340	55,868	55,545

1/ Quantities are (Mil. bu. wheat; mil. tons feed grains; mil. bales cotton)

Wheat	0	75	150	225	300	375	425	525
Feed Grains	0	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Cotton	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0

2/ Acreages are specified for each crop as shipments under P.L. 480 programs are expanded for that particular crop. Exports of all other crops are held constant under that model. The retired acres are also specifically related to the level of exports of that crop under P.L. 480 programs but are total acreages retired from all crops.

for 1970 technology, shipping 375 million bushels of wheat under P.L. 480 programs leaves some 53.0 million acres for retirement under government programs. Reducing P.L. 480 shipments to 225 million bushels (Level 3) increases land retirement to 58.7 million acres and eliminating these shipments completely leaves a total of 66.6 million acres unused.[1/]

Shipments of feed grains under government sponsored programs are considerably smaller than wheat. In 1966-68 an average of 2.6 million tons of feed grains were shipped into export market under these programs. This level of shipment is estimated to require 2.4 million acres and combined with domestic and commercial export demand requires a total of 89.6 million acres of feed grains with the yield levels postulated.[2/] As might be expected the Corn Belt is the major producer for P.L. 480 programs, with nearly 70 percent of the acreage located in this region. The comparative advantage of production in this region combined with low cost water transportation to the Gulf ports gives the Corn Belt an advantage in supplying feed grains to the export market.

Shipments of cotton under P.L. 480 programs averaged nearly 1.0 million bales in the 1966-68 period. This level of shipment is estimated to require 1.1 million acres of cotton with approximately 65 percent located in the Southern Plains under this type land retirement program. Eliminating cotton exports under P.L. 480 programs drops total acreage to 11.1 million acres. Retired acres of major cropland total 60.2 million but this assumes

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1/ These figures are based on the assumption that 3.0 million tons of feed grains and 2.0 million bales of cotton are still shipped under these programs. Eliminating all P.L. 480 shipments would increase acres retired still further.

2/ Acreages of feed grains totaled 95.4 million acres in 1969, wheat used 47.6 million acres and cotton was harvested from 11.1 million acres.

shipments of 3 million tons of feed grains and 225 million bushels of wheat remain.

'roduction Effects with Limitations on Long-Term Land Retirement

The general outcome of placing a limitation on land retirement is an increase in the acreage required to produce a given level of crop output. The change in wheat acreages is not very significant however -- showing an increase of approximately one-half million acres for the same level of demand and the limitation on retirement. For example, shipment of 150 million bushels (Level 2) with a 50 percent limitation on retirement require 49.0 million acres (Table B-2) while the unlimited retirement program require 48.5 million acres (Table B-1). The resource cost of this change is the production costs and use of an additional half million acres of cropland for wheat production. If each acre had production costs of $20 per acre, this additional cost would total $10,000,000 for this type program.

The increase necessary for feed grain acreage is somewhat greater, averaging somewhat over 3 million acres. The larger change in feed grain indicates the greater difference in crop yields between areas. As a limit is placed on the retirement of cropland, production is required on acres in less productive area. Also, some land must be retired for production in highly productive areas if supply is not to exceed aggregate demand. Consequently, production is shifted from highly productive areas to less productive areas with the result that lower yielding acres are used and a larger number of acres are required to produce the same level of output. This shift is more significant for feed grains (corn especially) than for

Table B-2 Acreages of Cropland used for Crop Production or Retired under Government Programs Assuming the U.S. Employs a Long Range Land Retirement Program with a 50 Percent Limit on Retirement in any Production Area

Crop and Land Use[2/]	Level of P.L. 480 Shipment[1/]							
	0	1	2	3	4	5	6	7
				(thousand acres)				
Wheat								
Acres Harvested	43,308	46,430	48,995	49,937	52,526	55,199	57,958	60,430
For P.L. 480	0	3,142	6,251	8,752	11,170	13,915	16,564	18,959
Northeast	0	0	0	0	235	318	345	345
Lake States	0	0	0	54	236	236	490	563
Corn Belt	0	0	0	11	462	720	1,151	2,415
N. Plains	0	2,799	5,229	6,758	7,073	8,672	9,920	9,920
Appalachian	0	0	21	64	75	75	75	150
Southeast	0	0	1	1	14	27	30	53
Delta	0	18	22	163	306	306	306	307
S. Plains	0	81	81	99	805	1,217	1,860	2,077
Mountain	0	179	745	1,282	1,558	1,558	1,558	2,300
Pacific	0	65	152	320	406	786	829	829
Acres Retired	63,260	60,628	57,903	56,270	53,411	50,720	47,786	45,299
Feed Grains								
Acres Harvested	90,226	91,012	91,653	92,533	93,275	94,226	95,042	95,817
For P.L. 480	0	793	1,588	2,428	3,082	4,009	4,825	5,713
Northeast	0	0	0	0	0	0	0	0
Lake States	0	0	0	0	0	342	808	1,000
Corn Belt	0	546	1,250	1,625	1,971	2,056	2,289	2,610
N. Plains	0	126	217	501	706	1,094	1,195	1,550
Appalachian	0	0	0	0	0	17	17	17
Southeast	0	0	0	0	0	0	0	17
Delta	0	10	10	10	10	24	24	27
S. Plains	0	7	7	73	176	203	209	209
Mountain	0	81	81	174	174	202	212	212
Pacific	0	23	23	45	45	71	71	71
Acres Retired	57,740	56,882	56,270	55,120	54,187	53,125	52,253	51,302

Table continued...

Table B-2. (continued)

Crop and Land Use[2/]	Level of P.L. 480 Shipments[1/]							
	0	1	2	3	4	5	6	7
Cotton								
Acres Harvested	11,186	12,375	13,598	14,411	15,465	16,458	17,336	18,095
For P.L. 480	0	1,189	2,412	3,225	4,279	5,240	6,034	6,761
Corn Belt	0	0	0	83	173	173	173	173
Appalachian	0	5	34	143	452	509	509	509
Southeast	0	140	338	347	357	364	706	1,108
Delta	0	399	458	732	913	1,261	1,331	1,331
S. Plains	0	23	23	23	23	23	192	248
Pacific	0	0	0	0	0	0	27	224
Acres Retired	54,792	54,000	52,781	51,974	51,461	50,933	50,422	49,976

1/ Quantities are (Mil. bu. wheat; mil. tons feed grains; mil. bales cotton)

Wheat	0	75	150	225	300	375	425	525
Feed Grains	0	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Cotton	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0

2/ Acreages are specified for each crop as shipments under P.L. 480 programs are expanded for that particular crop. Exports of all other crops are held constant under that model. The retired acres are also specifically related to the level of exports of that crop under P.L. 480 programs but are total acreages retired from all crops.

wheat since there is a greater difference in corn yields between regions.

The effect on cotton acreage is completely insignificant. Cotton uses a relatively minor acreage of cropland and hence is almost unaffected by a change in the land retirement program. Also, for areas where cotton is grown, its competitive position is relatively great and almost no other use of this cropland is competitive. Thus placing a limitation on retirement of marginal cropland does not cause a shift in production and total acreage of cotton remains independent of the program.

One effect that does show clearly under the cotton program analysis is the difference in total acres retired under the two programs. As a limitation is placed on the proportion of cropland which is retired in each region, total acres retired declines. This result is consistent with the previously explained effect on production. As retirement is restricted more acres are required to produce a given level of output; less acres remain idle and eligible for retirement under a government program. The total cost of crop production rises as more acres are farmed but the cost of land retirement may decline with fewer acres retired if a similar price level is established.

Production Effects with Annual Land Retirement

Annual programs of the type used for major crops in recent years represent a further step toward limiting the proportion of any region which can be retired. These programs generally limit any farmer to retiring 20 to 50 percent of his farm. Payment levels are adjusted to encourage land of all levels of productivity to enter the program. Thus

retirement is spread widely over all crop producing regions with few regions retiring more than the minimum amount since some farmers do not participate in the programs.

The result of further spreading retired acres over more regions is substantially enlarged acres of wheat. The major explanation is that as crop acres are restricted in each region, some additional price pressure causes a shift in demand for feed grains and wheat. With enlarged demand for wheat, acres of wheat produced increase. This effect clearly shows up in these data; wheat acreage increases over 8 million acres while feed grains remain about constant (Table B-3). Output of feed grains declines and output of wheat rises, feed grain acreage remains relatively constant as more marginal acres are placed in production and average yield decline. Wheat acreage rises to offset the decline in feed grain production and thus the total feed unit output of wheat and feed grains is maintained. In this way livestock production would reamin unchanged between the various land retirement programs.

As with the previous program changes analyzed, the shift to even a more restricted program causes almost no change in cotton acreage. But a sizable effect does show up on total land retirement. As land in all regions is placed in land retirement programs, less total acres are retired to reduce output by a given amount. This reduction varies from 6 to 10 million acres under the various commodities and level of P.L. 480 shipments considered.

Generalizing, the major effects associated with the more restricted programs are (1) a larger acreage of cropland is required for major crop

Table B-3. Acreages of Cropland used for Crop Production or Retired under Government Programs Assuming the U.S. Employs Annual Land Retirement-direct Payment Type Programs for Wheat, Feed Grains and Cotton.

Crop and Land Use[2/]	Level of P.L. 480 Shipment[1/]							
	0	1	2	3	4	5	6	7
Wheat				(thousand acres)				
Acres Harvested	51,486	54,624	57,799	60,223	62,329	63,806	65,675	67,266
For P.L. 480	0	3,138	6,313	9,095	11,768	14,302	16,409	18,706
Northeast	0	0	0	27	71	99	345	343
Lake States	0	0	0	0	59	104	220	220
Corn Belt	0	0	0	407	601	709	1,844	2,477
N.Plains	0	1,799	3,867	5,780	7,260	9,284	9,487	9,921
Appalachian	0	0	0	0	100	109	167	167
Southeast	0	0	0	4	17	29	58	58
Delta	0	2	3	224	271	311	311	311
S.Plains	0	496	505	580	677	677	751	1,527
Mountain	0	1,559	1,723	1,847	2,415	2,430	2,522	2,555
Pacific	0	198	215	226	297	550	704	1,125
Acres Retired	53,596	50,458	48,108	46,365	44,687	43,357	41,558	39,625
Feed Grains								
Acres Harvested	89,352	90,739	91,437	92,177	93,881	94,038	94,906	95,700
For P.L. 480	0	1,445	2,167	2,917	3,481	4,628	5,505	6,360
Northeast	0	26	26	26	26	26	26	26
Lake States	0	36	113	152	152	252	587	900
Corn Belt	0	161	798	1,425	1,968	2,292	2,365	2,458
N. Plains	0	454	454	504	504	1,056	1,367	1,809
Appalachian	0	0	0	0	0	0	36	36
Southeast	0	0	0	0	15	30	46	46
Delta	0	25	25	30	30	105	105	105
S.Plains	0	116	124	153	153	176	282	282
Mountain	0	377	377	377	382	441	441	441
Pacific	0	250	250	250	250	250	250	257
Acres Retired	47,493	46,365	45,501	44,777	44,081	43,304	42.515	41,821

Table continued...

Table B-3. (continued)

Crop and Land Use[2/]	Level of P.L. 480 Shipments[1/]							
	0	1	2	3	4	5	6	7
Cotton								
Acres Harvested	10,596	11,875	12,850	13,882	14,985	15,972	17,021	17,839
For P.L. 480	0	1,282	2,266	3,312	4,179	4,937	5,927	6,676
Corn Belt	0	107	173	173	173	173	173	173
Appalachian	0	188	191	509	509	509	509	509
Southeast	0	20	366	378	378	436	867	943
Delta	0	316	694	1,029	1,294	1,294	1,330	1,334
S.Plains	0	619	740	1,121	1,507	1,964	2,485	3,105
Mountain	0	32	72	72	225	225	225	248
Pacific	0	0	30	30	93	336	338	365
Acres Retired	47,475	46,772	46,365	45,614	44,999	44,392	43,877	43,382

1/ Quantities are (Mil. bu. wheat; mil. tons feed grains; mil. bales cotton)

Wheat	0	75	150	225	300	375	425	525
Feed Grains	0	1.5	3.0	4.5	6.0	7.5	9.0	10.5
Cotton	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0

2/ Acreages are specified for each crop as shipments under P.L. 480 programs are expanded for that particular crop. Exports of all other crops are held constant under that model. The retired acres are also specifically related to the level of exports of that crop under P.L. 480 programs but are total acreages retired from all crops.

production as land retirement programs are restricted in each region, (2) fewer total acres have to be retired to reduce output by a given amount, and (3) cotton production is nearly unaffected by the shift in land retirement programs. On a regional basis enlarged shipments of wheat under P.L. 480 programs causes a major increase in wheat acreage in the Northern Plains. Enlarged shipments of feed grains show major effects on Corn Belt acreage and the major effects of enlarged cotton shipments accrue to the Delta and Southern Plains regions. For the maximum shipment levels analyzed, total crop acres for the major crops shown require over 30 million acres of cropland, some 10 percent of total land used for crops in recent years.