ERS-FOREIGN 324

COMPOUND FEEDS IN THE UNITED KINGDOM

EFFECTS OF SUPPORT POLICIES ON USE OF INGREDIENTS

U.S. DEPARTMENT OF AGRICULTURE ● ECONOMIC RESEARCH SERVICE

ABSTRACT

Much of the animal feed in the United Kingdom is consumed as compound feed. Government support policy has a direct effect on consumption of compound feed and use of various ingredients in the composition of compound feed. The objective of this study was to analyze this relationship, and to project to 1980 total compound feed consumption and use of various ingredients. Three alternative policies were analyzed: deficiency payments, variable import levies, and European Community membership. Results of the study indicated an increased use of compound feed by 1980. The increase would be greatest with deficiency payments and least with EC entry. Major shifts in the composition of compound feed are likely. Discontinuation of deficiency payments would result in a significant reduction in cereal use, and an increase in the use of grain substitutes and high protein feeds.

Key Words: United Kingdom, feed-livestock, compound feed consumption, ingredient use, government policy, regression analysis, linear programming, projections.

NOTE

Unless otherwise mentioned, metric weight and U.S. dollar values are used throughout this report. One metric ton equals 2,204.6 pounds. Values are converted at the rate of £ = $2.40. In data analysis, references to the United Kingdom are understood to include England, Northern Ireland, Scotland, and Wales; whereas Great Britain is understood to exclude Northern Ireland.

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Washington, D.C. 20250

February 1972

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SUMMARY

Analysis of three possible agricultural support policies of the United Kingdom indicates that expected changes in ingredients used in U.K. compound feeds will cause price and production dislocations in the domestic feed industry, affecting its trade partners--among them the United States.

Specifically, import restrictions will result in a decreased use of cereals and an increased use of nongrain ingredients by 1980. Projections show the price of compound feeds in 1980 will be greatest when the United Kingdom joins the European Community and least if it had continued the traditional policy of deficiency payments.

The index of net returns (obtained by combining price of animal product, price of compound feed, as well as feed and labor required per unit of product into a single variable) indicates the following net returns projected to 1980 (1956-58 = 1.00):

(1) Poultry meat returns would be highest with deficiency payments (1.7) and somewhat lower with import levies or European Community membership (1.3 each).

(2) Returns from egg production would be slightly higher with deficiency payments (2.1) than with alternative policies (2.0 each).

(3) Returns from milk production would be greatest with United Kingdom-European Community merger (1.3), followed by deficiency payments (1.2), and variable import levies (1.1).

(4) Beef returns were projected to increase significantly with European Community entry (2.9), and to increase almost as significantly with other policies (2.5 each).

(5) Returns from pigmeat production would increase to an index of 2.0 with deficiency payment continuation or European Community membership, but to increase to only 1.8 with a levy arrangement.

Animal numbers were also projected through 1980:

(1) More broilers will be raised with deficiency payments (79 million) than with European Community membership (69 million) or with variable import levies (62 million).

(2) The number of laying hens will be approximately 80 million regardless of policy assumption.

(3) Dairy cow numbers will decrease slightly to 3.2 million head with deficiency payments, to 3.1 million with European Community membership, and to 3.0 million with variable levies.

(4) Beef cow numbers will increase substantially (1.7 million cows) with deficiency payments or variable import levies, but because of the elimination of production grants will fall to 1.3 million if entry in the European Community occurs.

(5) Hog numbers are projected to increase to 8.8 million with deficiency payments, slightly lower (8.7 million) with European Community membership, and to fall to 8.3 million with variable import levies.

Finally, all three policy assumptions were expected to produce increased compound feed consumption and ingredient use by 1980. Consumption of the major compound feeds was projected to increase from the 1969 level of 10 million tons to over 11.2 million tons in 1980 with deficiency payments, and to more than 10.6 million tons with other policies. The significant increase in the relative price of cereals with import duties or European Community membership will result in a sharp reduction in cereal use--6.1 million tons with deficiency payments, 4.7 million tons with variable import levies, and 4.0 million tons with Common Market entry.

No single ingredient category was projected to be substituted for this reduction in cereal use. Cereal byproducts, oil cakes and seeds, molasses, animal and fish meals, and other ingredients will all increase by 1980 under each policy. European Community union or import levy arrangements were projected to result in the greatest use of nongrain ingredients by 1980.

These changes in the use of various compound feed ingredients have serious implications for international trade. Since most cereals are grown domestically and imported, a decrease in quantity demanded is expected to first result in a decrease in imports, and only secondarily in a decrease in the quantity of domestic production demanded. Some products, however, are totally imported (as most oilseeds) and so any change in consumption will lead directly to a change in imports.

COMPOUND FEEDS IN THE UNITED KINGDOM: EFFECTS OF SUPPORT POLICIES ON USE OF INGREDIENTS

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INTRODUCTION

This report examines the compound feeds used in the United Kingdom, including the substitution of various ingredients in the composition of compound feeds, and the relationship between these feeds and alternative economic policies of the United Kingdom.

The agricultural economy of the United Kingdom is primarily a feed-livestock economy. About two-thirds of the value of United Kingdom agricultural production is related to livestock and livestock products. Per capita consumption of red meat ranks very high, making the United Kingdom the world's largest importer of red meat.

In 1965-66, over $1.3 billion was spent by the British farmer for livestock feedstuffs. Excluding the value of feeds produced and consumed directly on the farm, this was the largest item of expense in the national farm budget. Although grain production in the United Kingdom has been increasing, substantial grain imports are required to meet domestic feed needs. The United Kingdom also depends almost entirely on imports of high-protein feeds needed to provide a balanced ration. Almost 20 million tons of concentrated feedstuffs are estimated to be available for livestock feeding. Of this total, about 40 percent is used for cattle, and more than 25 percent each for pigs and poultry (52). Approximately two-thirds of all concentrated feeds have been compounded, that is, are a mixture of cereals and other ingredients that have received some degree of processing.

Statement of Problem

In recent years, new policy alternatives--relating especially to agriculture--have become available to the United Kingdom. Foremost is the United Kingdom's application for membership in the European Community (EC, or Common Market). After unsuccessful applications in 1961-63 and in 1967, the United Kingdom has recently been accepted by the EC. Entrance has been ratified by the British Parliament, although supporting legislation required to align various policies in the two areas must now be enacted.

For the past 20 years, an agricultural support scheme has been in effect, guaranteeing most agricultural products a preestablished Government price. Most agricultural imports have been allowed to enter the United Kingdom with low, if any, duties, and to compete with similar domestically produced commodities. In general, this policy has resulted in a low domestic market price. The Government then reimburses the producer for the difference between the market price and a preestablished guaranteed price. Because of high Government costs, this

method of price support has been open to criticism. The United Kingdom is currently imposing a system of increased import duties, somewhat similar to the EC system, so that lower priced imports will not depress the domestic market price. This will reduce Government support costs, since the difference between the guaranteed and the market price will be decreased, but will result in increased costs of agricultural commodities to the consumer. There are obvious trade-offs between these alternative policies (i.e., lower consumer food costs versus higher Government expenditures and therefore higher taxes).

Although agricultural support policies have ramifications for the entire agricultural economy, they are particularly important to the feed-livestock sector. Approximately 70 percent of the value of all agricultural production stems from livestock and livestock products, and about the same percentage of all agricultural land is devoted to the production of animal feed, either grain or pasture. Thus, it is obvious that an understanding of the compound feed industry, a sector of the feeds livestock complex, is essential in any examination of the agricultural economy of the United Kingdom.

Approximately 60 percent of all feed concentrates fed in the United Kingdom have been compounded. Historically, the major ingredient in compound feed has been feed grain--barley, corn, oats, and rye. Other ingredients, such as wheat middlings or other grain byproducts, soybean meal, and molasses, have been added to bring the mixture up to specified nutritional standards. With the development of linear programming during World War II, and the general access to computer facilities in the last decade, the process by which these various ingredients are chosen has become more scientific and much more complex. Price shifts within the alternative compound feed ingredients may now be analyzed rapidly, and the compound feed mixture may be altered to include the lowest price ingredients, subject, of course, to the various nutritional requirements. All of this has resulted in a most important role for what were once minor nonfeed grain ingredients in the compound ration.

Agricultural support policy directly affects the price of these ingredients. For example, by accepting EC membership, the United Kingdom also accepts the Common Agricultural Policy (CAP) applicable to all members of the Community. While exact price changes are uncertain, it is generally agreed that the CAP will result in significant increases (possibly 20-25 percent) in feed grain prices in the United Kingdom, chiefly because of higher support levels and variable import levies that equate import price with the domestic price. These higher prices should stimulate production in the United Kingdom, while at the same time the higher import prices caused by the variable import levy will tend to reduce imports. Thus, the displacement of grains from the traditional export countries (among them the United States) with increased domestic grain must be taken into account both by the exporters as well as United Kingdom authorities.

EC membership will also effect a shift in prices. As feed grain prices increase, the efficient compound feed manufacturer will be expected to use less grains and more substitute ingredients, such as soybean meal, corn gluten meal, and molasses, in the compound mixture. In other words, nongrain items or grain byproducts will be substituted for feed grains. To the extent that the substitute commodities are imported (many are totally imported), this shift represents a trade gain for the traditional exporters of these products, including the United States.

Objectives

The primary objective of this investigation, therefore, is to examine the effects of agricultural policy alternatives on the use of various compound feed ingredients, and to project the consumption of these ingredients under alternative policies to 1980. Supporting objectives are to: (1) examine the structure of the compound feed industry in the United Kingdom; (2) analyze factors affecting the quantity of compound feed consumed, by animal class; and (3) analyze the relationship between relative ingredient price and ingredients used in selected compound feeds.

Compound feeds supply only a portion of the total feed requirements for livestock. The importance of compound feed in relation to other feeds varies by livestock class. Compound feed is much more important for pigs and poultry, which rely primarily upon concentrates, than it is for cattle, which depend to a greater extent upon roughages to supply their daily feed requirements. Consequently, the relationship between concentrate and roughage consumption is also important.

The relationship between consumption of concentrated feedstuffs and bulk feedstuffs (forages and roughages) rests on technical as well as economic grounds. Both are significant to British livestock production. At some stages of production the two are substitutes; at other stages of production (especially for ruminant animals), they are complementary. Although measurement is not possible, the consumption of compound feed is in part a function of the supply of roughage. Within limits, as the relative supply of roughage decreases, the consumption of concentrated feed is expected to increase. As urbanization and other uses continue to remove land from agricultural production, roughage production will drop. Other things being equal, this will increase the consumption of concentrated feed. Emphasis in this study rests solely on the compound feed segment of animal feedstuffs.

Methodology

This analysis was divided into three integrated sections. In the first section, an analysis of total consumption of compound feed by various animal classes is presented. Multiple regression analysis was used to examine factors affecting this consumption, and to estimate the quantity of compound feed to be consumed in the future.

The second section of the study examines the mix of ingredients, and the substitution of these ingredients in the various compound feeds. Least cost linear programming was used in this examination.

The final section of the study concerns itself with the effects of various economic policies on total compound feed use and ingredient mix. The above-mentioned linear programming and regression techniques were used in assessing this relationship.

The compound feed industry of the United Kingdom is the most important segment of the agricultural economy not actually engaged in the production of crop or livestock products. In 1968-69, British farmers spent $1.2 billion (29 percent of their total expenditures) on feed. Of this total feed expediture, $926 million, or 79 percent, was spent on compound feed--$374 million on poultry feed, $293 million on cattle feed, and $194 million on pig feed. For comparison, during the same period farmers spent $763 million on labor, $646 million on machinery, and $358 million on fertilizers (13).

Production of Compound Feed

Production of compound feed in the United Kingdom increased steadily over the past decade. From a total production of more than 8.6 million tons in 1959, compound feed production increased by almost one-fourth, to almost 10.7 million tons in 1969 (table 1). The rate of increase in compound feed production was greater in Northern Ireland than in Great Britain.

During this 10-year period, poultry feed was continually the largest compound feed category produced and consumed in the United Kingdom, and in 1969 constituted 38 percent of all compound feed production. The major portion of this was layer ration. Cattle feed was next in importance, accounting for one-third of all compound feed production in 1969, while hog feed, with almost one-fourth of production, was the third largest compound feed category.

Compound feed and concentrates

One of the problems in examining the compound feed industry of the United Kingdom is definitional; some data refer to compound feeds while other data refer to the more general category of concentrates.

Specifically, terms commonly used in the United Kingdom are defined as follows:

Concentrated feedstuffs--includes compound rations processed straights, grain livestock mixtures, and unprocessed straights.

Compound rations--includes a mixture of cereals and other ingredients which have gone through some form of processing.

Processed straights--are grains which have not been mixed but have been processed.

Grain livestock mixtures--are mixtures of feed grains which have not been processed.

Straights--include feed grains, oil cakes, dried sugar beet pulp, or any other ingredient not mixed.

While these definitions demonstrate the inclusive nature of the term "concentrate," the dominance of compounds is noteworthy. Approximately 60 percent

Table 1.--United Kingdom: Production of compound feeds, by livestock class and area, 1959-69

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
	1,000 tons										
Cattle	2,723	2,839	2,793	2,917	2,784	2,740	2,954	2,955	3,193	3,280	3,569
Calf	320	329	306	350	374	393	424	393	379	380	400
Pig	1,893	1,792	1,880	2,181	2,073	2,076	2,253	1,965	2,047	2,175	2,432
Poultry	3,585	3,669	3,955	3,955	3,955	4,089	4,096	4,001	4,176	4,090	4,043
Broiler						616	766	818	911	914	923
Turkey						209	276	242	256	281	271
Other						3,264	3,053	2,941	3,009	2,894	2,849
Others	131	155	168	175	170	169	173	180	195	207	244
Total	8,652	8,785	9,102	9,578	9,356	9,467	9,898	9,949	9,991	10,132	10,689
Great Britain	7,848	7,866	8,042	8,553	8,344	8,453	8,835	8,500	8,898	8,986	9,474
Northern Ireland	804	919	1,060	1,046	1,012	1,014	1,064	994	1,093	1,146	1,215

Source: (38, various issues).

of all concentrated feed consumption in the United Kingdom is in the form of compound rations. For example, in 1966-67, 9.4 million tons of compound feed was delivered to farmers, representing 60 percent of the total of 15.9 million tons of all concentrates consumed (table 2). In general, the percentage of concentrates fed as compound feeds remained near this 60-percent level in each of the past 15 years.

Table 2 also shows the relationship between total deliveries of concentrates and of compound feed, or, in other words, the importance of compound feed production to the total volume of the feed manufacturer. Compound deliveries averaged almost 70 percent of all concentrate deliveries over the past 15 years.

Brief mention must be made of the apparent contradiction between the production of compound feeds found in table 1 and the deliveries of compound feeds in table 2. Table 1 is stated in calendar years, while table 2 is stated in split years, so that an exact comparison is not possible. Yet, deliveries appear to be less than production at times. Thus, 1963-64 deliveries of concentrates are stated at 9.2 million tons in table 2, lower than the production of compounds in either 1963 or 1964 as found in table 1. This slight difference is a result of the exclusion from table 2 of compounds produced and consumed without resale, that is feedstuffs which were compounded and consumed at the same location.

The concentrate-compound distinction is important in the discussion of the structure of the feed-manufacturing industry below.

Number of Factories

The total number of factories delivering concentrates in Great Britain declined substantially in recent years. In 1955-68, the number of feed-manufacturing factories decreased by almost one-third, from 1,100 to 758 factories (table 3). The decline was greater among port factories than among those located in the country.

Feed-manufacturing facilities are divided into "port" and "country area" classifications for historical reasons. The country segment developed from the numerous small flour mills that once utilized locally produced cereals. In the past 70 years, however, large flour mills developed at ports and in large cities, and the small country flour mills were, therefore, converted to feed manufacturing. In comparison, the port factories developed in conjunction with the flour milling and oilseed-crushing industries to make use of the milling byproducts and oilseed cakes and seeds associated with these mills.

In recent years, however, the distinction between "country" and "port" factories has blurred. The larger port firms have expanded into smaller ports and into the country areas. Through expansion, merger, and integration, a new class of feed manufactures has developed--the "national" compounders. There are seven of these compounders, so named because they operate on a nationwide basis.

The seven national compounders control almost two-thirds of the concentrated feed market in Great Britain. Since 1960, the more than 50 factories they control delivered approximately 5 million tons of compound feed annually (table 4).

Table 2.--United Kingdom: Consumption and purchases of concentrated feedstuffs, by amount and percent, 1955-56 to 1966-67

	1955-56	1957-58	1959-60	1961-62	1963-64	1965-66	1966-67
	Million tons						
(1) Total consumption of concentrated feeds	12.2	12.5	13.6	14.7	15.0	16.8	15.9
(2) Total deliveries of concentrates	10.3	11.2	12.3	13.5	13.3	14.8	13.7
As percentage of (1)	85.6	90.8	91.7	93.2	89.9	89.9	87.9
(3) Total deliveries of compounds	7.1	7.4	8.6	9.3	9.2	9.7	9.4
As percentage of (1)	59.2	60.3	64.4	64.4	62.5	58.5	60.6
As percentage of (2)	70.4	67.5	71.3	70.3	70.6	66.1	70.0
(4) Estimate of total concentrate retained on farm	1.9	1.3	1.3	1.2	1.7	1.9	2.1

Source: (6, page 390).

Table 3.--Great Britain: Total number of factories delivering concentrate feeds, 1/ by area, selected years, 1954-55 to 1967-78

July-June	Ports 2/	Country areas	All areas
	Number		
1954-55	168	942	1,110
1957-58	149	857	1,006
1961-62	134	803	937
1962-63	126	776	902
1963-64	120	743	863
1964-65	112	708	820
1965-66	110	706	816
1966-67	102	686	788
1967-68	100	658	758

1/ Includes some factories which have ceased to manufacture concentrates but still deliver unprocessed straights.

2/ Port factories are those located in London, Southhampton, Bristol, Cardiff, Swansea, Barry, Merseyside (including Manchester), Humber Ports, Tyneside, Clyde Ports, and Leith.

Source: (3 and 39).

Table 4.--Great Britain: Deliveries of compound feeds by the seven national feed manufacturers, selected years, 1957-58 to 1967-68

Year	Factories	Compound delivered	Percentage of all British deliveries
	No.	Million tons	Pct.
1957-58	57	4.3	64
1961-62	57	5.1	61
1965-66	60	5.2	61
1966-67	60	5.0	60

Source: (6, p. 402).

None of the nonnational manufacturers was comparable in size to even the smallest of the national compounders, emphasizing the amount of market share held by the national compounders (6, p. 399).

Average Volume Per Factory

With this rather significant decline in number of compound manufacturers, the increase in compound feed production over this period was even more striking. This combination of higher output and fewer factories was reflected in a doubling of the average sales volume by factory. Average sales per factory increased from 6,537 tons in 1954-55 to 12,587 tons in 1967-68 (table 5).

Distribution of Factories by Size

The decline in the number of factories delivering concentrated feeds in Great Britain has previously been discussed. Further understanding of structural changes in the industry can be gained from examination of changes in the number of factories in various size categories. As might be expected, the decline in factory numbers was primarily the result of a sharp decrease in the number of small factories. For example, between 1952-53 and 1967-68, the number of factories delivering concentrates declined by 31 percent, from 1,085 to 752 factories (table 6). During this same period, the number of factories delivering less than 1,000 tons of animal feed per year decreased by almost 60 percent, or from 634 to 267 factories. Undoubtedly, all of these firms did not go out of business; some expanded and moved into a larger size grouping. Most, however, simply became too small to remain competitive, and were forced out of the concentrated feed market. Yet, even with this substantial decrease, factories delivering less than 1,000 tons of animal feed per year accounted for 38 percent of all animal feedstuffs factories in Great Britain during 1967-68.

Production by Factory Size

Although the declining number of small concentrated feed manufacturers is still substantial, their share of the concentrated feed market is quite small. The smallest 38 percent of the manufacturers (those with an annual volume of less than 1,000 tons) produced only about 1 percent of all concentrated feeds (table 7). In contrast, the six largest factories (not to be confused with the national manufacturers each of which controls several factories) produced more than 23 percent of all concentrates delivered in Great Britain during 1967-68.

Production by Area and Type of Feed

A final way of examining the compound feed industry of Great Britain is to investigate the production centers of the various compound feeds. The increased importance of country production, considering compound feeds in general, is significant. In 1960-69, compound feed production increased by more than 1.6 million tons, or more than 20 percent (table 8). This increase was due entirely to increased production in country areas (up 76 percent); production in port areas actually declined slightly during this period. The increase in compound feed manufactured in country areas was not restricted to any particular kind of feed, although more than half of all compounded cattle feeds are still produced in port areas.

Table 5.--Great Britain: Average deliveries of manufactured concentrates per factory, by area, 1954-55 to 1967-78

July-June	Ports	Country area	All areas
	Tons		
1954-55	30,010	2,350	6,537
1957-58	33,275	2,920	7,415
1961-62	45,304	3,765	9,706
1962-63	48,701	4,018	10,260
1963-64	48,263	4,342	10,458
1964-65	52,756	4,828	11,375
1965-66	52,732	5,044	11,472
1966-67	54,336	5,193	11,555
1967-68	55,354	6,086	12,587

Source: (3 and 39).

Table 6.--Great Britain: Distribution of animal feedstuffs factories by size, selected years, 1952-53 to 1967-68

Tons delivered 1/	1952-53	1961-62	1965-66	1966-67	1967-68
	Number				
0 - 499	430	248	180	188	170
500 - 999	204	147	118	108	97
1,000 - 1,999	160	156	118	114	89
2,000 - 4,999	159	136	133	125	116
5,000 - 9,999	59	91	102	93	101
10,000 - 19,999	28	68	56	61	67
20,000 - 49,999	21	45	58	59	59
50,000 - 99,999	15	19	23	18	27
100,000 - 199,999	7	9	9	10	10
200,000 and over	2	7	6	6	6
Total	1,085	926	803	782	752

1/ July-June except 1961-62 for which October-September.

Source: (3 and 39).

Table 7.--Great Britain: Percentage distribution of animal feedstuffs production by factory size, selected years, 1952-53 - 1967-68

Tons delivered 1/	1952-53	1961-62	1965-66	1966-67	1967-68
	Percent				
0 - 499	1.6	0.6	0.4	0.5	0.4
500 - 999	2.8	1.2	0.9	0.9	0.7
1,000 - 11,999	4.3	2.4	1.8	1.8	1.4
2,000 - 4,999	9.1	4.8	4.6	4.5	3.7
5,000 - 9,999	7.6	6.9	8.1	7.2	7.3
10,000 - 19,999	7.9	10.4	8.7	10.0	9.5
20,000 - 49,999	12.3	15.1	18.8	20.8	22.4
50,000 - 99,999	20.0	14.8	16.4	13.0	15.0
100,000 -199,999	19.2	15.2	15.5	16.8	16.2
200,000 and over	15.2	28.5	24.7	24.5	23.3
Total	100.0	100.0	100.0	100.0	100.0

1/ July-June except 1961-62 for which October-September.

Sources: (3 and 39).

CONSUMPTION OF COMPOUND FEED

Selection of Compound Feeds

As previously defined, compound feed refers to a combination of grain and other ingredients that has received some degree of processing. Because of the nature of the feed and of the various nutritional requirements and feeding practices of particular animal classes, compound feed is more important in the feeding of some classes of livestock than it is of others. Sheep, for example, are fed some compound feed, but this is minor compared with the amount of feed derived from grazing. Horses and other animals of limited commercial importance are also negligible users of compound feed. In relation to the total amount of compound feed consumed in the United Kingdom, the amount consumed by these animals is insignificant (approximately 4 percent). For this reason, no attempt was made to examine the demand for compound feed by these animal classes.

After exclusion of these livestock classes, compound feed used by cattle, hogs, and poultry remained to be analyzed. Since there is little difference between the compound feed consumed by dairy cattle and that consumed by beef cattle, and because much of the beef produced in the United Kingdom stems from dual purpose cattle or the raising of home-reared dairy calves, no attempt was made to segregate the demand for compound diary feed from that of compound beef feed (4, p. 20). Two compound hog rations were considered, a hog starter for

Table 8 --Great Britain: Production of compound feedstuffs, by area and type of feed, 1960-69

	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969
	1,000 tons									
Cattle and calf	3,021	2,886	3,045	2,934	2,917	3,146	3,114	3,319	3,401	3,705
Port	2,256	2,103	2,189	2,051	2,009	2,147	2,080	2,171	2,089	2,157
Elsewhere	765	782	857	883	908	999	1,034	1,148	1,312	1,547
Pig	1,335	1,371	1,661	1,583	1,618	1,764	1,575	1,651	1,742	1,939
Port	775	784	982	923	971	1,021	886	911	908	969
Elsewhere	560	586	680	660	646	743	689	740	833	969
Poultry	3,356	3,618	3,654	3,659	3,750	3,754	3,635	3,738	3,648	3,592
Port	2,343	2,471	2,495	2,487	2,567	2,492	2,342	2,436	2,149	2,005
Elsewhere	1,013	1,147	1,158	1,172	1,184	1,262	1,293	1,403	1,499	1,587
Other	154	168	173	168	168	171	176	189	196	239
Port	103	115	116	109	109	119	120	132	128	145
Elsewhere	52	53	57	52	59	52	56	57	68	93
All compounds	7,866	8,042	8,533	8,344	8,453	8,835	8,500	8,898	8,986	9,474
Port	5,477	5,473	5,781	5,577	5,655	5,779	5,428	5,550	5,274	5,275
Elsewhere	2,390	2,569	2,751	2,767	2,797	3,055	3,073	3,348	3,712	3,182

Source: United Kingdom Ministry of Agriculture, Fisheries and Food (unpublished).

hogs 4 months of age or less, and a hog finisher for other hogs. Likewise, two poultry rations were considered, a compound broiler feed and a compound layer feed.

During the past decade, poultry feed was continually the largest compound feed category in the United Kingdom, and in 1969 constituted 38 percent of all compound feed consumption. The major portion of this was layer ration. Since data have been published segregating poultry feed into broiler and layer ration for a short time only, this research developed a method by which the consumption of all poultry compounds can be partitioned into broiler and layer ration.

During 1966-69, the only period when data were available, broilers consumed approximately 50 percent as much compound feed per bird as did layers. This was calculated by dividing total consumption in each category by the number of birds in that category, and then by comparing the respective amounts. During this period, broilers consumed 45-47 percent as much compound feed per bird as did layers (calculated from 40).

Assuming that this ratio will not significantly change in the period this research examines, this calculation was used with predicted poultry numbers to estimate future consumption of broiler and layer ration. For example, if the projections of number of poultry reveal NB (number of broilers) and NL (number of laying hens), total compound poultry feed consumption was divided as follows: 2NL + 1NB = 100 percent of compound poultry feed consumed. This manner of partitioning total compound poultry feed was used throughout this report. Although it was not attempted in this report, production of poultry meat and eggs could have alternatively been used to partition total compound poultry feed consumption.

Hog feed, at almost one-fourth of total compound feed consumption, was the final feed to be analyzed. Since no data were available dealing with consumption of the two hog rations to be examined (starter and finisher), this research attempted to estimate the percentage of each of these rations in total compound hog feed. In the past 6 years, 72 percent of all hogs were less than 5 months of age (40, various issues). These animals consume about one-fourth the compound feed per head as do sows, gilts, boars, and other hogs (52, p. 18). Weighting the number of hogs in the two classes by the respective feeding rates gives us an indication of compound feed consumed by each class. Results of this calculation indicate that approximately 60 percent of all compound hog feed consumed was finisher; the remainder was hog starter.

Selection of Time Period

With the exception of poultry, the base period chosen for this examination of factors affecting the consumption of selected classes of compound feed was 1957-69. Because of wartime measures, the compound feed industry in the United Kingdom was under Government control through 1953. Although consumption data were available from 1955, a period of adjustment was necessary after controls were lifted. Therefore 1957 was chosen as the base year in this time series analysis, except for poultry, because some data were unavailable prior to 1959.

Selection of Variables

Consumption equations

The quantity of an input demanded is a function of the price of that input, the price of substitute inputs (if any), and the price of the resulting product. In this study, the quantity of compound feed demanded was related to prices of the compound feed, price of alternative concentrated feeds, and price of the animal product. Of course, total consumption of compound feed for a particular animal class is also a function of the number of animals in that class.

As a first approximation to estimating the significance of various factors affecting the consumption of compound feed, an equation was developed as follows:

$$C_i = f\ (N_i,\ PC/PS_i,\ PC/PP_i)$$

where: C = consumption of compound feed; N = number of animals; PC = price of compound feed; PS = price of substitute feed; PP = price of animal product; and i = animal class.

The equations dealing wtih the consumption of compound hog feed differ from those dealing with compound cattle and poultry feed in that the former are a function of various prices dealing with all hogs, while the latter are a function of prices dealing with two separate subgroups. That is, consumption of compound cattle feed was a function of the price of milk as well as of beef, and consumption of compound poultry feed was a function of returns from broiler enterprises as well as from laying hens. Since these prices refer to different units (namely, gallons of milk versus pounds of beef) it would not be possible to average the two to develop a price of animal product variable to be used in any consumption equation. To avoid this, all variables relating to price in consumption equations were converted to an index, using 1956-58 as the base period. This was done for all preliminary forms of the estimating equations as well as for the final equations.

Results of this equation were unsatisfactory. While the explanatory power of the equation (as measures by R^2) was significant in all cases, animal numbers were the only significant independent variable, and the respective signs of the other independent variables were not those expected from economic theory (e.g., as the price of the compound feed increased in relation to the price of the animal product, more compound feed was consumed, etc.).

In an attempt to improve these results, two changes were made. First, the price of the chosen substitute feed was weighted according to its nutritional value in comparison with the nutritional value of the compound feed. Corn, for example, is the only noncompounded concentrate traditionally fed to poultry. But since corn possesses only about 70 percent of the nutrients of a complete compound poultry feed, the price of corn was divided by 0.70 to reflect the lower nutritional value. Similar adjustments were made for all animal classes.

Second, the variable examining the relative price of compound feed and animal product was modified to account for increased feeding efficiency. This was done by subtracting from the price of the animal product the price of the compound feed required to produce this unit of animal product. Improved husbandry practices and consequent lower feed requirements to produce a unit of animal product (most noticeable in the broiler industry) were reflected in the new independent variable. The equation developed at this stage was as follows:

$$C_i = f\left(N_i, PC/\frac{PS_i}{c}, PP - PC \text{ per unit of product}_i\right)$$

where: C = consumption of compound feed; N = number of animals; PC = price of compound feed; PS = price of substitute feed; PP = price of animal product; c = nutritional value of substitute feed in relation to that of compound feed; and i = animal class.

Although results of this formulation showed some improvement, they were still unsatisfactory. The explanatory power of the equations increased slightly, but the independent variable relating to relative price of feeds was still incompatible with economic theory. The variable relating to price of compound feed and price of animal product was compatible with economic theory in all cases but one, but was not statistically significant. The only statistically significant independent variable was animal numbers.

Two changes were made in the next formulation of the model. First, the variable relating to feed prices was eliminated. No direct substitute was found to exist for compound feed in and animal class. Second, the variable examining the relative price of compound feed and farm price of animal product was modified by including a coefficient of labor efficiency, man-days of labor required per animal unit. This was especially important for hogs and poultry, where economies of size and increased use of capital have resulted in significantly lower labor requirements for animal unit over the past 15 years. This variable will hereafter be called the net revenue variable (R), and is defined as as follows: 1/

$$R = \frac{PP - PC \text{ per unit of product}}{L}$$

1/ The use of a variable similar to this was recently noted in a study conducted at Michigan State University. According to this study "the use of (a variable of this type) has the advantage that it incorporates several factors which affect profits and thereby conserves on degrees of freedom in a regression analysis, and it reduces the problem of intercorrelation among independent variables It also allows more a priori information to be included than if product and factor prices were used as the explanatory variables. The disadvantage of using this type of variable is that the separate effects of product and factor prices cannot be measured except to the extent that they affect the variable " See John Ferris, et al., The Impact on U.S. Agricultural Trade of the Accession of the United Kingdom, Ireland, Denmark, and Norway to the European Economic Community (East Lansing, Michigan: Michigan State University) unpublished manuscript.

Converted to index form, this is referred to as IR_i.

where: R = returns per unit of animal product over the cost of required compound feed per man-day of labor; PP = price of animal product; PC = price of compound feed; and L = labor required per unit of animal product.

The final choice of variables used to examine compound feed consumption was therefore:

$$C_{i(t)} = f\ (N_{i(t)},\ IR_{i(t)})$$

where: C = consumption of compound feed; N = number of animals; IR = index of net returns per unit of animal product over the cost of required compound feed per man-day labor; i = animal class; and t = time.

Animal number equations

In a first attempt at prediction, animal numbers were considered to be a function of the animal numbers, net revenue variable, and index of net revenue for alternative enterprises in the preceding period. This was further modified to allow a 2-year distributed lag for each of the independent variables, thereby allowing a period of adjustment in the farmer's decisionmaking process as well as for imperfect knowledge.

Results were satisfactory, but the index of net revenue for alternative products was of inconsistent sign and was not statistically significant. Since this variable was not used in the section dealing with compound feed consumption, and since it added little to the explanatory power of the animal number equation, it was eliminated in these equations. The final choice of variables used in predicting animal numbers was therefore:

$$N_{i(t)} = f\ (N_{i(t-1)},\ IR_{i(t-1)})$$

where: N = number of animals; IR = index of net returns per unit of animal product over the cost of required compound feed per man-day of labor; i = animal class; and t = time.

The equations dealing with dairy and beef cows were, however, modified by including a variable of cull cow prices. As this variable increased, it was expected that marginal cows would be eliminated from the herd, thereby reducing animal numbers. In addition, the equation estimating beef cow numbers also included a variable of average production grant per cow. As part of the Government's attempt to encourage expansion of the beef industry, direct production grants to beef producers were authorized above and beyond the price incentives previously included in the net farm price of the animal product. Entry into the Common Market will eliminate these grants, probably curtailing beef expansion in relation to alternative policies.

An examination of factors affecting the number of animals in the various classes is also required to estimate total consumption of compound feed by animal class.

Selection of Functional Form

While observation of the data and graphic analysis suggested basic linear relationships, the possibility of nonlinear relationships led to the fitting of logarithmic, semilogarithmic, and linear functions. Results of the alternative forms varied considerably. The linear function was ultimately chosen on the basis of greater explanatory power and compatibility with economic theory.

Equations Developed 2/

The equations relating to compound feed consumption by animal class and number of animals in each class are presented below. The consumption, animal numbers, technical coefficients relating to feeding and labor, and price data used in this analysis are presented in appendix A. The coefficient of determination (R^2) and the standard error of the estimate (S.E.) are given for each equation. The significance of the equation (R^2) was determined by means of an F-test. The individual regression coefficients (b) and their standard errors are also given. The significance of each regression coefficient was determined by means of a t-test. Three levels of statistical significance are presented; (*) represents the 10-percent level; (**) -- the 5-percent level; and (***) -- the 1-percent level.

All equations dealing with consumption of compound feed were statistically significant at the 1-percent level. The average R^2 was .81.

Equations developed to predict consumption of compound animal feed are as follows:

Hogs:

$$CH_t = 408.44 + .1866^{***}NH_t + 251.3512\ IRH_t \qquad R^2 = .74^{***}$$

$$(.0643) \qquad (240.2382) \qquad S.E. = 116$$

Cattle:

$$CC_t = 3292.34 + 4.5624^{***}NC_t + 650.8051^{**}\ IRC_t \qquad R^2 = .88^{***}$$

$$(1.1537) \qquad (295.0367) \qquad S.E. = 130$$

Poultry:

$$CP_t = 1943.20 + 2.0696^{***}NP_t - 463.0550\ IRP_t \qquad R^2 = .81^{***}$$

$$(.4363) \qquad (238.9897) \qquad S.E = 68$$

where: CH = consumption of compound hog feed (1,000 metric tons); CC = consumption of compound cattle feed (1,000 metric tons); CP = consumption of compound poultry feed (1,000 metric tons); NH = number of hogs (1,000 head); NC = number of cattle (10,000 head); NP = number of

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2/ Equations were developed using U.K. units of measure and value. To simplify this report all data were converted to metric weights and U.S. dollars. The equation coefficients, however, were not altered.

poultry (100,000 birds); IRH = index of returns per unit of pig meat over the cost of the required compound feed input per man-day of labor; IRC = weighted average index of returns per unit of milk and returns per unit of beef over the cost of the required compound feed input per man-day or labor; IRP = weight average index of returns per unit of poultry meat and returns per unit of eggs over the cost of the required compound feed input per man-day of labor; and t = time (1957 = 1).

Of the two independent variables, the animal number variable was by far the most explanatory; it was statistically significant at the 1-percent level in each case. The index of returns per unit of product over the cost of concentrate per unit of labor showed the sign (+) expected from economic theory in every case but one, but was statistically insignificant in two cases. The inclusion of this variable increased the average R^2 by .06. The insignificance of this variable was understandable. The rational farmer, if faced with sudden changes in his return over the cost of compound feed per man-day of labor, will quite probably adjust the number of animals to be fed, rather than feed each animal more or less compound feed. The negative sign of this variable in the poultry equation may be explained by the great economies of size experienced in this industry in recent years. Some of the economies (e.g., labor and feeding efficiency), have been incorporated into the revenue variable used in this research but others have undoubtedly been ignored. The effects of both vertical and horizontal integration have also been a factor, but could not be examined within the limitations of this study.

All equations estimating the number of animals by animal class were statistically significant; the dairy cattle equation was significant at the 5-percent level, and all other equations were significant at the 1-percent level. The average R^2 was .76. All independent variables expressed a positive sign, as expected from economic theory. The animal number variable was statistically significant at the 1-percent level in each equation.

Equations developed to predict animal numbers are as follows:

Hogs:

$$NH_t = 1441.30 + \underset{(.2304)}{.6892^{***}}NH_{t-1} + \underset{987.5404}{648.7140}\ IRH_{t-1} \qquad R^2 = .70^{***}, \quad S.E. = 443.79$$

Cattle:

$$NB_t = 7.7385 + \underset{(.2785)}{.8666^{***}}NB_{t-1} + \underset{(11.3985)}{4.5904}\ IRB_{t-1} + \underset{(1.0193)}{.2264}\ APG_{t-1} - \underset{(.2215)}{.0364}\ PC_{t-1} \qquad R^2 = .94^{***}, \quad S.E. = 3.94$$

$$ND_t = 79.51 + \underset{(.1903)}{.6808^{***}}ND_{t-1} + \underset{(27.4131)}{43.2061}\ IRD_{t-1} - \underset{(.1568)}{.2036}\ PC_{t-1} \qquad R^2 = 61^{**}, \quad S.E. = 5.55$$

$$NC_t = 448.94 + \underset{(.6120)}{2.4272^{***}}NB_t + \underset{(1.1408)}{1.5396}ND_t \qquad R^2 = .82^{***}, \quad S.E. = 22.44$$

Poultry:

$$NBR_t = -6.1002 + .0954^{***}NBR_{t-1} \quad (.0196)$$
$$+ 52.2062\ IRBR_{t-1} \quad (108.1602) \qquad R^2 = .84^{***},\ S.E. = 34.90$$

$$NL_t = 270.8610 + .5831^{***}NL_{t-1} \quad (.1896)$$
$$+ 33.9192\ IRL_{t-1} \quad (17.8302) \qquad R^2 = .64^{***},\ S.E. = 19.11$$

$$NP_t = NBR_t + NL_t$$

where: NH = number of hogs (1,000 head); NB = number of beef cows (1,000 head); ND = number of dairy cows (1,000 head); NC = number of cattle (10,000 head); NBR = number of broilers (100,000 birds); NL = number of laying hens (100,000 birds); NP = number of poultry (100,000 birds); IRH = index of returns per unit of pig meat over the cost of the required compound feed input per man-day of labor; IRD = index of returns per unit of milk over the cost of required compound feed input per man-day of labor; IRB = index of returns per unit of beef over the cost of the required compound feed input per man-day of labor; IRBR = index of return per unit of poultry meat over the cost of the required compound feed input per man-day of labor; IRL = index of returns per unit of eggs over the cost of the required compound feed input per man-day of labor; PC = price of cull cows (shillings per 112 pounds); APG = average production grant per beef cow (£ per cow); and t = time.

Applications

The major use of the consumption and animal number equations developed in this section is to project the consumption of compound feed, and therefore the use of compound feed ingredients, to 1980. Before these projections can be made, however, a determination of the level of the independent variables at these future dates must be made, including a projection of the future price of compound feed itself. The results of an analysis of the future price of this feed, as well as of the future levels of other independent variables, will be made below to predict the future use of compound feed and compound feed ingredients.

DEVELOPMENT OF LINEAR PROGRAM

This section of the study develops the linear programming model needed to examine ingredient substitution in compound animal feeds. All ingredient restrictions and all nutritional restrictions are presented, as are the required nutrient coefficients (nutrient composition) of each ingredient. After prices for 1968 are introduced into the model, the results are compared with actual inredient use to evaluate the accuracy of the program.

Linear Program Data

The data required for the linear programming analysis are presented below. Table 10 presents the nutritional restrictions for each of the five compound feeds to be examined; table 11 - the ingredients that can be used, as well as the nutritional values of each ingredient; and table 12 - the limits on those ingredients for which any restrictions exist.

Actual Composition of Compound Animal Feed in 1968

The use of various categories of ingredients used in compound animal feed in the United Kingdom in 1968 is presented in table 9. This table indicates that 5,768 thousand tons of cereals were used during 1968 in the production of 10,132 thousand tons of compound feed. In other words, cereals represented 56.9 percent of the composition of compound feed. Similar data are available for other major ingredient categories: cereal byproducts, oil cakes, animal meal, molasses, and other. These categories are defined as follows:

1. Cereals -- include corn, sorghums, wheat, barley, oats, and rye.

2. Cereal byproducts -- include corn gluten feed, wheat middlings, wheat bran, and brewers grains.

3. Oil cakes and seeds -- include soybeans, flaxseed, soybean meal, linseed meal, cottonseed meal, palm kernal meal, peanut meal, sunflower meal, and rapeseed meal.

4. Animal meal -- includes meat and bone meal, blood meal and fish meal.

5. Molasses -- includes only molasses.

6. Other ingredients -- include peas, horse beans, alfalfa meal, grass meal, beet pulp, dried whey, dried skim milk, oyster shells, and tallow.

Table 9.--United Kingdom: Composition of compound animal feed, by volume and percentage, 1968

Category	Amount	Percentage of total
	1,000 tons	Pct.
Cereals	5,768	56.9
Cereal byproducts	990	9.8
Oil cakes and seeds	1,148	11.3
Animal meal	699	6.9
Molasses	281	2.8
Other	1,246	12.3
Total	10,132	100.0

Source: (Calculated from 24).

Table 10.--United Kingdom: Nutritional specifications of selected compound animal feeds

Nutritional specification	Cattle		Hog starter		Hog finisher		Broiler		Layer	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	Percent									
Crude fat	4.00	8.00	---	5.00	2.70	6.00	---	8.00	2.50	8.00
Crude protein	21.50	30.00	---	19.00	---	17.00	21.00	23.00	16.00	17.50
Starch equivalents	65.30	---	69.10	---	68.10	---	---	---	---	---
Metabolizable energy (Megacals per pound)	---	---	---	---	---	---	1.45	---	1.23	---
Crude fiber	---	8.00	---	8.00	---	8.00	---	5.00	---	8.00
Calcium	1.00	1.25	.65	1.00	.60	1.00	.90	1.10	1.75	3.00
Phosphorus	.70	---	.65	---	.60	---	.50	---	.60	---
Lysine	---	---	.90	---	.70	---	1.10	---	.60	---
Methionine	---	---	---	---	---	---	.40	---	.30	---
Methionine plus cystine	---	---	.57	---	.59	---	.75	---	.58	---

Source: Derived from unpublished data of the U.S. Department of Agriculture, Foreign Agriculture Service.

Table 11.--United Kingdom: Nutritional values of various compound animal feed ingredients

Ingredient	Starch value	Metabolizable energy	Crude fat	Crude protein	Crude fibre	Calcium	Phosphorus	Lysine	Methionine	Methionine and cystine
	SE*/lb.	Megacals/lb.	Percent							
Corn	80.00	1.54	4.30	9.00	2.40	0.02	0.30	0.27	0.20	0.42
Sorghum	73.50	1.44	3.10	9.80	2.00	0.02	0.25	0 23	0.17	0.35
Wheat	73.40	1.37	1.90	12.00	2.30	0.05	0.38	0.36	0.19	0.47
Barley	69.20	1.22	2.00	11.10	5.10	0.97	0.36	0.40	0.19	0.45
Oats	60.70	1.15	5.70	10.60	10.50	0.10	0.35	0.38	0.16	0.42
Rye	71.80	1.25	1.50	9.80	2.00	0.05	0.37	0.35	0.17	0.41
Peas	69.10	1.12	1.30	22.10	5.80	0.08	0.40	1.64	0.22	0.53
Horse beans	67.30	0.00	1.10	25.20	8.00	0.13	0.59	1.57	0.21	0.48
Corn gluten feed	69.50	0.99	3.40	22.20	8.70	0.30	0.70	0.71	0.40	0.91
Wheat middlings	55.00	0.74	4.10	17.20	8.00	0.10	0.90	0.65	0.24	0.60
Wheat bran	48.20	0.59	4.40	15.60	8.90	0.11	1.23	0.59	0.22	0.55
Brewers grains	60.10	0.00	7.20	23.20	15.60	0.29	0.48	0.90	0.40	0.40
Grass meal	35.00	0.46	3.50	14.50	20.60	0.58	0.32	0.63	0.18	0.36
Alfalfa meal	38.00	0.43	2.20	16.80	26.30	0.70	0.23	0.79	0.25	0.43
Beet pulp	62.80	0.00	0.90	8.60	18.50	0.68	0.70	0.48	0.14	0.26
Soybeans	84.30	1.36	16.30	36.60	4.40	0.27	0.60	2.23	0.51	1.06
Soybean meal	69.00	0.98	1.00	43.00	7.50	0.30	0.70	2.62	0.60	1.25
Linseed	98.00	0.00	35.30	22.70	6.40	0.23	0.65	0.81	0.45	0.88
Linseed meal	66.20	0.75	6.50	33.80	9.60	0.35	0.80	1.22	0.68	1.32
Cottonseed meal	60.30	0.92	6.00	42.10	11.50	0.20	11.15	1.68	0.67	1.39
Palm kernal meal	60.50	0.63	2.10	18.50	18.50	0.00	0.69	0.74	0.31	0.77
Peanut meal	64.70	1.01	1.20	51.00	9.50	0.16	0.60	1.68	0.56	1.22
Sunflowerseed meal	41.60	0.69	2.50	35.50	21.50	0.42	1.20	1.21	0.78	1.38
Rapeseed meal	52.10	0.00	1.70	36.90	12.90	0.60	1.10	0.00	0.00	0.00
Fish meal	71.80	1.46	12.00	65.70	0.00	4.50	3.00	4.86	1.91	2.56
Meat and bone meal	54.00	0.87	3.70	49.90	2.40	0.81	0.41	2.60	0.65	0.90
Blood meal	52.80	1.18	6.80	58.20	2.00	7.50	3.60	3.38	0.87	1.39
Dried whey	78.50	0.87	0.10	12.30	1.00	0.86	0.72	0.70	0.30	0.61
Dried skim milk	77.80	1.14	1.10	33.10	0.60	1.28	0.04	2.70	0.80	1.20
Molasses	42.20	0.97	0.00	3.20	0.00	0.50	0.06	0.00	0.00	0.00
Oyster shells	0.00	0.00	0.50	0.00	0.00	38.00	0.00	0.00	0.00	0.00
Tallow	209.00	3.30	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*Starch equivalent.

Source: Derived from unpublished data of the U. S. Department of Agriculture, Foreign Agricultural Service.

Table 12.--United Kingdom: Maximum amount of various ingredients in selected compound animal feeds 2/

Ingredient	Compound feed			
	Cattle	Hog starter	Hog finisher	Poultry 2/
	Percent			
Sorghum	50	50	50	50
Wheat	50	50	50	50
Rye	20	5	5	5
Peas	20	20	20	--
Beans	5	5	5	--
Linseed	10	--	--	--
Rapeseed meal	10	--	--	--
Soybeans	10	--	--	--
Corn gluten feed	20	20	20	20
Wheat middlings 3/	25	25	25	25
Wheat bran 3/	25	25	25	25
Beet pulp	15	5	5	--
Molasses	10	5	5	3
Oyster shells	--	--	--	5
Meat meal 4/	10	10	5	5
Fish meal	5	5	5	7
Tallow	5	5	5	5
Brewers grains	20	5	3	5
Skim milk, dried	5	5	5	5
Whey, dried	5	5	5	5
Meat and bone meal 4/	10	10	5	5
Cottonseed meal	--	10	5	5
Linseed meal	20	--	--	--

1/ All ingredients not shown in this table may be used in unlimited amounts in all compound feeds considered in this analysis.

2/ Broiler and layer rations differ only in nutritional requirements; restrictions on various ingredients are the same for both feeds.

3/ Any combination of these ingredients is restricted by the specified percentage.

4/ Any combination of these ingredients is restricted by the specified percentage.

Source: Derived from unpublished data of the U.S. Department of Agriculture, Foreign Agricultural Service.

Estimated Composition of Compound Animal Feed in 1968

The use of 1968 ingredient prices in the least cost linear program results in the percentage of various ingredients used in each of the five rations examined. 3/ To compare this analysis with known ingredient use, these percentage figures were converted to absolute amounts by weighting the percentage of a given ingredient used in a compound feed by the percentage of that compound feed to all compound feed. For example, of the 9,545,000 tons of compound cattle, hog, and poultry feed consumed in 1968, 3,280,000 tons (34.37 percent) were compound cattle feed, 870,000 tons (9.13 percent) - compound hog starter, 1,306,000 tons (13.67 percent) - compound hog finisher, 3,067,000 tons (32.13 percent) - compound layer ration, and 1,022,000 tons (10.70 percent) - compound broiler ration.

Results of the linear programming analysis indicated that wheat was used in four of the five rations; 1.20 percent in compound cattle feed, 25.38 percent in compound hog starter, 21.38 percent in compound hog finisher, and 25.84 percent in compound layer ration. No wheat was used in compound broiler rations. Weighting these wheat percentages by the above-given percentages of each of the compound feeds resulted in a total wheat use of 13.95 percent of all compound feed. This procedure was used for each ingredient.

Comparison of Actual and Estimated 1968 Ingredient Use

Results of a comparison of this estimated ingredient use with actual ingredient use (table 13) showed the linear program to be an accurate method in predicting use of various ingredients. Total cereals used in compound feeds were predicted to be 52.20 percent, slightly lower than the actual usage of 56.90 percent. The major substitutes for cereals, namely, cereal byproducts and oil cakes and seeds, were both estimated slightly higher (1.16 and 2.33 percent, respectively). However, these differences were not considered sufficiently large to necessitate a reevaluation of the linear program.

EFFECTS OF ALTERNATIVE POLICIES ON PROJECTED LEVEL OF INDEPENDENT VARIABLES

Based on the above discussions of demand analysis and linear programming, projections of all necessary independent variables affecting the consumption of compound feed in the United Kingdom can now be made. These include: price of animal products, price of compound feed ingredients, price of compound feed, technical coefficients, and an index of net returns. These projections are used to estimate consumption of compound feed and compound feed ingredients to 1980.

3/ Prices used were those most representative of the prices paid by the compounder. For domestically produced commodities, market prices were used. For commodities that were imported, the price used reflected all insurance, freight, and tariff charges.

Table 13.--United Kingdom: Composition of compound animal feed, estimated composition using 1968 ingredient prices, and actual 1968 composition, by percentage

Category	Actual 1968	Estimated 1968	Absolute percentage difference
	Percent		
Cereals	56.90	52.20	-4.70
Cereal byproducts	9.80	10.96	+1.16
Oil cakes and seeds	11.30	13.63	+2.33
Animal meal	6.90	6.66	-0.24
Molasses	2.80	2.53	-0.27
Other	12.30	14.02	+1.72
Total	100.0	100.0	---

(Calculated from 24.)

Projected Price of Selected Agricultural Products

Theoretical prices

Figure 1 shows the theoretical effects of alternative economic policies upon the price of agricultural products in the United Kingdom. The market price of the commodity, P_1, is shown to have increased over time, as has the total price (market price plus direct Government payment, P_2). Other things being equal, these are projected into the future at the same rate as they have changed in the past. Under the deficiency payment method of price support used until recently in the United Kingdom, the farmer received P_2 for his product, P_1 of which comes from the market price, and $P_2 - P_1$ from a Government payment.

Since the United Kingdom is a net importer of agricultural products, the total price of P_2 can alternatively be supported through a system of import restrictions. If these restrictions are gradually imposed during the period T_1 to T_2, the market price will increase from P_1 to P_2, the farmer will still receive a total price equal to P_2, and the direct Government payment will have been eliminated. While this does not affect the total price received by the farmer, it does increase the market price of the commodity. If the commodity is a grain, the increased market price must be absorbed by the compound feed manufacturer, with the result that the price of compound feed may increase and less grain may be used in the final least cost ingredient mix.

With functional EC membership, prices at existing CAP levels will be imposed upon the United Kingdom. A transition period (in this case T_1 to T_3) will of course be required to reduce the impact of these new prices. The result, however, will be an increase in the farm price of the commodity to P_3. The impact on the compound feed manufacturer will be similar, although more severe than under the

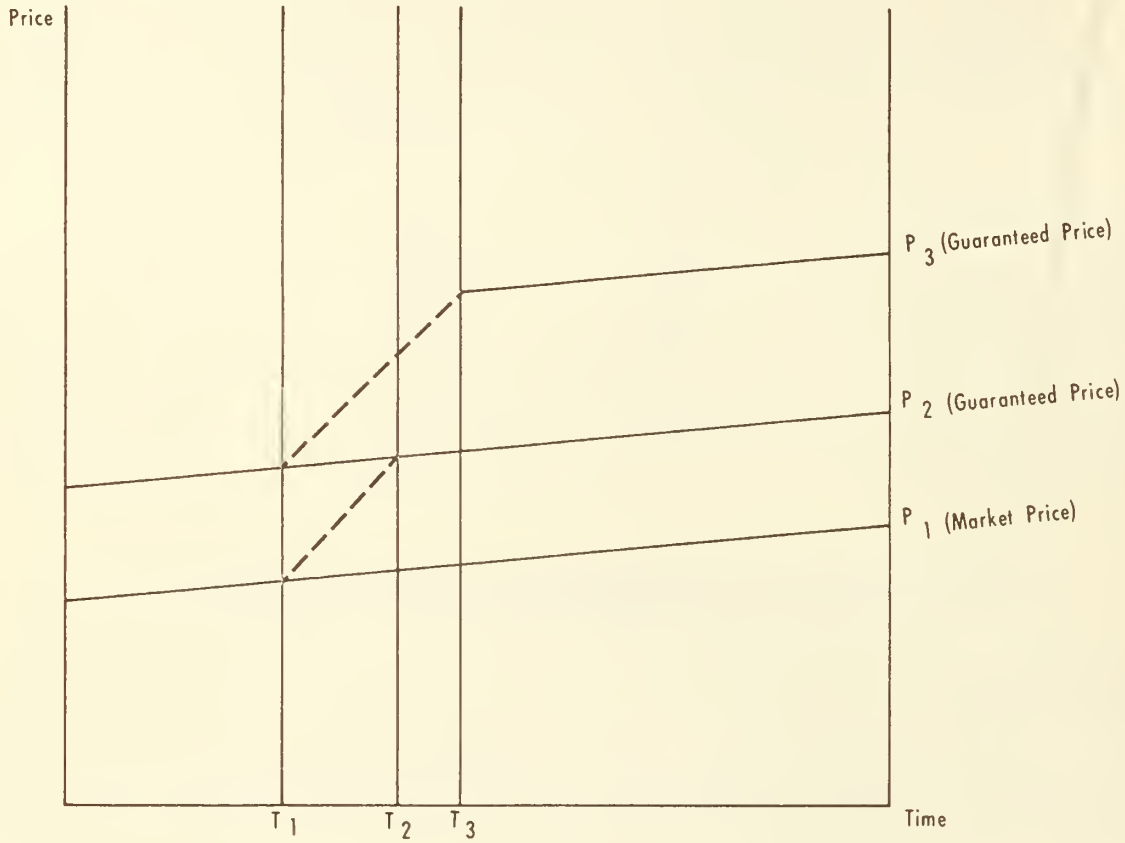

FIGURE 1.

UNITED KINGDOM: EFFECTS OF ALTERNATIVE POLICIES
ON PRICE OF SELECTED PRODUCTS

variable import levy system. The farmer, however, will receive a higher price for most agricultural commodities than under either of the two alternative policies.

Projected prices

Animal products.--Projections of nominal prices of animal products in the United Kingdom for 1971-80 are presented in table 14. The projections were made under three policy assumptions: (1) Continuation of the deficiency payment method of price support, (2) replacement of deficiency payments with an increased minimum import price and variable import levies, and (3) entry into the EC at full CAP prices.

Using price data from the 1957-70 period, projections of the price of each product were made to 1980 and used for both the deficiency payment and variable import levy policy assumptions. In doing this, time was used as the independent variable for beef, milk, and pig meat, and the log of time as the independent variable for poultry meat and eggs. The projection of poultry meat price was modified to show a slight increase in price, rather than a small decrease projected from the above equation. Considerable adjustment in the size of broiler operations, with accompanying economies of size, was noted in the United Kingdom in the past decade. These decreased costs of production (due to greater labor and feed conversion efficiency, etc.) cannot be expected to continue as in the past, and so an upward modification of expected poultry meat price was required.

Because it was assumed that the stated purpose of variable import levies, viz., to reduce Government costs, and not to increase farm income, will in fact be carried out, the price projections dealing with the first two policies are identical. Variable import levies will be set at a level to assure market prices equal to the previous market price plus deficiency payment. Since the projected price under the deficiency payment system included all Government price-support payments, there should be no difference between the two price projections.

Membership in the EC is expected to result in higher farm prices than would have been realized under alternative policies for all commodities considered in this report. It was assumed that United Kingdom entry into the EC would begin in 1972, a transition period to allow impact for change in farm-support prices would begin in 1973, and that full EC membership and farm prices fully supported at CAP levels would be in effect by 1978. For this reason, farm prices assuming EC membership increased gradually over the price under other policies in the period 1973-78, after which time no further increases attributable solely to EC membership will be noted.

In estimating CAP price levels in 1978, the final year of the expected transition period, the latest EC intervention prices were used for grains. An orientation price was used for beef, a target price for milk, and a base price for pork. Average producer prices were used for poultry products. The intervention price for a commodity is that price at which the EC is authorized to purchase commodities in the market, thereby supporting prices. Although differing among individual commodities, the basic price for each important domestically produced commodity is the target price. Since target prices in the EC are substantially higher than world prices, it is necessary to insulate the domestic market from imports being sold at lower prices. A threshold price, which is the

Table 14.--United Kingdom: Projected farm price of selected animal products, various policy assumptions, 1971-80 1/

Commodity and policy	Unit	Year									
		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
		Cents									
Poultry meat	lb.										
DP		16.69	16.40	16.84	17.28	17.72	18.16	18.58	19.00	19.25	19.50
VIL		16.69	16.40	16.84	17.28	17.72	18.16	18.58	19.00	19.25	19.50
EC		16.69	16.40	17.04	17.68	18.32	18.98	19.62	20.25	20.50	20.75
Eggs	doz.										
DP		33.78	33.35	32.94	32.55	32.18	31.83	31.49	31.17	30.86	30.56
VIL		33.78	33.35	32.94	32.55	32.18	31.83	31.49	31.17	30.86	30.56
EC		33.78	33.35	33.04	32.77	32.49	32.33	32.00	31.77	31.56	31.33
Beef	lb.										
DP		22.51	23.41	24.31	25.21	26.11	27.01	27.51	28.81	29.71	30.61
VIL		22.51	23.41	24.31	25.21	26.11	27.01	27.91	28.81	29.71	30.61
EC		22.51	23.41	24.91	26.41	27.92	29.42	30.92	32.43	33.33	34.23
Milk	gal.										
DP		39.74	39.97	40.19	40.41	40.64	40.86	41.08	41.30	41.53	41.74
VIL		39.74	39.97	40.15	40.41	40.64	40.86	41.08	41.30	41.53	41.74
EC		39.74	39.97	40.64	41.34	41.98	42.65	43.32	43.98	44.19	44.40
Cull cows	lb.										
DP		13.82	14.13	14.44	14.75	15.06	15.37	15.69	16.00	16.31	16.62
VIL		13.82	14.83	15.88	16.96	17.27	17.59	17.90	18.21	18.52	18.83
EC		13.82	14.69	15.59	16.52	17.47	18.45	19.45	19.78	20.11	20.44
Pig meat	lb.										
DP		26.89	26.83	27.33	27.83	28.33	28.84	29.34	29.84	30.34	30.84
VIL		26.89	26.83	27.33	27.83	28.33	28.84	29.34	29.84	30.34	30.84
EC		26.89	26.83	28.20	29.57	30.94	32.31	33.68	35.04	35.19	35.34

1/ DP = Continuation of deficiency payment price-support system, deficiency payment included.
VIL = Enaction of a system of variable import levies (1971-73 transition period).
EC = Membership in the European Community with full acceptance of the Common Agricultural Policy (1973-78 transition period).

minimum import price, is established to ensure that imported commodities may not be delivered at a price lower than the target price, taking into account quality and transportation differentials. For each commodity, the lowest c.i.f. price is determined, and an amount (a variable import levy) is added to this so that the price is equal to the target price. The variable import levy is then applied to all imports of the particular commodity.

Even with this protection from low-priced imports, prices received by farmers might fall below a minimum level consistent with the target price. To prevent this, intervention prices are established at the wholesale level. If the farm price falls below the intervention price, an intervention agency is authorized to purchase the commodity. In recent years, the authority to intervene has been required, and the intervention price has usually been the price actually received by the farmer. With this in mind, the intervention price was used in this research as the price most likely to be realized in the event of United Kingdom membership in the EC.

Compound feed ingredients.--The projected price of compound feed ingredients is presented in table 15. For items produced domestically, the home market price is projected. For items primarily or totally imported, a c.i.f. price plus any import charge is projected, although in most cases there have been no import restrictions. In other words, the price projections are those faced by the compound feed manufacturer. A 1957-70 time series was developed and used to predict prices to 1980 ($P_i = f(T)$), under the assumption of continued deficiency payments. For commodities not affected by support policy under any of the considered policy alternatives, the projected ingredient prices in 1980 under each policy alternative are identical. The price of ingredients subject to Government support (feed grains) varies in each alternative policy. For example, the price of barley in 1980 is projected at $57.46 per ton under deficiency payment price supports, to $84.54 per ton under a variable import levy policy, and to $97.40 per ton with acceptance of EC membership. This higher price of feed grains relative to other compound feed ingredients is expected to result in a decreased use of feed grains and an increased use of substitute ingredients in compound animal feeds.

Compound animal feed.--The ingredient prices developed were used in the linear programming model to show what shifts can be expected in the percentage of ingredients used under alternative policy assumptions. As ingredient prices change, however, not only do ingredient proportions change but total ingredient cost in the optimal mix changes (least cost solution) as well. The change in the total ingredient cost was used to predict change in total price of the compound feed paid by the farmer. These projected compound feed prices are presented in table 16.

The price of compound feed projected to 1980, assuming continuation of deficiency payments, is simply a linear projection of the rate of change in the price of compound feeds during 1957-69. This was done since the individual ingredient prices were assumed to change in the same manner. Thus, the price of compound broiler ration was projected to increase from $103.09 per ton in 1971 to $116.88 per ton in 1980, if the policy of deficiency payments had continued.

Price projections under a deficiency system were then used as a base in all other projections. A constant percentage margin over the cost of the feed

Table 15.--United Kingdom: Price of compound feed ingredients, actual 1968 prices and projected 1980 prices under various policy assumptions

Ingredient	1968	1980 2/		
		DP Deficiency payments	Variable import levies	EC European Community
		$/M.T.		
Corn	53.44	66.29	79.62	95.62
Sorghum	52.22	73.74	81.25	96.45
Wheat	49.41	77.81	84.03	107.46
Barley	51.85	57.46	84.59	97.40
Oats	42.09	54.14	68.15	93.57
Peas	117.12	197.84	197.84	197.84
Horse beans	64.85	93.09	93.09	93.09
Corn gluten feed	76.25	133.30	133.30	133.30
Flaxseed	122.98	135.59	135.59	135.59
Linseed meal	115.29	159.48	159.48	159.48
Peanut meal	129.32	186.61	181.61	181.61
Cottonseed meal	100.04	138.76	138.76	138.76
Rapeseed meal	74.18	85.96	85.96	85.96
Soybeans	117.61	152.45	152.45	152.45
Soybean meal	121.39	169.68	169.68	169.68
Sunflower meal	91.26	103.07	103.07	103.07
Wheat pollards	54.90	71.81	71.81	71.81
Wheat bran	74.42	95.75	95.75	95.75
Palm kernal	85.40	113.80	113.80	113.80
Beet pulp	56.73	73.64	73.64	73.64
Alfalfa meal	66.49	73.15	73.15	73.15
Grass meal	65.88	69.20	69.20	69.20
Molasses	26.57	50.19	50.19	50.19
Blood meal	217.16	284.80	284.80	284.80
Fish meal	202.52	273.45	273.45	273.45
Tallow	51.00	67.08	67.08	67.08
Brewers grains	65.88	78.03	78.03	78.03
Skim milk	234.24	338.01	338.01	338.01
Whey powder	163.48	205.59	205.59	205.59
Meat and bone meal	109.80	120.34	120.34	120.34
Oyster shells	33.55	28.13	28.13	28.13

1/ Farmer and Stockbreeder (London: Agricultural Press, Ltd.) various issues.

2/ Developed from time series used in footnote 1. Modifications for alternative economic policies are explained in figure 1.

DP = Continuation of deficiency payment price-support system, deficiency payment included.

VIL = Enaction of a system of variable import levies (1971-73 transition period).

EC = Membership in the EC with full acceptance of the Common Agricultural Policy (1973-78 transition period).

Table 16.--United Kingdom: Projected price of compound animal feeds, by class, various policy assumptions, 1971-80

Compound class and policy	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	$/M.T.									
Broiler										
DP	103.09	104.60	106.14	107.68	109.21	110.73	112.26	113.80	115.31	116.85
VIL	107.09	112.63	118.14	119.68	121.22	122.76	124.29	125.83	127.39	128.93
EC	103 09	104.60	109.90	115.17	120.46	125.73	131.00	136.30	137.79	139.32
Layer										
DP	87.60	88.89	90.18	91.48	92.79	94.09	95.38	96.67	97.99	99.28
VIL	91.01	95.89	100.00	101.99	103.29	104.51	105.73	107.16	108.48	109.78
EC	87.60	88.89	93.40	97.92	102.43	106.95	111.46	115.97	117.29	118.58
Cattle										
DP	93.60	94.82	96.04	97.26	98.48	99.72	100.94	102.16	103.38	104.63
VIL	96.84	101.31	105.80	107.02	108.24	109.48	110.70	111.92	113.14	114.39
EC	93.60	19.82	98.50	102.19	105.87	109.53	113.22	116.90	118.12	119.36
Hog										
DP	86.50	87.35	88.21	89.06	89.94	90.77	91.65	92.50	93.35	94.23
VIL	91.45	97.26	103.04	103.68	104.31	104.94	105.58	106.21	107.07	107.95
EC	86.50	87.35	91.87	96.36	100.87	105.38	109.90	114.41	115.27	116.14

1/ DP = Continuation of deficiency payment price-support system, deficiency payment included.
VIL = Enaction of a system of variable import levies (1971-73 transition period).
EC = Membership in the EC with full acceptance of the Common Agricultural Policy (1973-78 transition period).

ingredients was assumed, 4/ and as the least cost solution increased by a given percentage, the price of the compound feed was projected to increase by that same percentage. For example, each compound feed linear program was run assuming 1980 ingredient prices under various policies. Results of this analysis indicated that the total cost of ingredients used in compound broiler ration would be 10.34 percent higher with variable import levies, and 19.23 percent higher with entry into the EC, than would be expected under the deficiency payment system. The 10.34 and 19.23 percents were therefore used to project price of compound broiler feed in 1980 to be $128.93 and $139.32 per ton under the respective policy assumptions. This method was employed for other years, as well as for all compound feeds.

In table 16 the timing of changes and the absolute level of changes in 1980 is significant. In general, the variable import levy assumption results in a rather severe increase during 1971-73 and then a tapering off of increases to 1980. Entry into the EC will result in less severe increases to 1973, but more severe increases through 1978, and therefore a greater change in the long run than under any other policy assumption. The timing of these shifts is, of course, directly traceable to the 1971-73 transition period assumed for enaction of variable import levies, and the 1973-78 transition period assumed for entry into the EC.

Projected Technical Coefficients

Projections were also made for technical coefficients (feeding rates and labor requirements) for each of the animal products considered. These projections, conversions of those done by Ferris 5/, are presented in tables 17 and 18.

Table 17 shows very little rate of change in concentrate requirement per gallon of milk projected to 1980. A slight increase is projected in feeding rates for beef. If beef production becomes more intensive, the feeding rate could increase even more. Efficiency in pig meat feeding is expected to increase, with resultant lower feeding rates. Factors contributing to this greater efficiency include artificial insemination, improved breeding stock, progeny testing, and earlier weaning of young. Most of the increases in feed conversion efficiency with respect to poultry meat production have already been realized. Further improvement will be limited, since the rapid structural adjustments experienced by the broiler industry in the past decade are not likely to continue at the same rate. The trend in feed conversion rates for egg production, although decreasing at a slower pace than in the past decade, is still projected to decrease considerably by 1980 because of a shift from small-or medium-scale operations to larger operations, similar to the shift already noted in the broiler industry.

4/ There was no a priori reason for expecting this margin to be a constant amount rather than a constant percentage. Specialists in the United Kingdom suggested the use of the constant percentage margin, although there was no unanimity in this opinion. In the event that further analysis suggests any different assumption concerning this margin, the model could be readily altered.

5/ This study used both published and unpublished material in arriving at these estimates. Unpublished Ministry of Agriculture, Fisheries, and Food (M.A.F.F.) farm surveys were particularly useful, as well as discussions with various officials in the United Kingdom. With the exception of some conversion so that units would be consistent, no changes were made in these projections used in the study presented herein. See (11).

Table 17.--United Kingdom: Projected amount of concentrates fed per unit of output, various livestock products, all holdings, 1971-80

Pounds of concentrate fed per:	Year									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Gallon of milk	3.66	3.64	3.62	3.60	3.58	3.56	3.54	3.52	3.50	3.48
Dressed beef	4.93	4.96	4.99	5.03	5.06	5.09	5.12	5.16	5.19	5.22
Dressed pig meat	5.23	5.18	5.12	5.07	5.02	4.96	4.91	4.85	4.80	4.75
Dressed poultry meat	3.13	3.10	3.07	3.04	3.01	2.98	2.95	2.52	2.89	2.86
Dozen eggs	3.03	2.99	2.95	2.91	2.87	2.83	2.79	1.75	2.71	2.67

Source: Extrapolated from (11).

Table 18.--United Kingdom: Projected technical coefficients of labor requirements for various livestock classes, 1971-80

Livestock	Year									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	Man-days									
Dairy	15.26	15.20	15.14	15.08	15.03	14.97	14.92	14.86	14.80	14.75
Livestock (beef)	14.89	14.62	14.34	14.09	13.83	13.56	13.30	13.03	12.77	12.50
Hogs	1.145	1.110	1.075	1.040	1.005	1.970	0.935	0.900	0.865	.830
Broilers	.00695	.00680	.00665	.00650	.00635	.00620	.00605	.00590	.00575	.0056
Laying hens	.1095	.1055	.1015	.0975	.0935	.0895	.0855	.0815	.0775	.0735

Source: Extrapolated from (11).

Projections of labor requirements (man-days) were made similar to feed conversion rate projections. Gains in labor efficiency will be most noticeable with hogs. Labor requirements for all other stock classes, while projected to decrease, will not change as rapidly through 1980 as in the past decade.

Projected Index of Net Returns

Using the projections of various prices and technical coefficients previously presented, projected net return indices can now be calculated. They are presented, with the respective policy assumptions, in table 19.

The index of net return projections for poultry meat indicates higher returns in 1980 with deficiency payments than under the other two policies. The index in 1980 with other policies is approximately equal, although variable import levies are expected to result in a major decrease in this return during the 1971-73 transition period, followed by a steady recovery from 1974 to 1980. The trend reflects the underlying increase in price of compound feed with no increase in the price of poultry meat during the period of transition.

The other segment of the poultry industry--egg production--is also expected to benefit from higher returns under deficiency payments than under other policies. The difference between the respective policies, however, is not as great as is projected for poultry meat. Also, in the case of egg production, there is not significant decrease in the net return index during the 1971-73 transition to variable import levies, as appeared in the broiler industry.

Contrary to expected net returns in the poultry industry, the index of net returns for both beef and dairy shows the greatest increase in the event of entry into the EC. The large increase in index of net returns of milk, stemming in part from the lack of a two-price plan in the EC, would result in substantially higher prices for manufacturing milk and lower prices for liquid milk, but the overall effect would be a fairly substantial increase in milk prices. Likewise, owing to substantially higher beef prices in the EC, entry is expected to result in a large increase in net returns per unit of beef by 1980.

The index of net returns must not be confused with total revenue expected from a unit of beef, since Government production grants have been an additional incentive to produce beef. In addition to guaranteed prices to support current prices, the Government has in the past offered direct payments to beef producers to help meet certain expenses. These payments have been quite substantial, and their increase has been one of the major reasons for the continued expansion of the beef industry. As the United Kingdom accepts entry into the EC, these production grants will be phased out, and the incentive toward increased beef production will have been reduced. In other words, the net return per unit of beef variable is meaningful only when viewed in combination with the production grants received directly from the Government.

Net returns per unit of pig meat are expected to increase under each assumption, although because of higher price for compound feed with no corresponding increase in pig meat price, these returns will be smaller under a variable import levy system than under other policies.

Table 19.--United Kingdom: Projected index of returns per unit of product over the cost of required concentrate per unit of labor, by animal product and policy assumption, 1971-80 1/

(1956-58 = 1.00)

Animal product and policy	Year									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Poultry meat										
DP	0.801	0.828	0.833	0.955	1.100	1.201	1.329	1.464	1.560	1.663
VIL	0.754	0.587	0.477	0.575	0.700	0.820	0.920	1.072	1.162	1.258
EC	0.801	0.830	0.775	0.882	0.875	0.939	1.003	1.072	1.167	1.266
Eggs										
DP	1.646	1.675	1.708	1.747	1.789	1.839	1.894	1.958	2.029	2.109
VIL	1.614	1.610	1.610	1.645	1.685	1.732	1.785	1.834	1.911	1.985
EC	1.646	1.675	1.686	1.702	1.804	1.743	1.772	1.805	1.881	1.965
Milk										
DP	1.151	1.161	1.171	1.181	1.191	1.202	1.211	1.221	1.233	1.243
VIL	1.129	1.118	1.106	1.116	1.126	1.137	1.148	1.157	1.168	1.178
EC	1.151	1.166	1.211	1.246	1.289	1.301	1.312	1.324	1.335	1.347
Beef										
DP	1.830	1.902	1.947	2.046	2.122	2.204	2.286	2.374	2.463	2.557
VIL	1.825	1.889	1.954	2.026	2.101	2.182	2.264	2.351	2.438	2.533
EC	1.830	1.922	2.019	2.135	2.257	2.386	2.520	2.659	2.753	2.855
Pig meat										
DP	1.499	1.540	1.587	1.635	1.690	1.745	1.806	1.874	1.961	2.024
VIL	1.439	1.416	1.457	1.444	1.494	1.551	1.610	1.676	1.742	1.810
EC	1.499	1.540	1.575	1.611	1.650	1.698	1.747	1.819	1.906	2.007

1/ DP = Continuation of deficiency payment price-support system, deficiency payment included.
VIL = Enaction of a system of variable import levies (1971-73 transition period).
EC = Membership in the European Community with full acceptance of the Common Agricultural Policy (1973-78 transition period).

Projected Livestock Numbers

Employing the projected net return variable in the animal number equations developed earlier, animal numbers may now be projected through 1980. These projections are presented in table 20 and will lead directly to an estimate of compound feed consumption.

Broilers

The number of broilers increased substantially during the past decade, despite declining poultry meat prices. Even when labor and feeding efficiency are considered, returns per unit of poultry meat declined slightly. Apparently, economies of size were realized, resulting in this expanded broiler industry. One of these must be lower than average compound feed costs (average was used in this analysis) available to the increased number of broiler operations with 20,000 or more birds. Because these economies will not be as readily available in the future, broiler expansion is expected to continue at a slower pace.

The most rapid increase in broiler numbers is expected with a continuation in deficiency payments, chiefly because of a slight increase in projected poultry meat price and continued increases in labor efficiency. The price of compound feed is expected to increase, but with an offsetting decrease in feeding rates.

The number of broilers under the other two policies will be substantially reduced from this number, although still remain above 1970 levels. Increased compound feed prices, with no corresponding increase in poultry meat price under the variable import levy system, will result in the greatest reduction in broiler numbers. A somewhat higher poultry meat price if EC membership is accepted will increase broiler numbers slightly, although still substantially below deficiency payment system levels.

Laying hens

The number of laying hens has increased steadily, but moderately, in the last 10 years. This expansion is projected to continue through 1980 with a continuation in deficiency payments. It is expected that a slight reduction in this number will be realized with variable import levies on EC membership, owing to the increase expected in the price of compound layer ration. Regardless of policy assumption, the number of laying hens is therefore expected to increase only moderately.

Dairy cows

The number of milk cows has shown more consistency than any other livestock category during 1957-69. The slight increase in milk cow numbers has been quite regular. The index or net returns calculated for this period showed a slight increase.

A slight decrease in the number of milk cows is projected to 1980, regardless of the assumed policy. The decrease will be smallest with deficiency payments because of modest increases in compound feed prices. Also, the price of cull cows is expected to continue at low levels, offering little incentive to reduce the number of dairy cows.

Table 20.--United Kingdom: Projected livestock numbers, by class, various policy assumptions, 1971-80 1/

Animal class and policy	Year									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
	Thousands									
Broilers										
DP	52,417	53,719	54,987	56,833	59,351	62,830	66,268	70,253	74,556	79,747
VIL	52,171	52,226	51,704	51,518	52,193	53,463	54,675	56,353	58,747	62,002
EC	52,417	53,729	54,694	56,173	57,547	59,192	61,096	63,272	65,844	68,815
Laying hens										
DP	77,093	77,713	78,186	78,594	78,968	79,362	79,778	80,238	80,747	81,315
VIL	76,985	77,429	77,688	77,959	78,251	78,422	78,681	79,012	79,632	80,244
EC	77,093	77,713	78,111	78,398	78,911	79,013	79,155	79,356	79,731	80,234
Poultry										
DP	129,510	131,432	133,173	135,427	138,319	142,192	146,046	150,491	155,303	161,062
VIL	129,156	129,655	129,392	129,476	130,440	131,855	133,356	135,365	138,379	142,246
EC	129,510	131,442	132,882	134,571	136,458	138,195	140,251	142,628	145,575	149,049
Dairy cows										
DP	3,265	3,251	3,240	3,231	3,224	3,217	3,210	3,204	3,198	3,191
VIL	3,242	3,223	3,185	3,144	3,100	3,069	3,046	3,031	3,017	3,003
EC	3,243	3,225	3,215	3,205	3,199	3,181	3,145	3,135	3,120	3,109
Beef cows										
DP	1,260	1,308	1,356	1,403	1,450	1,497	1,544	1,592	1,640	1,689
VIL	1,260	1,305	1,348	1,388	1,429	1,471	1,513	1,556	1,600	1,645
EC	1,260	1,307	1,353	1,378	1,385	1,377	1,356	1,326	1,286	1,255
Cattle										
DP	12,576	12,670	12,770	12,870	12,974	13,077	13,180	13,287	13,395	13,502
VIL	12,540	12,625	12,666	12,670	12,732	12,786	12,852	12,934	13,019	13,106
EC	12,542	12,628	12,724	12,770	12,777	12,730	12,636	12,536	12,415	12,323
Hogs										
DP	8,040	8,192	8,152	8,191	8,242	8,315	8,407	8,517	8,652	8,788
VIL	7,999	7,922	7,897	7,871	7,887	7,837	8,012	8,109	8,221	8,345
EC	8,040	8,035	8,056	8,095	8,149	8,219	8,300	8,405	8,537	8,698

1/ DP = Continuation of deficiency payment price-support system, deficiency payment included.
VIL = Enaction of a system of variable import levies (1971-73 transition period).
EC = Membership in the European Community with full acceptance of the Common Agricultural Policy (1973-78 transition period).

With variable import levies, and more significantly with entry into the EC, compound feed prices and cull cow prices are expected to increase. This policy will lead to a reduction in the number of dairy cows, although increased milk prices in the EC will tend to support dairy cow numbers.

Beef cows

Because of the United Kingdom's encouragement of beef production as a means of reducing imports, Government policy has favored beef production in recent years. The result has been a marked increase in beef cow numbers in the past 10 years. Under the assumption of a continuation in deficiency payments, beef cow numbers should continue this steady expansion, providing there is a continuation of the trend in the level of production grants that have been available to beef producers. Variable import levies will increase compound beef feed prices, but will not affect any other variables. This policy is expected to result in a somewhat smaller number of beef cows in 1980 than would be noted with deficiency payments.

The major change in beef cow projections will occur with accession to the EC. This policy will increase beef prices rather sharply, resulting in an increase in the index of net returns for beef. In contrast to this incentive, however, is the elimination of all production grants by 1978. Since beef producers have in the past relied heavily upon these grants, the final result is expected to be a significantly smaller beef herd in 1980 under this policy than under either deficiency payment or variable import levy systems. The number of beef cows is expected to increase during the early and middle 1970's, until the full effect of the production grant elimination is felt in the middle and late 1970's.

Hogs

Production of pig meat, like that of beef, has shown continued improvement in recent years. At least in part, the improvement is attributable to the direct relationship between feed prices and deficiency payments. Assuming the relationship continues, deficiency payment continuation is expected to result in increased hog numbers by 1980. Although hog numbers will also expand with variable import levies, the increased cost of compound feed will dampen this expansion. Entry into the EC will further increase the compound feed price, but it will also increase the price of pig meat. The 1980 projection of hog numbers in the event of EC membership is, accordingly, higher than under the variable import levy assumption, although still below the deficiency payment projection.

Livestock and policy overview

In general, livestock numbers in 1980 are projected to be greatest if deficiency payments are assumed to continue, and slightly less under each of the alternative policy assumptions. The number of cattle, however, is expected to be significantly lower if EC entry is assumed than if variable levies are employed. Contrariwise, hog numbers are projected to be greater in 1980 with EC entry than with a system of variable levies. Deficiency payments are forecast to increase hog numbers even further. Poultry numbers projected to 1980 are greatest with deficiency payments and least with variable import levies.

Independent variable projections are here used to project the amount of compound feed and compound feed ingredients consumed through 1980. Implications of these results with respect to trade of ingredients are also discussed.

Projected Compound Feed Ingredient Use

Consumption of compound animal feed and corresponding ingredient use is projected to 1980 in table 21. (A more detailed presentation is available in appendix table 8.) Projections refer only to cattle, hog, and poultry feed; no attempt was made to examine other compound feeds, which amounted to only 6 percent of total consumption in 1969.

Total

All three policy assumptions are expected to produce increased compound feed consumption by 1980. Consumption of the major compound feeds is projected to increase from the 1968 level of 10.0 million tons to over 11.2 million tons in 1980 with deficiency payments, and to over 10.6 million tons by 1980 under other policies. Major shifts within this total consumption are also apparent. For example, compound cattle feed consumption in 1980 is projected to be substantially lower with EC entry, whereas consumption of compound layer ration is projected to show a slight increase.

Because of changes in the relative price of compound feed ingredients, significant changes in the mix of each compound feed have been hypothesized. Examination of various ingredient categories indicates what these changes can be expected to be.

Cereals

As hypothesized, the significant increase in the relative price of cereals with a variable import levy system, and even further increases with EC entry, will result in a sharp reduction in use of cereals in compound feeds. Cereal use is projected to decrease from 6.1 to 4.7 and finally to 4.0 million tons under the respective policies. Because of nutritional restrictions, however, this reduction will not be uniform among each compound feed examined. The most substantial reduction occurs with cattle feed, with a more modest decrease in cereal use for compound hog feed, and an even more modest decrease expected in poultry feeds.

On a percentage basis, with continuation of deficiency payments, cereals are expected to constitute 54 percent of total compound feeds in 1980 (table 22), or approximately the same percentage as in 1968. Variable import levy increases in grain prices will reduce this percentage to 44 percent in 1980, while EC membership will reduce the percentage in 1980 to a lower 37 percent. The most significant percentage reduction is predicted in compound cattle feed, with no significant change in broiler rations being predicted.

Table 21.--United Kingdom: Projected amount of various feed ingredient categories used in compound feed, by policy assumption, 1980 1/

Category	Feed					
	Cattle	Hog starter	Hog finisher	Layer	Broiler	Total 2/
	1,000 tons					
Cereals						
DP	1,690.5	622.8	955.5	1,895.6	920.0	6,084.5
VIL	1,312.6	471.1	696.8	1,432.2	754.8	4,667.6
EC	568.5	478.6	691.7	1,461.1	808.6	4,008.4
Cereal byproducts						
DP	834.1	197.8	311.8	---	---	1,343.7
VIL	791.5	226.3	344.6	264.1	---	1,626.5
EC	801.5	237.0	348.6	269.4	---	1,656.5
Oil cakes and seeds						
DP	1,111.4	29.6	92.3	---	347.5	1,580.7
VIL	1,034.1	65.3	162.4	---	272.9	1,534.7
EC	1,132.1	72.9	180.2	---	292.5	1,677.7
Molasses						
DP	---	---	---	---	---	---
VIL	95.4	---	---	89.5	---	184.9
EC	370.2	10.0	34.1	91.3	---	505.7
Animal and fish meals						
DP	273.7	103.8	61.6	326.8	145.1	911.0
VIL	253.6	98.4	69.1	309.5	119.2	849.7
EC	379.0	103.0	71.1	315.7	127.7	1,002.5
Other						
DP	260.2	85.0	137.8	775.1	63.8	1,322.0
VIL	469.7	122.6	202.7	888.8	70.6	1,754.5
EC	538.1	128.9	214.1	906.8	75.7	1,863.6
Total						
DP	4,169.9	1,039.1	1,558.9	2,997.6	1,476.4	11,241.9
VIL	3,957.0	983.7	1,475.6	2,984.1	1,217.5	10,618.0
EC	3,789.4	1,030.4	1,545.9	3,044.3	1,304.5	10,714.5

1/ DP = Continuation of deficiency payment price-support system, deficiency payment included. VIL = Enaction of a system of variable import levies (1971-73 transition period). EC = Membership on the European Community with full acceptance of the Common Agricultural Policy (1973-78 Transition period). 2/ Total may not add to sum of individual feeds due to rounding errors in converting from long to metric tons.

Table 22.--United Kingdom: Projected percentage of various feed ingredient categories used in compound feed, by policy assumptions, 1980 1/

Category	Feed					
	Cattle	Hog starter	Hog finisher	Layer	Broiler	Total
	Percent					
Cereals						
DP	40.54	59.93	61.30	63.24	62.31	54.13
VIL	33.17	47.89	47.22	48.00	61.99	43.96
EC	15.00	46.43	44.74	48.00	61.99	37.38
Cereal byproducts						
DP	20.00	19.03	20.00	---	---	11.95
VIL	20.00	23.00	23.35	8.85	---	15.32
EC	21.15	23.00	22.55	8.85	---	15.46
Oil cakes and seeds						
DP	26.65	2.84	5.92	---	23.54	14.06
VIL	26.13	6.63	11.00	---	22.42	14.45
EC	29.87	7.07	11.66	---	22.42	15.66
Molasses						
DP	---	---	---	---	---	---
VIL	2.41	---	---	3.00	---	1.74
EC	9.77	.97	2.21	3.00	---	4.76
Animal and fish meals						
DP	6.57	10.00	3.95	10.90	9.83	8.10
VIL	6.41	10.00	4.68	10.37	9.79	8.00
EC	10.00	10.00	4.99	10.37	9.79	9.36
Other						
DP	6.24	8.19	8.84	25.86	4.32	11.76
VIL	11.87	12.47	13.74	29.79	5.80	16.52
EC	14.20	12.52	13.84	29.79	5.80	17.39
Total compound feed						
DP	37.10	9.24	13.87	26.66	13.13	100.00
VIL	37.27	9.26	13.90	28.10	11.47	100.00
EC	35.37	9.62	14.43	28.41	12.17	100.00

1/ DP = Continuation of deficiency payment price-support system, deficiency payment included.
VIL = Enaction of a system of variable import levies (1971-73 transition period).
EC = Membership in the European Community with full acceptance of the Common Agricultural Policy (1973-78 transition period).

Cereal byproducts

One of the major substitutes for cereals is cereal byproducts, including wheat middlings, wheat bran, and dried brewers grains. In general, these are residual products from the processing of cereals for human consumption. In 1968, cereal byproducts constituted approximately 10 percent of all compound feed. This percentage is expected to increase slightly with continued deficiency payments to almost 12 percent by 1980. Alternative policies are expected to raise this to 15 percent by 1980. However, lower total compound feed requirements will reduce the overall effect of this percentage increase, so that total use of cereal byproducts in 1980 is projected to be 1.3 million tons with deficiency payments, and approximately 1.6 million tons under other assumptions.

Within the individual compound feeds, a single ration contributes substantially to this increased use of cereal byproducts. In 1980, the use of cereal byproducts used in layer rations will increase from none with deficiency payments to just over 250,000 tons in other cases. No cereal byproducts are projected for use in broiler rations. Compound cattle feed is the only category to show decreased use of cereal byproducts with variable import levies or EC membership.

Oil cakes and seeds

Another potential substitute for cereals is oil cakes and seeds. Valued as a high-protein supplement, this category totalled more than 11 percent of all compound feed ingredients in 1968. Projections to 1980 indicate that continued use of deficiency payments will increase this percentage slightly, to 14 percent, requiring the use of 1.6 million tons of oil cake products, primarily cottonseed meal, rapeseed meal, soybean meal, and sunflower meal.

Realignment of prices under levy and EC assumptions will increase the percentage of these items used, although not significantly. Both hog starter and hog finisher are projected to use considerably more oilseed products in 1980 under these two assumptions. Because of the reduction in total compound used with these policies, however, the total amount of oil cakes and seed increases only slightly over deficiency payment levels with EC entry, and actually decreases with a variable levy arrangement.

Molasses

Both import levies and EC entry would result in increased use of molasses, primarily in compound cattle feed. Care must be taken in analyzing these results, however, since the linear program indicates no molasses used in 1980 with a deficiency payment support policy. Although this is not a logical conclusion (at least a small amount of molasses should be used as binder and to help in reducing dust), it was decided to allow the computer results to remain unchanged, thereby preserving the general nature of the model.

Total molasses used in 1980 is projected to be 185,000 tons under a levy arrangement and to increase to about 500,000 tons with acceptance of EC membership.

Animal and fish meals

Also used as high-protein supplements, animal and fish meals have seen increased use in the United Kingdom compound industry in recent years, although the percentage of total ingredients was still only 7 percent in 1968. Nutritional restrictions limit the amount of these products that may be used in compound feeds.

Projected use of animal and fish meals will reach 8 percent in 1980 with deficiency payments or a variable levy system. The percentage increases to more than 9 percent with EC entry. In terms of total amount required, projections indicate 911,000 tons with deficiency payments, 450,000 tons under levy arrangements, and over 1 million tons with EC accession. With the exception of a slight decrease in the amount of animal and fish meals used in broiler rations, all compound feeds are projected to use more of them in 1980 with EC entry than under alternative policies.

Other

Finally, other ingredients, such as alfalfa meal, beet pulp, horse beans, oyster shells, and tallow represented 12 percent of the total ingredients in 1968. With continued deficiency payments, 1980 use of these materials is expected to remain at 12 percent, or approximately 1.3 million tons. Variable import levies are forecast to increase the use of other ingredients to 1.8 million tons (17 percent) by 1980. EC membership is projected to increase this use to 1.9 million tons (also 17 percent) during the same period.

The major ingredient changes responsible for this increase in 1980 with EC or variable levy assumptions are: (1) increased use of beet pulp in cattle feed with EC entry, (2) increased use of horse beans in cattle feed under both assumptions, (3) increased use of alfalfa meal in layer rations under both assumptions.

Conclusions

In summary, continuation of deficiency payments will result in no significant change in the mix of the major compound feeds by 1980. Cereal, at 54 percent, is forecast to maintain its dominance as a compound feed ingredient. Total compound consumption (cattle, hog, and poultry) is projected at 11.2 million tons in 1980.

Movement to a variable import levy policy will reduce the percentage of cereals in compound feeds in 1980 to 44 percent. Increased cereal byproducts, molasses, and other ingredients, with slight increases in oil cakes and meals and animal and fish meal, will be substituted for this reduced cereal input. Total compound feed consumption under this system is forecast at 1.6 million tons for 1980.

Entry into the EC is projected to accentuate the trend away from cereals (37 percent in 1980). All other ingredient categories will be used to substitute for the displaced cereal. EC membership projects approximately the same total of 10.7 million tons of compound feed consumption in 1980, slightly more than was noted in the case of variable levies.

Comparison of United Kingdom and Netherlands Compound Feed Use

As a final check on projections assuming United Kingdom accession to the EC, the results of this study are compared with actual ingredient use in the Netherlands between 1962 and 1969. The Dutch, as early as 1962, had a large and efficient compound feed manufacturing system. Computers and linear programming were employed, and adjustment of ingredient mix to ingredient price change was rapid. In 1962, the first steps towards acceptance of the CAP were taken, and by 1968 the CAP was in full effect. During this time in the Netherlands, the price for feed grains increased rapidly. In other words, the situation in the Netherlands during 1962-68 was quite similar to the situation anticipated in the United Kingdom during the 1970's, with EC membership forthcoming.

In 1962-63, cereals comprised almost 65 percent of total compound feed ingredients in the Netherlands (table 23). Implementation of the CAP reduced this to 50 percent by 1966-67, and to 37 percent by 1968-69. Oilseed meals, beet pulp, manioc, and alfalfa meal were among the principal substitutes for cereals. Although domestic agricultural support policy in the Netherlands prior to 1962 differed from that of the United Kingdom in 1970 (and therefore some differences in compound feed ingredient use could be expected), the trends in ingredient use seen in the Netherlands between 1962-68 tend to support the projections of this study relative to United Kingdom compound feed mix in 1980 with EC membership.

Trade Implications

Such changes in compound feed ingredient mix will have a significant effect on the pattern of trade in the United Kingdom. Traditional suppliers of compound feed ingredients to the United Kingdom (among them the United States) have much at stake regarding this changing pattern of trade.

For several reasons, no estimate can be made of the actual gain or loss in world trade expected by 1980 under the policies considered. First, data concerning imports used solely by the compound feed industry are unavailable. It is impossible, for example, to separate tallow imports into those used for compound feed and those used for other purposes. Second, any analysis of trade must examine supply as well as demand for each feed ingredient. The limitations of this study could not allow for a detailed examination of the supply of each ingredient. For example, higher prices associated with EC membership are expected to result in increased grain production, and a corresponding reduction in imports, regardless of any changes in the ingredient mix used for compound feeds.

Exact trade effects for the United States are even more difficult to estimate. It is difficult, for example, to calculate total U.S. soybean exports to the United Kingdom, because many U.S. soybeans are shipped to Canada and the Netherlands only to be transshipped to the United Kingdom. In 1970, when less than two-thirds of soybean imports were shipped directly from the United States, almost 97 percent were of U.S. origin. This problem of transshipment seriously hampers any investigation of U.S.-U.K. trade patterns, particularly an investigation of nongrain trade.

With regard to these trade shifts, several generalizations can be made. If deficiency payments were to be continued through 1980, the United Kingdom would

Table 23.--The Netherlands: Trends in composition of concentrate feeding for various classes of livestock, by ingredient, 1962-63, 1966-67, and 1968-69

Ingredient	1962-63	1966-67	1968-69
		Percent	
Wheat	3.1	1.3	3.8
Rye	7.7	2.6	2.0
Barley	7.2	4.7	4.5
Oats	12.6	4.8	2.9
Sorghum and other grains	10.6	6.8	2.0
Corn	23.3	29.7	21.6
Total grains	64.5	49.9	36.9
Grain byproducts	8.9	8.5	9.5
Pulses	.6	2.7	4.0
Oilseed meals and cakes	15.6	19.1	21.3
Fish and meat meal	3.9	3.2	3.6
Animal fats	---	.6	1.5
Vegetable fats	---	.3	.3
Dried beet pulp	---	4.4	6.4
Dry fibers	---	*	.1
Brewers grain	---	.1	.1
Molasses	2.1	3.6	3.3
Manioc or tapioca	---	1.6	4.5
Dried grass and alfalfa meal	2.6	3.4	4.0
Sugar	---	*	2.1
Citrus pulp	---	---	.2
N. F. D. milk	1.8	2.0	2.3
Total other components	35.5	50.1	63.1
Grand total	100.0	100.0	100.0
Base tonnage	5,727,000	6,873,000	7,805,000

*Less than 0.05 percent.

Source: Brice Meeker, Development of the Livestock and Mixed Feed Industries of the Common Market (The Hague, Netherlands: American Embassy) unpublished.

still rely upon imports to supply a significant amount of grain, and almost all oil cakes and seeds used in compound feed. Adoption of variable import levies is expected to substantially reduce these grain imports by 1980. Imports of high-protein feedstuffs will be expected to increase, but not sufficiently to compensate for the loss in grain trade. The effects of EC entry will be of a similar nature but of a greater magnitude than that of a levy arrangement. Examination of the projections made to 1980 indicates that much of the disruption in trade--compared with that expected from deficiency payment continuation--expected to result from entry into the Common Market will occur with a variable import levy system.

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Appendix table 1.--United Kingdom: Consumption of compound feed, by animal class, 1957-69 1/

Year	Poultry	Cattle	Pig	Other	Total
	1,000 tons				
1957	2,769	2,181	1,677	336	6,964
1958	3,180	2,477	1,816	416	7,889
1959	3,585	2,723	1,893	441	8,652
1960	3,669	2,839	1,792	485	8,785
1961	3,955	2,793	1,880	473	9,102
1962	3,955	2,917	2,181	524	9,578
1963	3,955	2,784	2,073	545	9,356
1964	4,089	2,740	2,076	562	9,467
1965	4,096	2,954	2,253	596	9,898
1966	4,001	2,955	1,965	573	9,494
1967	4,176	3,193	2,047	574	9,991
1968	4,090	3,280	2,175	587	10,132
1969 2/	4,043	3,569	2,432	644	10,689

1/ Prior to 1959, data refer to Great Britain with an estimate for Northern Ireland. Estimate based on percentage of United Kingdom compound feed consumed in Northern Ireland during 1959-69.

2/ Preliminary.

Source: (38).

Appendix table 2.--United Kingdom: Livestock numbers, 1957-69

Year	Laying hens	Broilers	All poultry	Dairy cows	Beef cows	All cattle	Pigs
	1,000 head						
1957	66,700	28,168	94,868	3,085	806	10,881	5,974
1958	70,300	29,424	99,724	3,094	790	10,956	6,485
1959	72,000	34,605	106,605	3,045	804	11,291	5,984
1960	68,900	34,105	103,005	3,165	848	11,771	5,724
1961	71,200	43,089	114,289	3,246	908	11,936	6,024
1962	70,200	38,830	109,030	3,290	978	11,859	6,722
1963	72,900	39,275	112,175	3,247	1,013	11,717	6,859
1964	75,600	42,777	118,377	3,144	982	11,627	7,379
1965	72,300	45,847	118,141	3,186	1,018	11,943	7,979
1966	73,600	45,340	118,940	3,162	1,106	12,206	7,333
1967	75,000	50,624	125,624	3,214	1,141	12,342	7,107
1968	75,900	51,559	127,459	3,275	1,152	12,151	7,387
1969	76,200	51,020	127,220	3,241	1,211	12,374	7,783

Source: (44).

Appendix table 3.--United Kingdom: Production of animal products, 1957-69

Year	Poultry meat	Eggs	Beef and veal	Milk	Pork
	1,000 tons				
1957	182	679	826	10,303	660
1958	233	736	812	10,027	717
1959	262	772	718	9,681	715
1960	312	758	821	10,687	677
1961	352	794	905	11,179	707
1962	345	793	917	11,511	789
1963	362	840	944	11,179	805
1964	379	888	876	10,945	834
1965	407	851	832	11,408	943
1966	442	860	867	11,296	895
1967	482	887	921	11,696	823
1968	526	901	904	12,009	859
1969	563	---	870	12,169	923

Source: (49).

Appendix table 4.--United Kingdom: Prices of selected agricultural products, 1957-69

Year	Broilers (lb.) 1/	Eggs (doz.) 2/	Cattle (lb.) 3/	Milk (gal.) 4/	Pigs (lb.) 5/
	Cents				
1957	26.84	51.6	17.4	36.0	28.3
1958	25.44	45.4	17.0	36.5	27.7
1959	24.64	44.3	17.0	37.7	27.2
1960	22.27	40.0	16.8	35.6	27.6
1961	19.49	40.0	17.5	35.0	26.6
1962	20.41	42.2	17.7	34.3	27.5
1963	19.89	37.3	18.1	35.0	26.1
1964	19.65	35.4	19.1	38.0	26.6
1965	18.52	39.5	19.3	39.0	26.4
1966	18.49	33.4	19.7	40.0	27.7
1967	17.00	34.0	20.3	41.0	28.7
1968	16.81	36.7	22.1	40.0	28.7
1969 6/	16.42	34.8	23.0	40.1	28.4

1/ Slaughter weight $3\frac{1}{2}$-4 pounds.

2/ Average producer price for first quality eggs, all sizes, including Government payments.

3/ Certified steers and heifers, average price at live weight, auctions, including payments under the fat-stock guarantee scheme.

4/ Average liquid price (whole milk), including Government payments.

5/ Average market price (slaughter weight) for all certified pigs, including Government payments.

6/ Preliminary.

Source: (14).

Appendix table 5.--United Kingdom: Prices of selected animal feedstuffs, 1957-69

Year	Compound feed				Corn 1/	Oats 2/	Barley 2/
	Cattle	Pig	Layer	Broiler			
	$/M.T.						
1957	78.76	76.23	72.74	85.55	61.37	53.22	51.85
1958	78.10	76.86	72.49	85.25	51.24	54.24	54.00
1959	80.79	76 30	72.74	85.55	51.85	51.90	49.90
1960	77.62	73.83	70.37	82.76	51.73	46.58	47.51
1961	78.76	75.40	71.25	83.81	50.14	47.82	48.70
1962	80.74	77.25	73.47	86.42	49.29	49.56	47.97
1963	84.62	78.49	76.74	90.26	55.51	48.53	49.90
1964	84.81	80.52	78.69	98.35	56.24	50.58	49.78
1965	86.96	82.69	80.74	94.99	59.90	53.14	51.90
1966	85.62	81.91	80.59	94.79	60.15	52.46	51.14
1967	89.55	83.13	82.96	97.60	57.34	47.70	50.83
1968	91.30	84.74	85.13	100.16	60.39	49.61	52.95
1969	91.67	85.35	85.64	100.58	66.49	47.58	51.85

1/ Average of Argentine and U.S. No.3 Corn, c.i.f.

2/Market price (excluding Government payments).

Source: (14 and 44).

Appendix table 6.--United Kingdom: Amount of concentrates fed per unit of output, various livestock products, all holdings, 1957-69

June-May year beginning	Pounds of concentrate fed per:				
	Gallon of milk	Pound of dressed beef	Pound of dressed pigmeat	Pound of dressed poultry meat	Dozen hen eggs
	Pounds				
1957	3.72	2.29	6.30	5.09	4.16
1958	3.47	3.05	5.98	4.77	4.04
1959	3.87	4.24	5.84	4.60	3.89
1960	3.78	4.16	5.90	4.54	3.74
1961	3.76	3.71	5.85	4.43	3.51
1962	3.79	3.75	5.60	4.28	3.39
1963	3.87	4.11	5.79	4.15	3.22
1964	3.84	4.58	5.81	4.01	3.20
1965	3.76	4.78	5.38	3.78	3.17
1966	3.80	4.07	5.42	3.64	3.16
1967	3.74	4.76	5.50	3.46	3.12
1968	3.74	4.80	5.27	3.30	3.12
1969	3.70	4.86	5.34	3.19	3.11

Source: (11).

Appendix table 7.--United Kingdom: Technical coefficients of labor requirements for various livestock classes, 1955, 1960, 1965, and 1968

Livestock	Year			
	1955	1960	1965	1968
	Man-days per animal unit			
Dairy	17.0710	16.4420	15.8010	15.4200
Livestock (beef)	22.6500	21.0900	17.7200	15.6800
Pigs	1.9000	1.6500	1.4000	1.2500
Broilers	0.0148	0.0133	0.0083	0.0074
Laying hens	0.2975	.2880	0.1950	0.1215

Source: (11).

Appendix table 8.--United Kingdom: Projected amount of various feed ingredients used in compound feed, by type of feed and policy assumption, 1980 1/

Ingredient	Feed					
	Cattle	Hog Starter	Hog Finisher	Layer	Broiler	Total 2/
	1,000 tons					
Cereals						
Corn						
DP	---	406.4	---	629.4	920.0	1,955.9
VIL	---	301.9	213.4	543.0	754.8	1,813.0
EC	---	323.9	266.9	668.7	808.6	2,068.1
Sorghums						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Wheat						
DP	---	---	---	---	---	---
VIL	719.1	---	---	---	---	719.1
EC	---	---	---	---	---	---
Barley						
DP	1,690.5	216.4	955.5	1,266.2	---	4,128.6
VIL	593.6	147.5	424.4	889.2	---	2,054.8
EC	568.5	154.6	424.8	792.4	---	1,940.4
Oats						
DP	---	---	---	---	---	---
VIL	---	21.7	59.0	---	---	80.8
EC	---	---	---	---	---	---
Totals Cereals						
DP	1,690.5	622.8	955.5	1,895.6	920.0	6,084.5
VIL	1,312.6	471.1	696.8	1,432.2	754.8	4,667.6
EC	568.5	478.6	691.7	1,461.1	808.6	4,008.4
Cereal Byproducts						
Corn gluten feed						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Wheat middlings						
DP	834.1	197.8	311.8	---	---	1,343.7
VIL	791.5	196.8	295.2	264.1	---	1,547 5
EC	757.9	206.2	309.2	269.4	---	1,542.6
Brewers grains						
DP	---	---	---	---	---	---
VIL	---	29.5	49.5	---	---	78.9
EC	43.6	30.9	39.4	---	---	113.9
Total cereal byproducts						
DP	834.1	197.8	311.8	---	---	1,343.7
VIL	791.5	226.3	344.6	264.1	---	1,626.5
EC	801.5	237.0	348.6	269.4	---	1,656.5

Appendix table 8.--United Kingdom: Projected amount of various feed ingredients used in compound feed, by type of feed and policy assumption, 1980 1/--Continued

Ingredient	Feed					
	Cattle	Hog Starter	Hog Finisher	Layer	Broiler	Total 2/
	1,000 tons					
Oil cakes and seeds						
Soybeans						
DP	---	---	---	---	147.6	147.6
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Flaxseed						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	4.6	---	---	---	---	4.6
Soybean meal						
DP	---	29.6	---	---	111.5	141.0
VIL	---	25.1	---	---	198.4	223.5
EC	524.9	27.1	---	---	212.7	764.7
Linseed meal						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Cottonseed meal						
DP	274.0	---	---	---	77.3	351.4
VIL	24.2	---	---	---	74.5	98.7
EC	17.5	---	---	---	79.9	97.3
Palm kernal meal						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Peanut meal						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Sunflower meal						
DP	420.3	---	92.3	---	11.1	523.7
VIL	614.2	40.3	162.4	---	---	816.8
EC	206.2	45.7	180.2	---	---	432.1
Rapeseed meal						
DP	417.0	---	---	---	---	417.0
VIL	395.8	---	---	---	---	395.8
EC	379.0	---	---	---	---	379.0
Total oil cakes and seeds						
DP	1,111.4	29.6	92.3	---	347.5	1,580.7
VIL	1,034.1	65.3	162.4	---	272.9	1,534.7
EC	1,132.1	72.9	180.2	---	292.5	1,677.7

Appendix table 8.--United kingdom: Projected amount of various feed ingredients used in compound feed, by type of feed and policy assumption, 1980 1/--Continued

Ingredient	Feed					
	Cattle	Hog starter	Hog finisher	Layer	Broiler	Total 2/
	1,000 tons					
Animal meal						
Meat and bone meal						
DP	208.3	37.9	11.9	---	41.8	300.0
VIL	197.8	49.2	48.9	---	32.1	328.0
EC	163.7	51.5	54.3	---	34.4	303.9
Blood meal						
DP	---	14.0	---	149.9	---	163.9
VIL	---	---	---	100.6	1.8	102.4
EC	25.8	---	---	102.6	1.9	130.4
Fish meal						
DP	65.4	51.9	49.7	176.9	103.3	447.3
VIL	55.8	49.2	20.2	208.9	85.2	419.3
EC	189.5	51.5	22.9	213.1	91.3	568.3
Total animal meals						
DP	273.7	103.8	61.6	326.8	145.1	911.0
VIL	253.6	98.4	69.1	309.5	119.2	849.7
EC	379.0	103.0	77.1	315.7	127.7	1,002.5
Molasses						
DP	---	---	---	---	---	---
VIL	95.4	---	---	89.5	---	184.9
EC	370.2	10.0	34.1	91.3	---	505.7
Other						
Peas						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Horse beans						
DP	---	51.9	77.9	---	---	129.9
VIL	197.8	49.2	73.8	---	---	320.8
EC	189.5	51.5	77.3	---	---	318.3
Alfalfa meal						
DP	---	---	---	565.3	---	565.3
VIL	---	---	---	689.0	---	689.0
EC	---	---	---	702.9	---	702.9
Grass meal						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Beet pulp						
DP	---	---	---	---	---	---
VIL	---	49.2	73.8	---	---	122.9
EC	112.9	51.5	77.3			

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Appendix table 8.--United Kingdom: Projected amount of various feed ingredients used in compound feed, by type of feed and policy assumption, 1980 1/--Continued

Ingredient	Feed					
	Cattle	Hog starter	Hog finisher	Layer	Broiler	Total 2/
	1,000 tons					
Dried whey						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Dried skim milk						
DP	---	---	---	---	---	---
VIL	---	---	---	---	---	---
EC	---	---	---	---	---	---
Oyster shells						
DP	79.7	6.0	14.6	59.9	18.9	179.1
VIL	74.0	7.0	14.6	59.6	15.3	170.6
EC	46.2	7.2	14.7	60.9	16.5	145.5
Tallow						
DP	180.6	27.1	45.2	149.9	44.9	447.7
VIL	197.9	17.3	40.5	140.2	55.3	451.2
EC	189.5	18.7	44.7	143.1	59.2	455.2
Total other						
DP	260.2	85.0	137.8	775.1	63.8	1,322.0
VIL	469.7	122.6	202.7	888.8	70.6	1,754.5
EC	538.1	128.9	214.1	906.8	75.7	1,863.6
Total compound feeds						
DP	4,169.9	1,039.1	1,558.9	2,997.6	1,476.4	11,241.9
VIL	3,957.0	983.7	1,475.6	2,984.1	1,217.5	10,618.0
EC	3,789.4	1,030.4	1,545.9	3,044.3	1,304.5	10,714.5

1/ DP = Continuation of deficiency payment price-support system, deficiency payment included.
VIL= Enaction of a system of variable import levies (1971-73 transition period).
EC = Membership in the European Community with full acceptance of the Common Agricultural Policy (1973-78 transition period).

2/ Total may not add to sum of individual feeds due to rounding errors in converting from long to metric tons.