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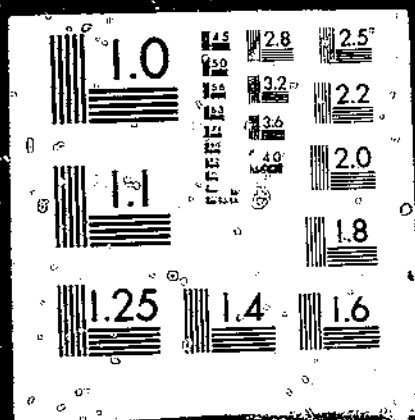
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Foreign Agricultural Economic Report No. 88

# Growth Potential of Corn Production in Western Europe through 1975 and 1980



U.S. Department of Agriculture

Economic Research Service

# ABSTRACT

The study examines growth potential of corn in France, Italy, Spain, and the aggregate of Other Western Europe (OWE) through 1975 and 1980. Changes in production, causes of these changes, and potential developments are investigated. Projections of corn production for 1975 and 1980 are made assuming specified price levels and technological development. Consumption of corn for 1975 and 1980 is estimated by using previous study. The resulting impact on trade is presented. Corn production will more than double from 1969-71 to 1980, with consumption rising at a lagging rate. Utilization and production of corn are estimated to be 45.0 and 33.4 million metric tons, respectively. Thus, a net import requirement of 11.6 million metric tons for Western Europe is implied. This level of import needs would be below average annual imports in 1969/70-1971/72. Since the United States has the largest share of this market (about 60 percent for 1960/61-1971/72), it would be subject to most of the demand. Major determinants of the growth potential of corn production in Western Europe would be the agricultural policies concerning producer prices for grains and poultry and live stock products, developments in corn production technology, and improvement or expansion of resources used for corn production.

Keywords: Corn, Feed grains, Supply, Projections, Western Europe.

## FOREWORD

This study's main focus is on evaluation of the corn production potential in Western Europe to 1975 and 1980. Special attention is given to France, Italy, and Spain, the region's major corn producers. An evaluation is made of probable corn utilization in 1975 and 1980, and the implied net trade impact is presented.

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# CONTENTS

	Page
SUMMARY . . . . .	viii
INTRODUCTION . . . . .	1
Methodology . . . . .	1
Corn's Position in Agricultural Economy and Trade . . . . .	2
Production . . . . .	2
Consumption . . . . .	2
Imports . . . . .	3
Physical Constraints on Corn Expansion . . . . .	7
FRANCE . . . . .	9
Corn Production--Historical Development . . . . .	9
Corn Utilization and Imports . . . . .	12
Factors Influencing Corn Production . . . . .	16
Prices and Policy . . . . .	16
Irrigation . . . . .	18
Competition for Land Use . . . . .	20
Farm Structure and Technology . . . . .	25
Outlook . . . . .	28
ITALY . . . . .	30
Corn Production--Historical Development . . . . .	30
Corn Utilization and Imports . . . . .	36
Factors Influencing Corn Production . . . . .	38
Prices and Policy . . . . .	38
Irrigation . . . . .	40
Competition for Land Use . . . . .	41
Farm Structure and Technology . . . . .	44
Outlook . . . . .	45
SPAIN . . . . .	46
Corn Production--Historical Development . . . . .	46
Corn Utilization and Imports . . . . .	52
Factors Influencing Corn Production . . . . .	53
Prices and Policy . . . . .	53
Irrigation . . . . .	57
Competition for Land Use . . . . .	59
Farm Structure and Technology . . . . .	61
Outlook . . . . .	64
OTHER WESTERN EUROPE . . . . .	65
Mediterranean Area . . . . .	66
Greece . . . . .	66
Portugal . . . . .	67

	Page
Northern Area . . . . .	68
Austria . . . . .	68
West Germany . . . . .	69
Switzerland . . . . .	70
Belgium, the Netherlands, and the United Kingdom . . . . .	71
Outlook . . . . .	73
PROJECTIONS FOR 1975 AND 1980 . . . . .	74
Production . . . . .	74
Consumption . . . . .	79
Corn Utilization . . . . .	83
Implications of Expansion of Corn Production . . . . .	85
LITERATURE CITED . . . . .	88



# TABLES

Table	Page
1. Corn area, yield, and production for principal producers in Western Europe and total Western Europe, 1955-71 . . . . .	3
2. Corn area, yield, and production for minor producers (OWE) in Western Europe, 1955-71 . . . . .	4
3. Western Europe: Total grain, coarse grain, and corn consumption, 1960/61-1971/72 . . . . .	6
4. Western Europe: Total grain, coarse grain, and corn consumed by poultry and livestock, 1960/61-1971/72 . . . . .	6
5. Western Europe: Total and net corn imports and U.S. share, 1960/61-1971/72 . . . . .	7
6. Western Europe: Total and net coarse grain imports and U.S. share, 1960/61-1971/72 . . . . .	8
7. France: Grain area and production, selected averages, 1955-70, annual 1970, 1971, and 1972 . . . . .	10
8. France: Corn area, yield, and production by region, averages 1955-57, 1960-62, 1965-67, annual 1968-70 . . . . .	13
9. France: Grain area by region, averages 1955-57, 1965-67, annual 1970 . . . . .	14
10. France: Supply and distribution of corn, 1955/56-1971/72 . . . . .	15
11. France: Producer prices for wheat, barley, and corn and price ratios, 1950/51-1970/71 . . . . .	17
12. France: Yield and net returns per hectare for selected crops in three French regions, 1970 . . . . .	22
13. France: Net returns for corn in three French regions, 1970 . . . . .	23
14. France: Optimum crop plans on selected farms in the Aunis and Beauce regions, 1970 . . . . .	26
15. France: Application of fertilizers and herbicides in corn production according to farm size in three French regions, 1969 . . . . .	27
16. France: Distribution of corn area according to field size in three French regions, 1969 . . . . .	27
17. Italy: Grain area and production, selected averages, 1955-1970, annual 1970-72 . . . . .	31
18. Italy: Total, hybrid, and nostrano corn area, yield, and production, selected averages, 1955-1967, annual 1968-71 . . . . .	31
19. Italy: Corn area (hybrid and nostrano), yield, and production by region, 1971 . . . . .	33
20. Italy: Total, hybrid, and nostrano corn area by region, averages 1955-57, 1957-59, 1965-67, annual 1971 . . . . .	34
21. Italy: Supply and distribution of corn, 1955/56-1971/72 . . . . .	37
22. Italy: Total and individual grains fed to livestock and corn and barley as a percentage of total, 1955/56-1971/72 . . . . .	37
23. Italy: Agricultural land utilization, selected averages, 1950-67, annual 1968 and 1969 . . . . .	42
24. Italy: Area planted to corn and selected competing crops, selected averages, 1950-67, annual 1968-71 . . . . .	43

## Table

Page

25. Spain: Grain area and production, selected averages, 1955-70, annual 1970, 1971, and 1972 . . . . .	47
26. Spain: Corn area (dry and irrigated), yield, and production by region, 1969 . . . . .	50
27. Spain: Total, dry, and irrigated corn area, yield, and production, selected averages, 1955-67, annual 1968, 1969, 1970, and 1971, projected 1975 and 1980 . . . . .	50
28. Spain: Dry and irrigated corn area by region, averages 1955-57 and 1965-67, annual 1969 . . . . .	51
29. Spain: Hybrid corn area, yield, and production, total and for the three major corn-producing regions, average 1965-68, annual 1969 . . . . .	53
Spain: Supply and utilization of corn, 1955/56-1972/73 . . . . .	54
Spain: Total and individual grains fed to livestock and poultry and corn and barley as a percentage of total, 1955/56-1972/73 . . . . .	55
32. Spain: Support prices for wheat, corn, and barley and price ratios, 1953/54-1971/72 . . . . .	56
33. Spain: Area and number of farms planted to corn, alone or with pulses, 1962 . . . . .	62
34. Summary of ordinary least-squares analysis of corn area and yield in France, Spain, Italy, and Other Western Europe (OWE), 1955-71 . . . . .	75
35. Summary of corn production projections . . . . .	81
36. Projected share of coarse grain and corn utilization in 1975 and 1980, for France, Italy, Spain, and other West European countries, and 1960/61-1971/72 average . . . . .	84
37. Estimated coarse grain and corn utilization for France, Italy, Spain, and all Other West European countries, average 1969/70-1971/72, annual 1975/76 and 1980/81 . . . . .	85
38. Western Europe: Corn consumption, production, net import needs, and imports from the United States, averages 1965/66-1967/68, 1969/70-1971/72, and projections 1975/76 and 1980/81 . . . . .	86

# ILLUSTRATIONS

Figure	Page
1. Western Europe: Corn Production, 1970 . . . . .	5
2. France: Areas and Departments . . . . .	11
3. Italy: Regions . . . . .	35
4. Spain: Regions . . . . .	48
5. Western Europe: Corn Production, 1955-72 and Projected 1975 and 1980	82

## DEFINITIONS

Coarse grains are corn, barley, oats, sorghum, rye, and other minor grains, such as millet, buckwheat, and mixed grains, except where noted otherwise.

The metric system is used throughout this report. One metric ton equals 2,204.6 pounds.

ha. = hectare or 2.471 acres.

kg. = kilogram or 2.2046 pounds.

qu. = quintal or one-tenth of 1 metric ton.

A crop year—for example, 1971/72—starts August 1 (1971) and continues through July 31 (1972).

In tables -- = not applicable.

## MONETARY CONVERSIONS

Country and currency	Official exchange rate, July, 1972
	<u>Units per dollar</u>
Austria (schilling)	23.3000
Belgium-Luxembourg (franc)	44.8159
France (franc)	5.1157
West Germany (Deutsche mark)	3.2225
Greece (drachma)	30.0000
Italy (lira)	581.5000
Netherlands (guilder)	3.2447
Portugal (escudo)	27.2500
Spain (peseta)	64.5000
Switzerland (franc)	3.8400
United Kingdom (pound)	0.53838

## SUMMARY

Western Europe's corn production in 1980 is projected at 33.4 million tons--107 percent above the 1969-71 average. Utilization of corn will be an estimated 45 million tons. The implied net import requirement is therefore projected at 11.6 million tons, a 13-percent drop from the level in 1969/70-1971/72 and 30 percent below the 3-year high average of 1965/66-1967/68.

The U.S. share of Western Europe's net corn imports averaged 60 percent from 1960/61 to 1971/72. If it is assumed that the United States will share proportionately in the decreased import need, U.S. corn exports to Western Europe would drop from 8.2 million tons in 1969/70-1971/72 to 7 million in 1980/81. This decrease would occur despite the expected rise in West European corn utilization--15.5 million tons from 1969/70-1971/72 to 1980/81. It should be noted that the implied net import requirement of 11.6 million tons for 1980/81 is also projected for 1975/76. Thus, the impact on trade is estimated to be the same for the 2 years.

West European self-sufficiency in corn (or maize, as the Europeans term it) is anticipated to increase from 55 percent in 1968/69-1971/72 to 68 percent in 1975/76 and 74 percent in 1980/81. All four areas of Western Europe--France, Italy, Spain, and Other Western Europe (OWE)--are projected to have greater increases in production than in consumption. The rate of increase in corn output will be highest in France, followed by OWE, Spain, and Italy. Price boosts in these countries have encouraged increases in corn production, but other factors have also been important.

France, the largest producer and the only country in Western Europe self-sufficient in corn, accounted for 46 percent of West European corn production in 1969-71. By 1980, French corn is expected to account for 56 percent of West European output. Corn production is projected to approach 19 million tons by 1980, almost 2 1/2 times the level of 1969-71. During the same period, corn area is anticipated to almost double to 2.8 million hectares, largely at the expense of oats, rye, and root crops, such as fodder beets. Also, some pasture and fallow land will be shifted into corn. Yields are expected to rise from 5 tons per hectare (80 bushels per acre) to nearly 7 tons per hectare (108 bushels per acre) by 1980.

Western Europe will feel the greatest impact in corn production from the developments in France. France is not only the largest West European producer but is also projected to have the most rapid expansion in corn production (154 percent from 1969-71 to 1980). These larger crops that are expected during the 1970's will be channeled into a rising corn demand--mainly for poultry and pork feed rations--in France and in the eight other countries in the European Community (West Germany, Italy, the Netherlands, Belgium, Luxembourg, the United Kingdom, Denmark, and Ireland). French grain farms, larger than those in other West European countries, generally allow France a more efficient and profitable corn production through the fuller use of mechanization and more adequate facilities for marketing.

Italy's corn output will show comparatively little growth by 1980. Potential corn area is limited, and an expansion in output will have to come via improved yields. Production was record high in 1972 with nearly 5 million tons. Hybrid varieties, which now account for about four-fifths of total corn area, have continued to replace domestic "nostrano" varieties, resulting in considerably higher output per hectare. Expansion in Italian corn production by 1980 will be limited because the shift to better

yielding hybrids will soon be essentially completed; the decline in arable land, and thus, stiffening competition from other crops, notably fruits and vegetables, will continue; availability of new irrigated land will be limited; and the small fragmented farm structure will hamper adoption of cost-saving technology.

Total production by 1980 should reach almost 6 million tons (compared with 4.6 million tons in 1969-71). The increase will come from rising yields, since area will remain essentially unchanged.

Spain will continue to encourage higher corn production through a number of Government programs. Output in 1972 reached 2.2 million tons--90 percent above the 1965-67 level. Since 1963, the Spanish Government has launched irrigation projects, subsidized fertilizer and hybrid seed costs, and provided incentives for cooperative use of machinery. In response to these programs, both corn area and yields have expanded.

Spanish corn production in 1980 is projected to be almost 4 million tons, more than twice the 1969-71 average. Yields will increase almost 50 percent, from 3.5 to over 5 tons per hectare.

Other Western Europe (OWE) is an aggregate grouping of minor corn producers--Austria, West Germany, Portugal, Greece, Switzerland, Belgium, the Netherlands, and the United Kingdom--which currently produce 14 percent of West European corn. These countries will continue to make a sizable contribution to total corn output in Western Europe, with production approaching 5 million tons by 1980, more than double the 1969-71 level. Corn area is estimated to rise by 25 percent from 1969-71 to 1980, with all countries expanding area except Portugal. A more than two-thirds rise in yields is foreseen by 1980, with output approaching 5 tons per hectare.

Austrian corn yields have been the highest in Western Europe and are expected to remain in the lead. Yields have nearly doubled since the midfifties, in response to better adapted hybrid varieties and more intensive cultivation techniques. Similarly, corn area almost doubled, but in a much shorter period--1968 to 1972. Traditionally a large net importer of corn, Austria now borders on self-sufficiency.

West Germany's corn production was relatively unimportant in the 1950's. By 1972, production had increased to nearly 600,000 tons, led in large part by a rapid expansion of area.

Portugal's corn production has not deviated much, except in years of unusual weather, from the average 550,000 tons produced during the 1960's. Increased yields have been offsetting a declining corn area. Nevertheless, Portuguese corn yields are the lowest in Western Europe, partly because farmers interplant corn for grain area with beans and corn for forage. Also, only one-tenth of total corn area is planted with hybrid varieties. The shift away from native corn varieties continues to be slow. Portugal is expected to continue to depend on corn imports for about half of its requirements during the 1970's.

Greece's corn area has increased slightly in recent years due to increased availability of irrigated land and encouragement under a "15-year economic plan" to increase self-sufficiency. However, most of the increase in corn production has resulted from higher yields. Output in 1972 was over 600,000 tons, more than double that of the midsixties.

Switzerland's corn production has also risen, in large part the result of increased area. However, productive Swiss grain area is relatively limited, and expansion may be only modest through 1980.

Belgium, the Netherlands, and the United Kingdom will continue to be relatively minor corn producers, as the presently available corn varieties are not suitable for the climates in these countries. Also, these countries do not have sufficiently large enough potential corn area to have an important impact on the total of West European corn output. Nevertheless, corn crops will expand in these countries as in all the corn-producing countries of Western Europe.

The production projections in this report are based on ordinary least-squares analysis, with specified price and technological developments assumed. For the quantitative aspects of this report, national economic development plans, past experiences and developments, and other factors were analyzed and used to determine the independent variables and their future values. Trend analysis was also used, mostly for estimating yields.

# GROWTH POTENTIAL OF CORN PRODUCTION IN WESTERN EUROPE THROUGH 1975 AND 1980

by

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## INTRODUCTION

Corn has become increasingly important in the agricultural economy of Western Europe. In the early and mid-1960's, the region's demand for corn tended to increase more rapidly than its production, resulting in a sizable increase in net imports. More recently, West European corn production has grown somewhat faster than regional demand. Although remaining high, net imports of corn have fallen from the 1967/68 peak of 17.2 million tons.

Although West European corn production accounts for only about 6 percent of total world production, it is a crucial factor in determining the world import market for corn. Western Europe is the world's largest market for corn, usually absorbing about 65 to 70 percent of total world imports. The U.S. share of Western Europe's net imports has fluctuated, but the average for 1960/61-1971/72 was about 60 percent. About one-half of U.S. agricultural exports of corn have gone to Western Europe in recent years. With rising demand for livestock and poultry products and a competitive price relationship, an expanding West European market for corn seems to be a reasonable expectation. The question arises as to how this market will be supplied in the future--largely from domestic production or from imports?

This report analyzes the growth of West European corn production, 1/ with emphasis primarily on the three major producers: France, Italy, and Spain. Its primary objective is to provide a quantitative explanation of corn production in Western Europe and to determine the impact of economic, institutional, technological, and environmental factors on corn output. These results are used as the basis for projecting corn production levels through 1975 and 1980. These production projections, matched against estimates of consumption which were determined on the basis of a previous study (66), 2/ provide estimates of corn imports by Western Europe in 1975 and 1980.

## Methodology

Equations involving factors that affected corn production were estimated by using the ordinary least-squares method. Equations were estimated separately for the three major producers--France, Italy, and Spain--for both area and yield. For the remaining corn-producing countries in Western Europe, termed Other Western Europe (OWE) in this report, yield was estimated for the aggregate OWE by using trend equations. Area for

1/ This analysis is concerned with corn for grain. However, the relationship between corn for grain and corn grown for silage and forage is considered to the extent permitted by the limited information available.

2/ Underscored numbers in italics refer to items in Literature Cited at the end of the text.



OWE countries was estimated directly for each country rather than from a specific equation; however, trend analysis was in some cases used as a guide in making these estimates. Since production patterns differ and the potential for expansion of output varies among these countries, area and yield were analyzed separately, rather than production estimated directly. Through this method, a basis for a more indepth analysis into the forces affecting corn production was provided.

### Corn's Position in Agricultural Economy and Trade

#### Production

Corn is the third most important grain produced in Western Europe, following wheat and barley. In 1971, output totaled 17.8 million tons (tables 1 and 2). In 1972, corn production rose to 18.5 million tons. From 1955 to 1971, total output increased at an average annual rate of over 6 percent. <sup>3/</sup> The growth rate for Western Europe was essentially the same rate as for the combined total of the three major producing countries. These three--France, Spain, and Italy--account for 85 percent of the West European corn output. France's main corn-producing regions are the Centre and Parisienne (Center and Paris) in the North and the Aquitaine in the South (fig. 1). The Po Valley is most important in Italy. Galicia and Asturias-Santander are the most important in Spain.

Corn area in Western Europe increased less rapidly than production, with improving yields explaining the bulk of increased output. Yields doubled from 1955-57 to 1969-71.

#### Consumption

Utilization of total grains, coarse grains, and corn for all purposes (feed, food, industrial, seed, and other) has steadily expanded in Western Europe (table 3). Corn accounts for about one-fifth of total grains used and one-third of coarse grains used. Corn utilization increased at an average annual rate of 6.2 percent from 1955/56 to 1971/72. <sup>4/</sup> Corn for all uses is estimated to have surpassed 31 million tons in 1971/72.

Poultry and livestock account for approximately 85 percent of all West European corn utilization. The amount fed averaged 25.6 million tons for 1970/71-1971/72 (table 4)--a level 50 percent greater than the average 17.1 million tons fed in 1960/61-1964/65. Corn accounts for more than one-third of the coarse grains used for feeding, compared with less than 30 percent in the early sixties.

France, Spain, and Italy accounted for 60 percent of corn consumption in Western Europe during 1967/68-1971/72. Although the bulk of corn used in these three countries is fed to poultry and livestock, in some countries (particularly the United Kingdom), important quantities are used for industrial purposes, including the manufacturing of glucose, starch, cornmeal, corn oil, breakfast foods, and adhesives. The brewing and distilling industries also require substantial amounts of corn.

The self-sufficiency ratio--corn production divided by consumption--shows that Western Europe supplied about one-half of its corn needs from indigenous production during 1967/68-1971/72, compared with 82 percent for coarse grains and 86 percent for all grains, excluding rice. France is the only West European country to have reached and exceeded self-sufficiency. Self-sufficiency ratios for 1967/68-1971/72 are as follows:

<sup>3/</sup> Based on linear trend with the coefficient of determination,  $r^2 = 0.83$ .

<sup>4/</sup> Based on linear trend with the coefficient of determination,  $r^2 = 0.98$ .

Percentage self-sufficient

France	154
Italy	49
Spain	43
OWE	16
Total Western Europe	49

Imports

Corn is the grain imported in largest quantities by Western Europe, both in total and from the United States. Total West European corn imports rose substantially during the early and mid-1960's but have tended to remain on a plateau of about 18 million tons in recent years (table 5). Net imports--those excluding imports from West European suppliers--have fallen from the 1967/68 peak of 17.2 million tons to approximately 13 million tons in recent years.

Table 1 --Corn area, yield, and production for principal producers in Western Europe and total Western Europe, 1955-71

Year	France			Italy			Spain		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
	1,000 hectares	Quintals/hectare	1,000 metric tons	1,000 hectares	Quintals/hectare	1,000 metric tons	1,000 hectares	Quintals/hectare	1,000 metric tons
1955	453	24.1	1,091	1,237	25.9	3,204	356	17.3	616
1956	653	26.6	1,738	1,254	27.2	3,410	369	19.3	714
1957	544	25.6	1,392	1,251	27.9	3,496	376	20.5	771
1958	590	28.4	1,673	1,217	30.1	3,670	389	23.6	916
1959	704	25.9	1,825	1,193	32.5	3,879	405	23.7	959
1960	824	34.1	2,813	1,188	32.1	3,813	428	23.6	1,012
1961	975	25.3	2,470	1,197	32.9	3,936	447	23.9	1,067
1962	866	21.5	1,864	1,120	29.1	3,263	430	21.4	920
1963	955	40.6	3,877	1,121	32.9	3,692	487	24.0	1,171
1964	896	23.6	2,109	1,072	36.9	3,950	514	23.4	1,203
1965	871	39.4	3,420	1,028	32.3	3,317	478	23.9	1,142
1966	961	45.0	4,340	987	35.5	3,510	482	24.5	1,154
1967	1,013	40.6	4,111	1,017	38.0	3,860	478	25.0	1,195
1968	1,022	52.6	5,379	967	41.3	3,991	523	28.2	1,473
1969	1,184	48.3	5,723	1,000	45.1	4,506	494	30.5	1,507
1970	1,483	51.0	7,581	1,026	46.1	4,729	525	35.6	1,868
1971	1,635	54.0	8,771	936	47.7	4,469	540	38.1	2,056
France, Italy, and Spain			Total of Other Western Europe 1/			Total Western Europe			
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
	1,000 hectares	Quintals/hectare	1,000 metric tons	1,000 hectares	Quintals/hectare	1,000 metric tons	1,000 hectares	Quintals/hectare	1,000 metric tons
1955	2,046	24.0	4,911	765	12.2	930	2,811	20.8	5,841
1956	2,276	25.8	5,862	776	11.6	902	3,052	22.2	6,764
1957	2,171	26.1	5,659	756	11.4	860	2,927	22.3	6,519
1958	2,196	28.5	6,259	739	11.2	829	2,935	24.1	7,088
1959	2,302	28.9	6,663	740	12.7	943	3,042	25.0	7,606
1960	2,440	31.3	7,638	744	13.3	988	3,184	27.1	8,626
1961	2,619	28.5	7,473	748	15.2	1,134	3,367	25.6	8,607
1962	2,416	25.0	6,047	735	15.1	1,110	3,151	22.7	7,157
1963	2,563	34.1	8,740	740	14.8	1,092	3,303	24.8	9,832
1964	2,482	29.3	7,262	719	16.4	1,182	3,201	26.4	8,444
1965	2,377	33.1	7,379	710	14.9	1,060	3,087	29.0	8,939
1966	2,430	37.1	9,004	703	18.0	1,264	3,133	32.8	10,268
1967	2,508	36.5	9,166	676	21.5	1,454	3,184	33.4	10,620
1968	2,512	43.2	10,843	712	23.0	1,636	3,224	38.7	12,479
1969	2,678	43.8	11,736	780	27.2	2,122	3,458	40.1	13,858
1970	3,034	46.7	14,178	812	28.3	2,296	3,846	42.8	16,474
1971	3,111	49.2	15,296	808	31.6	2,553	3,919	45.5	17,849

1/ Other West European countries are Austria, West Germany, Portugal, Greece, Switzerland, Belgium, and Netherlands. See table 2 for area, yields, and production.

Sources: (47, 48, 76).

Table 2 --Corn area, yield, and production for minor producers (ONE) in Western Europe, 1955-71

Year	Austria			West Germany			Portugal			Greece		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
	1,000 ha.	Quintals/ ha.	1,000 M.T.	1,000 ha.	Quintals/ ha.	1,000 M.T.	1,000 ha.	Quintals/ ha.	1,000 M.T.	1,000 ha.	Quintals/ ha.	1,000 M.T.
1955.	56	27.0	152	7	29.8	20	471	9.3	437	228	12.5	285
1956.	51	28.1	144	7	28.4	20	487	9.9	481	228	10.5	238
1957.	49	30.3	149	6	28.3	16	483	8.8	427	216	11.9	257
1958.	49	31.6	155	5	29.3	13	479	8.9	425	204	11.0	226
1959.	46	31.4	146	5	27.8	13	481	10.1	487	206	14.1	290
1960.	58	36.5	213	6	31.3	20	468	10.0	466	210	13.7	282
1961.	51	38.6	198	8	30.7	23	495	12.8	632	191	14.0	270
1962.	54	35.6	193	13	33.6	43	498	11.9	591	166	16.0	266
1963.	50	39.0	194	13	36.4	48	488	10.7	523	185	16.9	312
1964.	50	42.4	212	18	34.6	63	496	12.3	597	150	19.2	289
1965.	50	37.3	187	27	35.9	96	484	9.5	559	144	20.7	298
1966.	55	49.4	275	31	40.5	127	473	11.9	565	139	19.8	275
1967.	60	52.2	316	42	47.2	197	436	13.2	577	133	25.6	339
1968.	74	54.1	399	58	49.2	287	438	12.5	548	137	27.4	375
1969.	117	59.6	698	81	49.2	400	427	13.0	553	147	29.2	430
1970.	124	49.3	612	59	50.9	507	418	13.9	581	159	33.2	527
1971.	125	57.7	722	116	51.1	594	385	13.7	529	163	36.0	586
	Switzerland			Belgium			Netherlands 1/			Total minor producers		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
	1,000 ha.	Quintals/ ha.	1,000 M.T.	1,000 ha.	Quintals/ ha.	1,000 ha.	1,000 ha.	Quintals/ ha.	1,000 M.T.	1,000 ha.	Quintals/ ha.	1,000 M.T.
1955.	1	36.5	4	2	49.5	9	6	37.8	23	771	12.2	930
1956.	1	33.0	3	2	42.8	7	3	25.1	9	779	11.6	902
1957.	1	26.5	2	1	48.0	4	2	32.9	5	758	11.4	860
1958.	1	40.9	3	1	46.0	3	1	40.6	4	740	11.2	829
1959.	1	42.6	4	1	43.1	2	1	23.4	1	741	12.7	943
1960.	1	32.6	4	1	41.6	2	--	38.1	1	744	13.3	988
1961.	2	47.0	8	1	45.2	2	--	39.0	1	748	15.2	1,134
1962.	3	45.4	13	1	43.9	4	--	38.0	--	735	15.1	1,110
1963.	3	48.8	13	1	43.3	2	--	42.6	--	740	14.8	1,092
1964.	4	49.3	19	1	47.1	2	--	--	--	719	16.4	1,182
1965.	4	42.3	18	1	44.6	2	--	--	--	710	14.9	1,060
1966.	4	49.5	19	1	44.2	3	--	--	--	703	18.0	1,264
1967.	4	57.1	22	1	46.7	3	--	--	--	676	21.5	1,454
1968.	4	60.0	24	1	45.0	3	--	--	--	712	23.0	1,636
1969.	7	52.9	37	1	47.8	4	--	--	--	780	27.2	2,122
1970.	9	61.1	55	2	51.8	10	1	45.0	4	812	28.3	2,296
1971.	14	66.4	93	3	54.0	19	2	45.0	10	808	31.6	2,553

1/ 1962-69 corn production was essentially zero; 1970 and 1971 data are unofficial.

Sources: (47, 48, 52, 76).



Table 3 --Western Europe: Total grain, coarse grain,  
and corn consumption, 1/ 1960/61-1971/72

Year	: Total : grains 2/	: Coarse : grains	: Corn	: Share of corn of--		: Corn consumed by : poultry and live- : stock as share of : total use
				: Total	: Coarse	
				: grains	: grains	
	: - 1,000 metric tons- -			- - - - -Percent- - - - -		
1960/61. . . . .	112,230	66,400	16,766	15	25	86
1961/62. . . . .	114,994	69,597	18,845	16	27	87
1962/63. . . . .	118,350	71,271	19,446	16	27	82
1963/64. . . . .	122,294	76,427	22,899	19	30	85
1964/65. . . . .	123,425	76,955	22,221	18	29	86
1965/66. . . . .	128,026	80,608	24,901	19	31	84
1966/67. . . . .	129,593	83,159	26,227	20	32	86
1967/68. . . . .	135,163	87,470	27,741	21	32	86
1968/69. . . . .	135,279	86,480	27,418	20	32	84
1969/70. . . . .	138,873	88,404	27,553	20	31	84
1970/71 3/ . . . .	141,454	89,268	29,511	21	33	84
1971/72 3/ . . . .	145,093	93,173	31,292	22	34	84

1/ Includes feed, food, seed, industrial, and other uses. 2/ Excludes rice.  
3/ Preliminary.

Sources: (48, 74, 75, 76).

Table 4 --Western Europe: Total grain, coarse grain, and corn  
consumed by poultry and livestock, 1960/61-1971/72

Year	: Total : grains 1/	: Coarse : grains	: Corn	: Share of corn of--	
				: Total	: Coarse
				: grains	: grains
	: - - - 1,000 metric tons- - -			- - -Percent- - -	
1960/61. . . . .	60,847	53,014	14,380	24	27
1961/62. . . . .	62,818	55,852	16,394	26	29
1962/63. . . . .	65,709	57,161	15,852	24	28
1963/64. . . . .	69,083	61,646	19,548	28	32
1964/65. . . . .	71,441	62,465	19,068	27	30
1965/66. . . . .	74,322	64,792	21,015	28	32
1966/67. . . . .	76,343	67,501	22,676	30	34
1967/68. . . . .	82,798	72,297	23,754	29	33
1968/69. . . . .	82,695	70,965	23,279	28	33
1969/70. . . . .	85,742	72,196	22,944	27	32
1970/71 2/ . . . .	89,023	73,500	24,537	28	34
1971/72 2/ . . . .	91,817	77,195	26,752	29	39

1/ Excludes rice. 2/ Preliminary.

Sources: (48, 74, 75, 76).

Table 5 --Western Europe: Total and net corn imports and U.S. share, 1960/61-1971/72

Year	Corn imports			Share of total corn imports		Share of net corn imports	
	Total	From United States	Net <sup>1/</sup>	From United States	Of total coarse grain imports	From United States	Of net coarse grain imports
	--- 1,000 metric tons ---			--- Percent ---			
1960/61.....	8,493	4,557	7,851	54	55	58	58
1961/62.....	11,021	6,374	10,729	58	57	59	63
1962/63.....	12,623	7,116	11,882	56	62	60	66
1963/64.....	14,540	7,343	13,349	51	68	55	75
1964/65.....	14,220	8,446	13,123	59	65	64	75
1965/66.....	18,285	12,011	16,408	66	67	73	73
1966/67.....	18,057	8,605	16,155	48	68	53	76
1967/68.....	18,799	9,553	17,155	51	75	56	86
1968/69.....	18,333	7,483	14,812	41	86	51	93
1969/70.....	17,802	8,757	13,108	49	84	67	88
1970/71 <sup>2/</sup> ...	18,389	7,993	13,236	44	62	60	68
1971/72 <sup>2/</sup> ...	18,942	7,796	13,642	41	71	57	93

<sup>1/</sup> Imports from West European suppliers subtracted from total imports.

<sup>2/</sup> Preliminary.

Sources: (48, 74, 75, 76).

Corn's share of total imported coarse grains expanded from about 56 percent in the early sixties to roughly 75 percent by the end of the decade. The U.S. share of the West European corn market declined from 56 percent to 44 percent in the same period. The considerable decline in 1968 was due to low U.S. export supplies and to larger than usual imports of other feed grains as a hedge against possible shortages in feed supplies (table 6). The U.S. share rebounded in 1969/70 and 1970/71, but declined again in 1971/72.

The principal importers of corn in Western Europe are Italy, the United Kingdom, West Germany, Spain, and the Netherlands. Together, these countries accounted for over four-fifths of regional corn imports during 1967/68-1971/72. These countries are also the most important markets for U.S. corn, importing almost 80 percent of all U.S. corn shipped to Western Europe.

#### Physical Constraints on Corn Expansion

The factors constraining the expansion of corn production differ greatly for the Mediterranean area and the northern area of Western Europe. The Mediterranean area is characterized by irregular rainfall, usually very scarce during the corn-growing season. The major obstacle to expanded corn area is lack of moisture. Research to develop drought-resistant corn varieties is well advanced; however, research to develop corn plants that can grow satisfactorily on lower total water intake has not advanced as far.

Table 6 --Western Europe: Total and net coarse grain imports and U.S. share, 1960/61-1971/72

Year	Coarse grain imports			Share of total coarse grain imports from the United States
	Total	From United States	Net <u>1/</u>	
	- - -1,000 metric tons- - -			Percent
1960/61. . . . .	15,489	7,671	13,632	50
1961/62. . . . .	19,364	9,135	16,963	47
1962/63. . . . .	20,337	10,884	18,118	54
1963/64. . . . .	21,384	9,484	17,783	44
1964/65. . . . .	21,724	10,788	17,525	50
1965/66. . . . .	27,459	15,879	22,489	58
1966/67. . . . .	26,514	12,414	21,297	47
1967/68. . . . .	25,039	11,026	19,940	44
1968/69. . . . .	21,224	9,740	15,978	46
1969/70. . . . .	21,144	8,921	14,817	42
1970/71 <u>2/</u> . . . .	26,787	9,514	19,422	32
1971/72 <u>2/</u> . . . .	26,617	8,244	14,736	31

1/ Imports from West European suppliers subtracted from total imports.

2/ Preliminary.

Sources: (48, 74, 75, 76).

The availability of irrigation is the key factor governing the expansion of corn production in this area.

In the northern areas of Western Europe, corn expansion is hampered by the following factors:

- Day-night effect of the short autumn days, which slows maturity
- Early frosts, which damage corn in the fall
- Low soil temperature at time of planting, which retards germination
- High moisture level at harvest, which often necessitates the use of artificial drying equipment and which, in addition, is conducive to stalk rots.

A great deal of agronomic research has been devoted to development of corn varieties which overcome these limitations. As a result, the northern corn-producing boundary has advanced rapidly northward in the past decade. New hybrid varieties that lend themselves to a shorter growing season and cool weather during the early growing period will continue to push corn production farther north. Most of the new hybrids contain corn germ plasm 5/ from varieties of northern or European origin, rather than adaptations of U.S. seed.

5/ Cells that bear the hereditary characteristics.

## FRANCE

### Corn Production--Historical Development

Corn has been a traditional grain crop in France, but its importance has increased dramatically in recent years. In 1955-57, corn averaged only 6 to 7 percent of both total grain area and production (table 7). The area planted to corn in 1955-57 averaged roughly one-fourth that of oats and one-third that of barley; average corn production was about one-third of barley and two-fifths of oats. France's corn production has, however, been steadily and rapidly increasing since the midfifties. Production totaled 8.6 million tons in 1972, even though poor weather conditions at harvesting cut the output by about 1 million tons.

The sharp increases in corn production came from both increased area and increased yields. Corn area increased rapidly from 1955 to 1961, but then remained stationary until the midsixties at about 900,000 hectares (table 1). The sharp decline in demand for oats, as mechanization replaced horses, pushed oats from the flat and good soils in the northern and west-central regions of France during the 1955-61 period (fig. 2). Higher yielding barley and corn replaced the oats. The replacement of national grain policies by the Common Market grain regulations during the transitional Common Agricultural Policy (CAP) period (1962-67) apparently discouraged French farmers from increasing corn area; however, barley area increased substantially. After the adoption of the unified European Community (EC) grain prices in 1967, and in response to a more favorable situation for corn production (see page 16), the farmers began to expand corn area. Starting in 1969, area began to increase rapidly. In 1971, corn area reached 1.6 million hectares, 72 percent above the 1965-67 average; corn area in 1972 was 1.9 million hectares.

Except in years of very favorable weather, corn yields fluctuated around 25 quintals per hectare during 1955-64. However, average corn yields in 1970-72 were just about double the 1955-64 average. This sharp increase in yields is attributable to widespread improvements in technology, such as improved corn seed, more adequate application of fertilizers, and increased use of herbicides and pesticides. These improvements are discussed starting on page 26.

Although total French grain production reached 40 million tons in 1972, more than double the average level in 1955-57, the share of corn in total production rose from 7 to 22 percent. Also, coarse grain production more than doubled to 22 million tons. In 1972, corn accounted for 39 percent of total coarse grain production, compared with an average of 14 percent in 1955-57.

The southwest 6/ was until recently France's leading corn region. As a result of climatic factors and the competitive advantage enjoyed by other regions in producing livestock or other crops, corn growing was concentrated in the southwest for many years. Except in the valleys and some hill areas, soils and climatic conditions in the southwest are not considered very favorable to agriculture. Moisture and rainfall are fairly high along the Atlantic coast but decrease inland, and summer drought is common in many areas. However, high temperatures and adequate moisture and rainfall during the germination period have encouraged corn growing in the region.

In 1955-57, the southwest accounted for more than two-thirds of corn area and more than half of production. Until 1968, it had continued to dominate the country's corn production, with about one-half of total area and almost one-half of production.

6/ Region IV in fig. 2.



Table 7 --France: Grain area and production, selected averages, 1955-70, annual 1970, 1971, and 1972

Year	Total grains 1/	Wheat	Coarse grains					
			Total	Barley	Corn	Oats	Rye	Other
Area:			1,000 hectares					
1955-57. . . . .	8,887	3,989	4,898	1,746	550	1,979	374	249
1965-67. . . . .	9,058	4,120	4,938	2,593	948	1,064	197	136
1968-70. . . . .	9,355	3,961	5,394	2,886	1,231	866	153	258
1970 . . . . .	9,269	3,746	5,523	2,953	1,489	799	135	147
1971 . . . . .	9,394	3,977	5,417	2,668	1,635	831	128	155
1972 2/. . . . .	9,554	3,998	5,556	2,639	1,877	762	125	153
Production:			1,000 metric tons					
1955-57. . . . .	19,144	9,043	10,101	4,236	1,407	3,607	464	387
1965-67. . . . .	29,063	13,342	15,721	8,037	3,957	2,623	362	742
1968-70. . . . .	32,616	14,122	18,494	8,866	6,174	2,302	312	840
1970 . . . . .	31,467	12,922	18,545	8,009	7,420	2,070	302	744
1971 . . . . .	36,122	15,120	21,002	9,010	8,270	2,490	300	932
1972 2/. . . . .	39,965	17,711	22,254	9,990	8,596	2,392	315	961

1/ Includes rice.

2/ Preliminary.

Sources: (42, 76).



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ERS NEG. 133-73 (3) ECONOMIC RESEARCH SERVICE

Figure 2

However, marked changes have occurred in more recent years (tables 8 and 9). During the midsixties, corn area in the southwest declined slightly, while expanding rapidly in other regions. More recently, the declining trend reversed, but in 1970, at nearly 500,000 hectares, the southwest's corn area was still nearly one-fifth below the high average in 1960-62. Although sharp increases in yields have permitted a substantial increase in corn production above the levels of the early 1960's, the southwest's share of production dropped to slightly more than one-fourth by 1970; its share of French corn area was down to one-third.

Since varying rainfall conditions in the southwest have frequently caused wide variations in yields, the expansion of corn production in area outside the southwest has been a major factor in stabilizing French corn yields.

The north <sup>7/</sup> is now France's leading corn region. In 1970, it accounted for more than a third of the corn area and close to half of production, compared with an average of 8 percent of area and 10 percent of production in 1955-57. Corn area in the North, particularly in the Centre and Parisienne regions, has steadily and rapidly increased since the midfifties. Total corn area in the Centre and Parisienne regions rose from 17,000 hectares in 1955 to 380,000 hectares in 1970.

The northern region has the most fertile soil in France. It is characterized by large farms, many over 100 hectares. Mechanization on the large farms is quite advanced, and use of fertilizers is widespread. Corn production in the northern region was given an initial boost in 1956 when frost destroyed most of the winter wheat, encouraging farmers to plant barley and corn in the spring. Yields turned out better than expected, and further experimentation with corn was encouraged. Where previously sugarbeets and potatoes were often planted in advance of wheat (still the dominant crop of the region) in the crop rotation, corn became increasingly important. The reduction in labor availability and quota restrictions on sugarbeet production have furthered this trend. Also, use of hybrid seed varieties has made it possible to offset some of the region's climatic disadvantages, particularly the short summers.

Other regions of France, notably the western and the central mountains, have also significantly increased both corn area and production. On the other hand, the Mediterranean-Southeast region, where yields are low relative to the rest of France, has shown a rapid decline in corn area.

#### Corn Utilization and Imports

France's rapid increase in corn production since the midfifties has considerably outstripped increases in domestic utilization. Consequently, since 1962, France has changed from being a net importer of corn to being a significant corn exporter. Exports of corn were less than 100,000 tons a year in the late 1950's. Starting in 1960, corn exports began to rise rapidly, and by 1971/72, had reached a high of 3.7 million tons. More than half of France's corn exports go to other EC members <sup>8/</sup>. France has been importing less than 500,000 tons of corn a year, and imports are expected to continue to be quite low (table 10).

Domestic utilization of corn has been expanding rapidly. In 1971, domestic utilization totaled 5.1 million tons, close to four times more than in 1955. By 1972, it was up to 5.8 million tons. Although food and industrial uses of corn have been increasing--about 850,000 tons in 1971, compared with 655,000 in 1969--most of the increase in corn utilization is due to the rapid expansion in feed uses.

<sup>7/</sup> Region I in table 8.

<sup>8/</sup> In 1971/72, the share of French corn exports going to other EC-6 members rose to an estimated 95 percent, compared with 55 percent in the previous year.

Table 8 --France: Corn area, yield, and production by region, averages 1955-57, 1960-62, 1965-67, annual 1968-70

Region and item <sup>1/</sup>	1955-57	1960-62	1965-67	1968	1969	1970
Northern (I):						
Area. . . . .	42	131	224	323	397	539
Yield . . . . .	35.7	30.0	54.0	58.9	54.4	62.8
Production. . . . .	150	393	1,209	1,899	2,160	3,389
Northeastern (II):						
Area. . . . .	20	11	16	18	22	22
Yield . . . . .	24.6	28.91	38.1	50.6	47.6	45.7
Production. . . . .	246	318	611	91	98	105
Western (III):						
Area. . . . .	42	60	91	98	135	204
Yield . . . . .	26.2	28.2	42.0	51.3	42.3	49.3
Production. . . . .	110	167	383	503	571	1,061
Southwestern (IV):						
Area. . . . .	376	581	482	427	444	496
Yield . . . . .	18.5	21.3	36.0	50.2	46.3	39.6
Production. . . . .	696	1,239	1,735	2,142	2,055	1,969
Central Mountains (V):						
Area. . . . .	51	73	115	141	170	208
Yield . . . . .	27.8	27.5	45.1	49.1	46.1	48.0
Production. . . . .	142	201	519	692	783	1,004
Mediterranean-Southeast (VI):						
Area. . . . .	30	32	19	15	16	16
Yield . . . . .	21.0	19.4	26.3	35.3	35.6	37.5
Production. . . . .	63	56	50	53	57	52
Total France:						
Area . . . . .	550	888	948	1,022	1,184	1,483
Yield. . . . .	25.6	26.8	41.7	52.6	48.3	51.0
Production . . . . .	1,407	2,382	3,957	5,379	5,723	7,581

Note: Regions are presented in fig. 2. The sum of individual items may not equal the total because of rounding.

<sup>1/</sup> Area is in 1,000 hectares; yield in quintals per hectare; production in 1,000 metric tons.

Source: (42).

Table 9 --France: Grain area by region, averages 1955-57, 1965-67, annual 1970

Region	Wheat	Barley	Oats	Corn	Other	Total <sup>1/</sup>
	1,000 hectares					
Northern (I):						
1955-57. . . . .	1,566	789	893	42	64	3,353
1965-67. . . . .	1,775	1,261	399	224	30	3,698
1970 . . . . .	1,721	1,325	278	539	11	3,874
Northeastern (II):						
1955-57. . . . .	206	154	214	10	31	615
1965-67. . . . .	178	143	82	16	23	442
1970 . . . . .	168	182	54	22	14	440
Western (III):						
1955-57. . . . .	977	389	404	42	124	1,936
1965-67. . . . .	814	594	274	91	83	1,859
1970 . . . . .	644	703	206	204	58	1,815
Southwestern (IV):						
1955-57. . . . .	562	120	142	376	75	1,275
1965-67. . . . .	547	177	92	482	51	1,349
1970 . . . . .	495	219	88	496	48	1,346
Central Mountains (V):						
1955-57. . . . .	569	244	284	51	294	1,442
1965-67. . . . .	686	371	201	115	107	1,480
1970 . . . . .	595	452	156	208	112	1,523
Mediterranean-Southeast (VI):						
1955-57. . . . .	108	45	42	30	41	266
1965-67. . . . .	120	46	16	19	38	239
1970 . . . . .	137	48	17	16	34	252
Total France:						
1955-57 . . . . .	3,989	1,746	1,979	550	625	8,887
1965-67 . . . . .	4,120	2,593	1,064	948	333	9,058
1970. . . . .	3,760	2,929	799	1,483	278	9,249

Note: Regions are presented in fig. 2. The sum of individual items may not equal the total because of rounding.

<sup>1/</sup> Includes rice.

Source: (42).

Table 10 --France: Supply and distribution of corn, 1955/56-1971/72

Year	Supply				Distribution			
	Net changes in stocks <sup>1/</sup>	Production		Imports	Total	Domestic Utilization		Exports
		Total	Off-farm marketings			Total	Feed	
1,000 metric tons								
1955/56. . . .	-19	1,091	181	387	1,459	1,422	1,216	37
1956/57. . . .	-153	1,738	447	206	1,791	1,744	1,538	47
1957/58. . . .	+92	1,392	361	320	1,804	1,767	1,535	37
1958/59. . . .	-178	1,673	615	255	1,750	1,652	1,438	98
1959/60. . . .	-198	1,825	892	132	1,759	1,673	1,313	86
1960/61. . . .	+5	2,813	1,473	218	3,036	2,302	2,079	734
1961/62. . . .	+39	2,470	1,205	327	2,836	2,536	2,276	300
1962/63. . . .	+179	1,864	1,008	473	2,516	2,144	1,901	372
1963/64. . . .	-174	3,877	2,032	442	4,145	3,149	2,829	996
1964/65. . . .	+153	2,109	1,283	762	3,024	2,417	2,083	607
1965/66. . . .	-49	3,420	2,106	590	3,961	2,678	2,345	1,283
1966/67. . . .	-81	4,340	2,839	575	4,834	3,125	2,756	1,709
1967/68. . . .	-81	4,111	2,925	540	4,570	3,266	2,770	1,304
1968/69. . . .	+39	5,379	3,899	465	5,883	3,587	2,884	2,296
1969/70. . . .	-274	5,723	4,339	447	5,896	3,548	2,908	2,348
1970/71. . . .	+88	7,581	6,224	499	8,168	4,606	3,788	3,562
1971/72. . . .	-250	8,771	7,174	301	8,822	5,096	4,184	3,726

<sup>1/</sup> Minus sign indicates net increase in stocks; plus sign indicates net decrease.

Sources: (3, 42, 48, (1972 No. 1), 53, 76).

The share of corn in total grains fed in France has significantly increased. In 1971, grain fed totaled about 15 million tons, roughly 50 percent more than in 1955. In the same period, corn's share of total grain fed nearly doubled, representing close to one-third in 1971. In 1971/72, about 4.2 million tons of corn was fed to livestock, or close to 3 1/2 times the level in 1955/56. Large quantities of corn are marketed, with more than 80 percent moving off the producing farms in recent years. On a percentage basis, less and less corn is being kept on the farm where it is produced. Less than one-fifth of the corn was fed on the farms where produced in 1970/71, compared with over one-third in 1966/67.

Surpluses of other domestic grains in France have dampened the rise in the feed use of corn. In 1971, about 5 million tons of barley and 2 million tons of oats were fed to livestock. Also, larger quantities of wheat are being fed, partially as a result of the EC feeding subsidy for wheat. Wheat has been in surplus production in recent years. In 1971/72, the use of wheat for feed approached 4 million tons, about double the level in 1955/56.

Food consumption of corn has been increasing but has not exceeded 600,000 tons. Industrial uses of corn have increased markedly and exceeded 550,000 tons in 1970/71.

#### Factors Influencing Corn Production

##### Prices and Policy

The French Government has long had an important role in the country's production of corn. Prior to the gradual establishment of a common (EC-wide) market organization for grains, beginning in July 1962, the French Government provided fixed, guaranteed prices to encourage corn production, while import fees and other restrictions were used to insulate domestic producers from the competition of foreign suppliers. Export and storage subsidies were also used to keep domestic prices high. The Office Nationale Interprofessionnel des Cereales (ONIC) regulated the corn market.

EC grain regulation No. 19 of April 1962 ended France's autonomy over its grain policy. Although the mechanics of price support in the EC's policy are considerably different, the basic features for corn are similar to the prior French policy. The EC policy, the CAP, relies essentially on import protection to support the corn price; the variable levy keeps the price of imported corn at or above the target price (or more properly, the threshold price--target price as computed at the border, adjusted for transportation). The regulations provide for Government intervention to support domestic corn prices, although, in practice, this has not yet proved necessary. Also, export subsidies are granted. A gradual adjustment to the CAP for grains was made during a 5-year transitional period from July 1, 1962, to July 1, 1967.

The adoption of the EC grain policy resulted in relatively less favorable treatment for corn in comparison with other grains, particularly wheat and barley. French corn producers had long been specially favored by national policies. The movement of French corn producer prices since 1950 and the relationship with wheat and barley prices appear in table 11. During the 10-year period preceding the start of the transitional period, corn producer prices actually averaged higher than wheat prices; barley producer prices averaged only 75 percent of corn prices. Since 1962, corn producer prices have averaged some 4 percent lower than wheat prices, while barley producer prices have moved (on average) to about 90 percent of corn prices. Barley target and threshold prices have actually been set higher than comparable prices for corn by the European Community.

It is true that the differences between the corn/wheat and the barley/corn ratios in the 3-year period prior to the EC policy (1959-61) and the post-1962 period are much

Table 11 --France: Producer prices for wheat, barley, and corn and price ratios, 1950/51-1970/71

Year	Wheat	Barley	Corn	Ratio		
				Barley/ corn	Barley/ wheat	Corn/ wheat
- - - -Francs/100 kg.- - - -						
1950/51. . .	25.61	16.94	22.25	76	66	87
1951/52. . .	36.05	23.23	31.70	73	64	88
1952/53. . .	36.05	28.70	36.00	80	80	100
1953/54. . .	36.10	24.83	36.35	68	69	101
1954/55. . .	34.27	24.38	35.97	68	71	105
1955/56. . .	34.25	25.08	35.70	70	73	104
1956/57. . .	37.84	25.26	35.78	71	67	95
1957/58. . .	29.40	25.84	36.47	71	88	124
1958/59. . .	33.84	28.14	39.32	72	83	116
1959/60. . .	36.80	31.37	38.43	82	85	104
1960/61. . .	37.81	31.00	35.55	87	82	94
1961/62. . .	40.03	31.10	36.50	85	78	91
1962/63. . .	40.90	35.42	37.85	94	87	93
1963/64. . .	39.24	33.48	37.29	90	85	95
1964/65. . .	38.70	32.17	39.93	81	83	103
1965/66. . .	37.46	32.92	38.54	85	88	103
1966/67. . .	41.58	35.41	38.62	92	85	93
1967/68. . .	43.35	36.91	38.73	95	85	89
1968/69. . .	43.24	37.75	40.63	93	87	94
1969/70. . .	43.11	37.53	42.15	89	87	98
1970/71. . .	44.75	38.96	42.89	91	87	96

Source: (42).

less pronounced, indicating that the French Government had begun to move towards a grain price structure less favorable to corn production even before the adoption of the CAP. However, the CAP tended to reinforce this development by:

- (1) Introducing, with the unification of the EC grain market in 1967, substantially higher support prices for all French grains except corn.
- (2) Eliminating the French quantum tax system. Under this system, French grain producers were taxed to help pay surplus-disposal costs when production exceeded a certain level.

The tax on wheat producers was progressive--that is, producers delivering larger quantities paid a proportionately higher tax than smaller producers; taxes on barley were levied at a uniform rate. The impact of the quantum (or surplus disposal) tax fell primarily on wheat and barley. It was collected from corn producers in only one year, 1960/61. According to the Stanford Food Research Institute, the lifting of this tax



burden meant that "many large wheat producers . . . will find their net returns per ton increased more for wheat than for barley and far more than for maize (19)."

Gains have been made in French producer corn prices in comparison with wheat and barley prices in the past several years. The average 1968-70 producer corn price was 9.0 percent above the average price during the transitional period (1962-67) from national to EC policy, whereas, the average transitional corn price was only 4.5 percent above the producer price for 1959-61. In part, these changes have been the result of EC price decisions. The EC target price for corn has been raised several times since unification of the market; the target price set for the 1972/73 crop year was about 12 percent above the target price for 1967/68. At the same time, barley and wheat prices have been depressed by surplus production.

The change in the grain price structure seems to have slowed the expansion of French corn production throughout the early and midsixties. French corn area in this period remained near 900,000 hectares--in contrast with the sharp increase in corn area during the 1950's when support prices favorable to corn existed (table 8). During the sixties, barley area was expanding rapidly. However, corn area expansion began a rapid increase in 1969, almost doubling from the 1967 level to 1.9 million hectares in 1972.

Although EC price policy has favored corn expansion in recent years, the magnitude of the increase in area suggests other factors have had a significant impact. Progress in improved seed, production practices, and technology have given producers cause to boost corn area. These factors are discussed in a later section in this report.

The future course of EC grain price policy is difficult to predict. In March 1972, the EC again raised corn threshold prices--by 5 percent for 1972/73. However, the enlargement of the European Community will make further grain price increases more difficult. The three new EC members (Denmark, Ireland, and, in particular, the United Kingdom) must substantially increase their grain prices to come into alignment with the common price level; they will probably be reluctant to commit themselves to further price increases. Indeed, the French have become increasingly concerned over the price relationships between grain and livestock products and noticeably less desirous of higher grain prices.

Increases in EC grain prices throughout the 1970's are likely to be quite moderate. EC decisionmakers might reasonably be expected to favor corn since it is the grain crop least likely to suffer from market disposal problems.

#### Irrigation

Because of the humid climate that prevails in all but the southern part of France, irrigation is less important to corn production in France than in other Mediterranean countries. However, the use of irrigation in corn production does result in considerably higher yields, particularly in the dry regions of the southwest. Also, irrigation reduces the risks caused by lack of water during the corn germination and flowering period.

Reliable and up-to-date data on France's irrigated corn area are limited. An official survey of irrigated areas (1967) in different crops in selected "Departments" shows that only one-tenth of the surveyed 600,000 hectares in corn were irrigated (55). More recently (1969), France's total irrigated corn area has been estimated at 120,000 hectares, about one-tenth of total corn area (43). The following tabulation presents irrigation of corn for selected regions and total France in 1969:

Department or region	Irrigated	Nonirrigated
	1,000 hectares	1,000 hectares
Seine-et-Marne . . . . .	3.0	97.0
Yvelines . . . . .	4.0	96.0
Essonne . . . . .	4.0	96.0
Val d' Oise . . . . .	--	100.0
Parisienne . . . . .	3.0	97.0
Eure-et-Loire . . . . .	30.5	69.5
Dordogne . . . . .	14.4	85.6
Gironde . . . . .	13.5	85.5
Landes . . . . .	9.5	90.5
Lot-et-Garonne . . . . .	22.8	77.2
Pyrenees-Atlantique . . . . .	2.0	98.0
Aquitaine . . . . .	9.0	91.0
Total selected . . . . .	115.7	1,083.3
Total . . . . .	(120.0)	(1,184.0)

Source: (55).

Irrigated corn area has been increasing rapidly in the north of France but has remained constant in the south since 1965 (55, 14-15). This development reflects a general trend towards the expansion of irrigation facilities in areas of France where rainfall is high--particularly the Beauce (Eure-et-Loire and Loire-et-Cher regions, southwest of Paris). However, the bulk of the irrigated area is still located in the south (82 percent in 1966).

It is expected that the expansion of irrigated corn area will continue in the north, particularly in the Beauce region. Large farms prevail in the Parisienne Region, facilitating rapid development of individual irrigation works. The same is not true of the southwest, where small, fragmented farms make collective irrigation a necessity. These smaller farms also tend to encourage the production of more intensive (higher value per hectare) crops such as vegetables.

The impact of irrigation on corn production is through its effect on yields. Although national statistics do not provide information on corn yields on irrigated area, two studies 9/ indicate the impact of irrigation on corn yields. These studies cover

9/ Part III of (55) summarizes these two studies.

the Arc Valley in Provence--a dry region--and the Pithiviers (north of the Loire)--a major humid region. In the case of the dry region, corn yields on irrigated area ranged from 70 to 100 percent higher than those obtained on nonirrigated land. In the humid region, corn yields on irrigated area, at 70 quintals per hectare, were about 30 to 40 percent higher than on land not irrigated.

In 1970, total irrigated area for all crops covered approximately 825,000 hectares. According to the French Vith Social and Economic Development Plan (1971-75), about 66,000 hectares per year will be added during the plan. This expansion rate is considerably higher than the average rates achieved in the past--45,000 hectares per year for 1966-70 and 25,000 hectares per year for 1956-66. Data on planned irrigated area in different crops are not given. Corn's share of the 1970 irrigated area is estimated at about 15 percent; its share of the newly irrigated area is expected to be higher but still much less than a third. Thus, irrigation is likely to cause a moderate increase in overall French corn yields through 1975 (and through 1980, a continuation of these trends is assumed). The large expansion of total corn area projected for the 1970's will keep the growth in the ratio of irrigated corn to total corn area rather small. Most of the increase can be expected in areas where rainfall is relatively high; thus, the impact on yields will not be as great.

#### Competition for Land Use

France's total agricultural land, <sup>10/</sup> particularly land in annual crops (arable land), has been declining. Between 1956 and 1970, agricultural land declined by 1.3 million hectares, and arable cropland dropped nearly 2 million hectares. The continued return of marginal cropland to permanent crops such as vineyards or grassland and the ongoing shift of land from agricultural to nonagricultural uses will reduce available land for grains, as well as restrict shifts from other crops to grains.

More than half of France's arable land is devoted to grain production. Grain area has been slowly increasing, totaling 9.4 million hectares in 1971, or 6 percent more than in 1955-57. The increase in grain area appears to have been primarily at the expense of root and forage crops and fallow land. Between 1956 and 1972, grain area increased by 623,000 hectares. In the same period, forage crops and root and tuber crops both showed area declines of slightly more than 500,000 hectares, while fallow land declined 650,000 hectares.

There have been significant shifts in area allocated to different grains (table 7). From 1955-57 to 1972, barley area increased 65 percent to about 2.6 million hectares, mostly at the expense of oats and rye; oats area declined by 1.2 million hectares to roughly 800,000 hectares; rye area dropped by 249,000 hectares to 125,000 hectares; wheat area did not deviate much from 4.0 million hectares; and corn area increased twofold to 1.9 million hectares.

French farmers' decisions on land use depend not only on the profitability of land use but also on many other factors such as size and layout of farms, available technology, types of soils, necessity of maintaining soil fertility and tilth, livestock to be fed, and pest control.

The available information on the cost and returns of corn production and the relative profitability of corn in comparison with the various competing crops is limited. Most of the work done in this area does not show a clear-cut advantage to corn production; consequently, this work is not very helpful in explaining the phenomenal increase in corn area in recent years. For example, data from the French

<sup>10/</sup> The total of arable land, permanent crops, and permanent grassland was about 33 million hectares in 1971.

Ministry of Agriculture cover corn and several other crops in three areas in northern and western France (Aunis, Grande Beauce, and Caen) (tables 12 and 13). Net returns (calculated as the value of production minus most variable costs--with the notable exclusion of labor costs) are seen to vary widely by region and size of farm. The data showed net returns for corn as higher than those for barley in two regions, while only in Caen were they higher than those for wheat. Where calculated, net returns on sugarbeets under quota and potatoes were considerably higher than those for corn (or for that matter, all grains); however, as previously noted, net returns did not take into account labor costs, which are particularly heavy for root crops.

Gross returns on corn production are higher than for other grains, particularly in the northern region, where corn returns in 1970-72 averaged about 2 1/2 times the 1965-67 level. The following tabulation presents the development of gross returns for the major grains produced in France:

Grain	Average 1955-57	Average 1965-67	Average 1970-72	Increase of 1970-72 over 1965-67
	Francs/hectare			Percent
Corn . . .	920	1,611	2,208	37
Wheat . . .	763	1,325	1,933	46
Barley . . .	592	1,096	1,315	20
Oats . . .	370	828	1,127	36
Rye . . .	318	692	906	31

A report by the Association Generale des Producteurs de Mais (AGPM) (French Association of Corn Producers) showed that at a price of 35 francs per quintal, gross returns in 1960 amounted to 1,095 francs per hectare for the Aquitaine and Midi-Pyrenees regions (at a yield of 31.3 quintals per hectare) and 1,683 francs per hectare for the Parisienne and Centre regions (at a yield of 46.8 quintals per hectare) (2, p. 16). In 1970, at 41.50 francs per quintal, the gross return was 1,647 francs and 2,506 francs per hectare, respectively, with yields of 39.7 and 60.4 quintals per hectare. This amount is almost a 50-percent increase in gross returns per hectare planted to corn for each region. Comparable figures were not given for other crops; however, corn yields have increased at a faster rate than the yields of the major competing crops. This suggests that the net returns to corn production have improved relative to other crops. The larger growth in corn yields, which has been particularly evident in recent years, is shown below:

Crop	Average yields, 1960-62	Average yields, 1970-72	Increase
	Quintals/hectare		Percent
Corn . . . . .	27.0	51.6	91
Rye . . . . .	14.0	22.9	64
Oats . . . . .	18.9	29.4	56
Wheat . . . . .	26.7	39.1	46
Potatoes . . . . .	162.0	229.7	42
Barley . . . . .	26.3	33.0	25
Sugarbeets . . . . .	380.3	437.0	15

Table 12 --France: Yield and net returns <sup>1/</sup> per hectare for selected crops in 3 French regions, 1970

Crops	Aunis		Grande Beauce				Caen (valley)	
	Yield	Net returns	Large farms		Small farms		Yield	Net returns
			Yield	Net returns	Yield	Net returns		
	Qu./ha.	Francs/ha.	Qu./ha.	Francs/ha.	Qu./ha.	Francs/ha.	Qu./ha.	Francs/ha.
Wheat (durum). . . .	35	1,849	37	2,177	29	1,666	--	--
Wheat (soft) . . . .	42-45	1,274-1,360	49	1,670	41	1,335	50	1,502-1,535
Barley . . . . .	38	929	46	1,475	38	1,181	45	1,207
Corn (grain) . . . .	50	1,283	53	1,443	43	1,043	65	1,668
Sorghum. . . . .	40	863	--	--	--	--	--	--
Sugarbeets (with quota). . . .	--	--	420	2,312	--	--	420	2,238
Sugarbeets (without quota) . .	--	--	420	993	--	--	--	--
Potatoes . . . . .	--	--	170	2,286	--	--	320	2,570
Sunflower. . . . .	24	1,719	23	1,683	21	1,480	--	--
Rapeseed . . . . .	21	1,024	24	1,691	22	1,583	22	1,104
Flax (fiber) . . . .	--	--	--	--	--	--	70	1,590

<sup>1/</sup> Gross sales value minus variable costs, excluding labor costs.

Source: (41).

Table 13 --France: Net returns for corn in 3 French regions, 1970

Item	Aunis	Grand Beauce		Caen (valley)
		Large farms	Small farms	
Yield (quintals/hectare) . . .	50	53	43	65
Price producers receive (francs/quintal) . . . . .	39	39	39	39
		Francs/hectare		
Gross value of production . .	1,950	2,067	1,677	2,535
Variable costs:				
Seeds . . . . .	50	50	50	72
Fertilizers . . . . .	339	309	309	402
Herbicides, pesticides . . .	88	125	125	99
Gasoline . . . . .	40	38	38	47
Other . . . . .	1/150	112	112	2/247
Total . . . . .	667	634	634	867
Net returns . . . . .	1,283	1,433	1,043	1,668

1/ Drying costs.

2/ Drying, storage, and grinding costs.

Source: (41).

The trends in land utilization since 1966 suggest that much of the increase in corn area has come from land previously planted to forage crops, rye, oats, and potatoes. Corn in some areas has also benefited--perhaps by about 100,000 hectares during 1966-71--from the reduction of fallow land. Changes in selected crop area from 1966 to 1971 are as follows (48):

	1,000 hectares
Corn . . . . .	+675
Wheat . . . . .	-15
Barley . . . . .	+26
Rye . . . . .	-70
Oats . . . . .	-263
Potatoes . . . . .	-152
Sugarbeets . . . . .	+124
Forage (annual crops) . . . . .	-990

For land use, corn competes with other grains--wheat, barley, oats, and rye--but it also competes with sugarbeets, potatoes, oilseeds, and forage crops. Most of the increase in corn area has come from land previously planted to oats, rye, and potatoes,

and fallow land. 11/

Area planted to oats, rye, and potatoes has registered a steady, long-term decline, as has fallow land. The area in these three crops, however, remains large--1.3 million hectares in 1971 (437,000 in potatoes, 762,000 in oats, and 125,000 in rye). Decreasing demand for these crops is expected to result in a further decline in area.

The decline in forage crop area, on the other hand, has been evident only since 1961, when total area reached a high of 6.0 million hectares. By 1970, forage area had dropped to 4.7 million hectares.

In recent years, there have been indications of a shift from barley to corn. Barley increased almost continuously through the past two decades, reaching a peak of 2.9 million hectares in 1970. Most of the increase occurred in the 1950's and first half of the 1960's. Area increased only 26,000 hectares between 1966 and 1970. A decline of 285,000 hectares was registered in 1971; a further decline of 29,000 took place in 1972 (47). Some of this area shifted into corn.

By assuming an expanded role in crop rotations, corn may have also increased somewhat at the expense of wheat in some areas and appears to have replaced sugarbeets and certain forage crops such as alfalfa in many rotations.

For irrigated land, the situation is different; here corn competes more with fruits and vegetables, forage, and certain other crops such as sugarbeets than with other grains. While some expansion of irrigated corn area is expected, it will be inhibited by the small farm size in some areas, particularly in those traditionally using irrigation. On small farms, more intensive crop production (for example, vegetables) is often necessary to recoup the large investments required for irrigation.

Competition with corn silage does not appear to be a major factor limiting the expansion of corn (for grain) area. In much of France, corn silage has served, and is still serving, to introduce farmers to growing corn. In many cases, after starting with corn silage, the farmers switch to the production of corn for grain.

Nevertheless, corn silage area has been expanding rapidly in recent years; from 1965 to 1972, it essentially doubled, reaching 527,000 hectares. Production totaled 25 million tons (green basis). As would be expected, silage is mainly produced on livestock farms and is more prevalent in the north, where the corn-growing season is short and risks of a bad crop are fewer for corn silage than for grain.

The increases in corn silage have been accompanied by marked changes in production in some regions. Decreases are reported where corn silage has been traditionally grown for green feeding, such as in the Aquitaine, Midi-Pyrenees, Poitou-Charentes, and Rhone-Alpes regions (fig. 2). On the other hand, rather large increases have been noted for Bretagne, Basse-Normandie, and the Loire regions. These three regions account for 50 percent of total area, with Bretagne accounting for 22 percent. Other regions, including some parts in the southwest and the pasturelands of the north, are showing increasing interest in corn silage. In many areas, corn silage is replacing fodder beets. Although the feed (fodder) value of fodder beets is higher than that of corn silage per hectare, production costs, especially labor, are higher for beets.

Corn silage is used for both dairy and beef cattle, though many farmers feel that silage fed to dairy cattle adversely affects cheese quality. Corn silage is preferred to grain in beef production because the qualities it confers on meat are more in line with French consumers' preferences. Also, corn silage fed to cattle for fattening

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11/ Fallow land declined from 1 million hectares in 1956 to less than 400,000 hectares in 1970.

induces good growth and allows cattle to grow to heavier weights (than if fed entirely grain) before becoming overly finished.

The growth rate in corn silage production is expected to remain high through the 1970's. While increases are expected for all regions, the increases are expected to be greatest for Bretagne, France-Comte, and Champagne.

Increases in corn silage area are likely to continue to come at the expense of other forage crops such as fodder beets and fodder cabbages, rather than at the expense of corn for grain. Between 1968 and 1972, the area in fodder beets and forage cabbages dropped 224,000 hectares, or nearly a third, to a total of 534,000 hectares. Such declines partially reflect the fact that the traditional orientation of the French agricultural economy, particularly the larger farms, toward grain production has been further reinforced by the EC price structure.

#### Farm Structure and Technology

The profitability of corn relative to most other crops seems to improve as farm size increases. The greater resources generally available to larger farms permit a higher level of investment in mechanization and other inputs; more importantly, larger farm size permits a more optimal utilization of these inputs in corn production. (The importance of this relationship with respect to irrigated land has already been pointed out in this report.)

Optimum crop plans for several farms of varying sizes in the Aunis (western region of France) and Beauce (Eure-et-Loire and Loire-et-Cher, southwest of Paris) generally confirm the positive relationship between farm size and the importance of corn production (table 14). In Aunis, corn's share of cultivated area was 12 percent on 40-hectare farms but 32 percent on 120-hectare farms. In the Beauce region, corn's share was 5 percent on 20-hectare farms but 40 percent on 60-hectare farms. However, it was only 21 percent on 120-hectare farms.

Fertilizer use per hectare in corn production tends to increase substantially with larger farm size (table 15). Despite the apparent positive relationship between corn and large farm size, a French Government survey shows that the fields planted to corn are not large. In the Parisienne and Eure-et-Loire regions, roughly 40 percent of the corn area is in fields of 10 hectares or more; 30 percent in fields of 5 to 10 hectares; and 20 percent in fields of 2 to 5 hectares. Fields of less than 1 hectare are not very important. In contrast, in the Aquitaine region, more than 70 percent of the corn area is in fields of less than 2 hectares (table 16).

Large farms dominated corn production in the Parisienne and Eure-et-Loire regions. In the Parisienne region, farms with more than 100 hectares contributed 70 percent of the corn production and in the Eure-et-Loire region, more than half. Comparable data were not found for the Aquitaine region.

A gradual enlargement in corn farm size and less fragmentation can be expected throughout the 1970's. The continuous departure of farmers will lead to farm consolidation. According to a European Community inquiry into farm organization in 1967, there were 1,690,000 farms in France (with an average of about 20 hectares); in 1955, there were 2,234,000 farms (with an average of 14 hectares). At this rate, the Community expects the number of farms in France to be about 1 million in 1980, with an average size of 30 to 35 hectares. The return to corn production should gradually improve as this trend proceeds.

In an earlier section, the influence of prices and Government policy on French corn production was examined. It was concluded that these factors could not explain in total the recent increases in French corn area and production. Instead, this



Table 14 --France: Optimum crop plans on selected farms in the Aunis and Beauce regions, 1970

Item	Aunis--farm size 1/			Beauce--farm size 2/			
	I	II	III	I	II	III	IV
Arable land use (hectares)	40	80	120	20	30	60	120
Laborers (number)	2	3	3	n.a.	n.a.	n.a.	n.a.
Tractors (number)	1	3/1	3/1	2	3	2	3
Harvesters (number)	1	1	1	1	1	1	1
Cows (number)	20	50	60	--	--	--	--
Land use (hectares):							
Corn	4.8	11.8	38.3	1	8	24	25
Soft wheat	--	--	14.5	10	15	24	40
Hard wheat	12.7	15.0	14.4	--	--	12	40
Sunflower	6.6	13.0	1.4	4/9	4/7	--	4/15
Alfalfa	10.8	27.6	38.0	--	--	--	--
Rye-grass	3.6	9.0	8.7	--	--	--	--
Other forage crops	1.5	3.3	4.7	--	--	--	--

n.a. = not available.

1/ Aunis--farms stressing livestock raising.

2/ Beauce--farms stressing crop production.

3/ Larger tractor with slight increases in power.

4/ Includes rapeseed.

Source: (41).

increase was in large part attributed to changes in technology (reflected by the rapid increase in French corn yields) and in the attitudes and practices of the French farmer--changes which significantly altered the framework upon which the price system worked. A combination of technical advances has led a large number of French farmers to discover that by using the appropriate package of inputs, corn production is profitable and can be readily fitted into their cropping plans.

One of the major technological advances has been the widespread use of improved seed varieties. The conversion to hybrid seed varieties was accomplished relatively rapidly in France. By 1971, hybrid corn covered about 98 percent of corn area, compared with about 50 percent in the early 1960's. Although time series data on the growth in the use of hybrid varieties are not available, the experience of other West European countries suggests that this growth may have been the major influence in the near doubling of yields that took place in the past decade. In addition, the development and expanded use of early-maturing corn varieties have permitted the northerly expansion of corn area. Continuing improvement of these varieties will probably allow a further expansion of corn in northern France as well as an improvement of yields in those areas.

Table 15 --France: Application of fertilizers and herbicides in corn production according to farm size in 3 French regions, 1969

Farm size (hectares)	Fertilizer <u>1/</u>			Herbicides <u>2/</u>		
	Pari- sienne	Eure-et- Loire	Aqui- taine	Pari- sienne	Eure-et- Loire	Aqui- taine
	- - Kilograms/hectare - -			- - Percent of area - -		
0-9.9 . . . . .	n.a.	n.a.	292	n.a.	n.a.	21.7
10-19.9 . . . . .	370	424	377	0.7	2.5	33.2
20-49.9 . . . . .	427	420	405	8.7	14.0	34.4
50-99.9 . . . . .	437	433	418	18.7	31.5	6.7
100 plus . . . . .	431	464	531	71.9	52.0	4.0
Average and total . . . . .	431	447	377	100.0	100.0	100.0

n.a. = not available.

1/ Nitrogen, phosphate, and potash.

2/ All herbicides (preemergence and postemergence).

Source: (43).

Table 16 --France: Distribution of corn area according to field size 1/ in 3 French regions, 1969

Region	Size of field (hectares)						Total
	Less than 0.5	0.5-0.9	1.0-1.9	2.0-4.9	5.0-9.9	10.0 or more	
	Percent						
Parisienne . . . . .	0.3	1.5	4.9	23.1	34.5	35.7	100
Eure-et-Loire . . . . .	0.5	1.0	6.5	19.5	27.0	45.5	100
Aquitaine . . . . .	15.3	28.0	29.2	19.7	5.0	2.8	100
	Average yields (quintals/hectare)						
Parisienne . . . . .	88.1	71.0	58.9	65.9	67.4	64.0	65.6
Eure-et-Loire . . . . .	70.3	59.0	58.6	62.6	62.3	66.5	64.0
Aquitaine . . . . .	49.8	56.7	61.5	60.4	66.3	73.8	52.7

1/ The area planted to corn on each farm.

Source: (43, p. 11).

Mechanization has also greatly contributed to the increase in corn production in the last 20 years. Until 1950, there were few mechanical corn harvesters in France. Today, the use of modern corn planters and harvesters/shellers is widespread. Estimated sales of harvesters/shellers rose from about 300 before World War II to 1,200 in 1950, 7,500 in 1960, and a peak of 14,400 in 1966. Total sales from before World War II through 1972 were over 175,000 harvesters (8, 42). (A large share of these machines, of course, are not in service due to their wearing out over time.) The quality of the machinery has also improved. The new machinery permits better and more timely preparation of seed beds and faster harvesting of corn, thus increasing yields and reducing losses in the fields. Also, corn driers are widely used.

Increased fertilizer use has also been an important factor in increased corn production. Declining "real" prices of fertilizer along with more widespread knowledge about higher yields to be expected from use with new hybrid seed corn have stimulated this increase. Although data on fertilizer applied to corn area are not available on a countrywide basis, data from some of the main corn-producing regions suggest a high level of use. In 1968, corn production absorbed two-thirds of the 36,000 tons of nitrogen consumed in the Pyrenees-Atlantique and Landes regions (64, p. 35). In 1969, the use of fertilizers by corn producers in two of the main producing regions, Parisienne and Aquitaine, averaged 431 kilograms per hectare and 377 kilograms per hectare, respectively (table 15).

The use of herbicides and pesticides among French corn producers has steadily increased. In the early 1960's, use of these was rather limited. However, by 1969 pesticides were used on all the corn area in the Parisienne and Eure-et-Loire regions and on all farms with more than 50 hectares in corn in the Aquitaine region (43, p. 11).

These technological improvements combined to increase the profitability of corn and to induce the French farmer to introduce corn into his cropping plan. In many cases, the French farmer discovered that his crop rotation could be quite favorably modified by the inclusion of corn. Machinery used for drying sunflower and rapeseed, for example, can also be used for drying corn. Also, grain harvesters can generally be modified to handle corn. In many areas, the inclusion of corn in the rotation enables the use of herbicides (often damaging to other grains, but generally not to corn) to eliminate troublesome weeds. Also, the relatively low labor requirements of corn production often make it preferable to the more labor-intensive crops such as potatoes, sugarbeets, and certain forage crops which traditionally have been used in the rotation for purposes of weed and disease control. Another advantage is that unlike sugarbeets, corn is under no production restrictions. Finally, for many farmers, the production of corn along with other grains has allowed farmers to better even out their labor requirements during the crop season.

#### Outlook

It seems very likely that France's corn production will continue to expand rapidly. This expansion will be stimulated by increasing needs in both domestic and neighboring markets as well as by the interest aroused among producers by new technology. Cultivation of corn is mechanized, requires little labor, and fits well with production of other crops, particularly on the growing number of large farms. Yields are higher than for other grains. Harvesting, storage, and marketing have not posed any major problem in the past 5 years. Also, there have not been any surplus problems, as in the case of wheat and barley.

Using ordinary least-squares analysis, the following projections of France's corn area, yield, and production were obtained:

Corn	Actual	Projected	
	average	1975	1980
	1969-71		
Area (1,000 ha.) . . . . .	1,436	2,380	2,760
Yield (qu./ha.) . . . . .	50	58	68
Production (million M.T.) . .	7.4	13.8	18.8

Thus, by 1980, corn production is projected to approach 19 million tons, about 2 1/2 times the average level of 1969-71. Area is projected to be almost 2.8 million hectares, nearly double the 1969-71 average level. Yields are projected to rise by over one-third.

Other sources also project considerable increases in France's corn area and production, although their estimates are lower than those presented in this analysis. The Association Generale des Producteurs de Mais (AGPM), in a recent report, forecast an increase in corn area to 2 million hectares, with a production of 11 million tons by 1975 (3). However, recent conversations with AGPM representatives indicated that they now feel a higher area figure--in the range of 2.0 to 2.2 million hectares--may be more probable, with yields continuing to increase moderately. France's Vth Social & Economic Development Plan (1971-75) projects 1.8 million hectares planted to corn by 1975, with a production of 10 million tons in that year (76).

The projected increase in corn area by 1980 is quite large--1.3 million hectares above the 1969-71 average and about 0.9 million hectares above the area for 1972. There are, however, several reasons for believing that such an increase is attainable:

(1) Area in wheat, rye, and oats has declined as evidenced by trend lines calculated for the various grains for 1955-71. Based on an adjusted linear trend, combined oats and rye area is estimated to decrease by 700,000 hectares by 1980. Some shift of barley area--as much as 200,000 hectares--into corn is likely. There may also be further decline in the area planted to root and forage crops. Corn stands to be the major beneficiary of such a decline, as no substantial expansion of area for other major competing crops is expected.

(2) More pastureland is expected to be shifted into corn production.

(3) Despite the sharp decrease in fallow land in the 1960's, fallow land still approaches 400,000 hectares, and therefore, further switches to corn production are still possible.

(4) As noted, the relative profitability of corn seems to increase with farm size. Thus, the gradual increase in the size of the French farm will favor the expansion of corn.

While significant increases in corn yields are projected through the 1970's (to 68 quintals per hectare in 1980), the rate of increase is expected to be much slower than that of the previous decade. Corn yields will, of course, improve as the result of continuing improvements in technology--improved seed varieties, greater use of fertilizer, irrigation, and other inputs.

There are three major reasons for a slowing down of yield increases. First, nearly all the corn area is now planted with hybrid seed, compared with about half in the early 1960's. Thus, the very large rise that generally accompanies the shift to hybrid seed will not be experienced in the 1970's. The rate of yield improvement of

new adapted varieties is not likely to be as fast as in the past. Second, the high cost of labor and the use of labor-saving devices may in some cases restrain increases in yields. Standard, ready-mixed fertilizers save time and are more readily available but may not give as good a combination of the various nutrients for all parts of the farm's cropland as individual fertilizers would permit. Third, weather and disease conditions may not be as favorable in the next decade as they were in recent years. Yields have benefited from favorable weather during the past 6 years. During this time, corn crops have matured, no real harvesting problems have been encountered; and few diseases or pests have attacked French corn. However, bad weather, such as a cool summer and an early fall frost, could sharply reduce yields. Also, French corn is not immune to diseases. According to official reports, the southern corn leaf blight that attacked U.S. corn in 1970 has since appeared in France's southwest--Sain-Martin-de-Hinx (Landes) and the Pyrenees (Pau) (41, p. 107).

## ITALY

### Corn Production--Historical Development

Corn has been a major crop in Italy for several centuries. It dominates the feed grain situation as in no other West European country. In 1971, Italian corn production accounted for 83 percent of coarse grain production (table 17); consumption of corn as livestock feed accounted for 78 percent of grain fed to livestock.

Italy's corn area reached its highest level--approaching 2 million hectares--near the turn of the century. A long-term decline followed; since 1965, area has remained close to 1 million hectares. Corn production in this century has fluctuated greatly. In the postwar era, it climbed rapidly to surpass prewar levels, despite almost continuously declining area. From 1956 to 1967, it fluctuated within a range of 3.3 to 3.9 million tons per year. In 1969, the 4-million ton mark was broken for the first time with a record crop of 4.5 million tons. Subsequent crops have been well above 4 million tons, with the 1972 output totaling 4.8 million.

The overall trend of Italian corn production in the postwar era (that is, decreasing area, increasing production) is misleading. In fact, there are two divergent trends within the general trend. Area and production of hybrid corn have been increasing rapidly since the early 1950's. At the same time, the decline in the area and production of the domestic open-pollinated corn varieties (nostrano) has continued.

At the start of the postwar period, hybrid corn area was insignificant. It has risen over time as a share of total corn area, reaching 77 percent in 1971; hybrid corn's share of production was up to 90 percent (table 18). Future Italian corn production can now be viewed almost solely in terms of hybrid corn production. The projections indicate that production of nostrano will be less than 50,000 tons by 1980.

Considering the divergence between hybrid and nostrano yields (in 1971, 55 quintals per hectare and 18 quintals per hectare, respectively), the pace of the changeover does not seem overly rapid. Several reasons for the slowness of Italian farmers to adopt hybrid corn are as follows:

(1) Available irrigated croplands are limited. Where supplemental water is not used, local nostrano varieties have more constant yields. Also, local varieties are more resistant to disease.

(2) Market prices for nostrano corn are significantly higher than for hybrid varieties, due to generally higher quality of nostrano corn. Nostrano varieties are high in protein and are believed to confer desirable coloring on poultry meat; in addition, they are preferred for the traditional cornmeal product, "polenta." During

Table 17 --Italy: Grain area and production, selected averages, 1955-70, annual 1970-72

Period	Total grains	Wheat	Coarse grains					
			Total	Corn	Oats	Barley	Rye <u>1/</u>	Other <u>2/</u>
Area:			<u>1,000 hectares</u>					
1955-57. . .	6,878	4,880	1,998	1,247	426	237	75	13
1960-62. . .	6,359	4,485	1,874	1,168	416	215	60	15
1965-67. . .	5,805	4,191	1,614	1,011	361	182	47	13
1968-70. . .	5,746	4,212	1,534	997	312	176	38	11
1970 . . .	5,690	4,138	1,552	1,026	302	179	35	10
1971 . . .	5,419	3,952	1,467	936	289	182	29	8
1972 . . .	5,252	3,853	1,399	919	266	184	26	4
Production:			<u>1,000 metric tons</u>					
1955-57. . .	13,221	8,889	4,332	3,370	537	288	107	30
1960-62. . .	12,803	8,197	4,606	3,671	538	265	94	38
1965-67. . .	14,034	9,591	4,443	3,562	520	278	83	34
1968-70. . .	14,908	9,643	5,265	4,421	456	288	72	28
1970 . . .	15,337	9,689	5,648	4,754	486	315	69	24
1971 . . .	15,480	10,070	5,410	4,469	501	367	55	18
1972 . . .	15,126	9,413	5,713	4,800	469	385	49	10

1/ Includes mixed grains.2/ Sorghum, other coarse grain.

Sources: (52, 76).

Table 18 --Italy: Total, hybrid, and nostrano 1/ corn area, yield, and production, selected averages, 1955-67, annual 1968-71

Year	Area			Yield			Production		
	Hybrid	Nostrano	Total	Hybrid	Nostrano	Average	Hybrid	Nostrano	Total
	<u>- - -1,000 hectares-</u>			<u>- - -Quintals/hectare-</u>			<u>- - -1,000 metric tons-</u>		
1955-57 <u>2/</u>	(353)	(898)	1,247	(49.2)	(19.6)	27.0	(1,736)	(1,761)	3,370
1957-59 :	365	857	1,221	51.6	21.0	30.2	1,884	1,798	3,682
1960-62 :	425	743	1,168	51.5	19.9	31.4	2,191	1,480	3,671
1965-67 :	511	500	1,011	51.1	19.0	35.2	2,610	952	3,562
1968 :	561	407	967	56.4	20.2	41.3	3,165	826	3,991
1969 :	652	348	999	58.0	21.1	45.2	3,784	735	4,519
1970 :	734	292	1,026	56.6	19.7	46.1	4,154	575	3/4,729
1971 :	734	224	3/958	55.0	18.3	3/36.4	4,040	410	3/4,450

1/ Native, open-pollinated varieties.2/ Figures in parentheses are for 1957 only.3/ These figures are based on an earlier estimate than those in table 17.

Sources: (30, 76).

the 1960's, nostrano prices ranged from 25 to 50 percent higher than hybrid prices (32).

(3) Many Italian farms, particularly in central and southern Italy, are very small and relatively backward--a situation not conducive to the adoption of new technology. The switch to hybrid seed corn requires a considerable change in farming practices.

The price incentives resulting from the adoption of the common grain prices of the EC (which caused Italian corn prices to increase substantially) appear to have been instrumental in overcoming the inertia in adopting hybrid corn. The rate of increase in hybrid area seems to have accelerated, as large increases were registered in 1967, 1969, and 1970. Similarly, there has been a surge in irrigated area planted to hybrid corn.

In the five major corn-producing regions <sup>12/</sup> of the north, hybrid corn area increased by about 65,000 hectares from 1960 to 1966, an average of about 3 percent per year. From 1966 to 1971, it increased by over 180,000 hectares, about 7 percent per year. In central and southern Italy, total corn area has continued its decline; however, there has been a spurt in hybrid area. In central Italy, hybrid area increased by almost 50,000 hectares after 1966, compared with an increase of less than 20,000 hectares in 1960-66; in southern Italy, an increase of about 15,000 hectares in hybrid was registered, compared with an increase of only 2,000 hectares in 1960-66. Because of this ongoing shift from nostrano to hybrid corn, Italy has been able to increase its total corn production sharply in recent years, even though corn area has been about 25 percent below the 1955-57 average.

Production was relatively unchanged, with a slight downward trend during 1957-67, while area decreased during that period (table 18). Since 1967, production has increased sharply, while the decline in area has slowed. The decline in corn area was part of a larger reduction in the area planted to grains throughout Italy; both corn and total grain area decreased by more than 20 percent from 1957-59 to 1971. In large part, this reduction was due to the abandonment of many marginal farms where grains were the dominant crop. It also reflected the increasing importance of live-stock and fruit and vegetable production, for the area in orchards and forage increased during this period.

There has been much speculation that the high corn prices of the EC (and relatively lower wheat prices) would cause a great expansion of Italian corn production. The increase in corn area in 1967--the first year of EC common grain prices--seemed to give evidence of such expansion. However, most of this increase was apparently due to severe flooding which wiped out the wheat crop in many parts of Italy and caused the planting of corn instead. In 1968, corn area again declined. In 1969 and 1970, it increased, and, as noted, the shift from nostrano to hybrid corn seemed to accelerate. However, in 1971, hampered by dry summer weather, total corn area declined by almost 9 percent, and hybrid area remained the same. Switches in area to wheat in 1972 caused a further 2-percent decline in total corn area. In sum, the adoption of EC grain prices seems to have resulted in a modest increase in production based on an acceleration of the shift from nostrano to hybrid varieties and a stabilization (or, at least, a slower decline) of corn area--a result considerably more modest than the expansion predicted by many observers.

The increasing dominance of hybrid seed has also led to an increasing concentration of corn production in northern Italy (tables 19 and 20). In 1971, five northern regions (Piemonte, Lombardia, Veneto, Friuli-Venezia Giulia, and Emilia-Romagna) accounted for nearly 70 percent of Italian corn area, over 80 percent of production, and over 85 percent of hybrid corn area and production. All five regions have

<sup>12/</sup> Piemonte, Lombardia, Veneto, Friuli-Venezia Giulia, Emilia-Romagna. (fig. 3).

Table 19 --Italy: Corn area (hybrid and nostrano <sup>1/</sup>), yield, and production by region, 1971

Area and region	Area			Yield			Production		
	Hybrid	Nostrano	Total	Hybrid	Nostrano	Average	Hybrid	Nostrano	Total
	-- -1,000 hectares-- -			-- -Quintals/hectare-- -			-- -1,000 metric tons-- -		
North:									
Piemonte . . . . .	115.4	2.5	117.9	54.6	28.0	54.0	630.0	7.0	637.0
Valle d'Aosta . . . . .	.2	.2	.3	43.8	23.3	33.9	.7	.3	1.1
Liguria . . . . .	.5	3.0	3.5	50.0	26.7	30.0	2.5	8.0	10.5
Lombardia . . . . .	170.0	8.5	178.5	63.5	34.2	62.2	1,080.0	29.0	1,109.0
Trentino Alto-Adige . . . . .	.1	6.1	6.2	57.1	26.2	27.0	.8	16.0	16.8
Veneto . . . . .	234.0	22.0	256.0	53.8	29.5	51.8	1,260.0	65.0	1,325.0
Friuli-Venezia Giulia . . . . .	80.0	1.0	81.0	47.5	25.0	47.2	380.0	2.5	382.5
Emilia-Romagna . . . . .	29.0	2.0	31.0	56.7	25.0	54.8	165.0	5.0	170.0
Central:									
Marche . . . . .	22.0	1.3	23.3	36.4	22.3	35.6	80.0	2.9	82.9
Tuscany . . . . .	29.0	11.0	40.0	58.6	27.3	50.0	170.0	30.0	200.0
Umbria . . . . .	17.0	.7	17.7	47.1	15.4	45.9	80.0	1.0	81.0
Lazio . . . . .	18.0	28.0	46.0	55.6	14.3	30.4	100.0	40.0	140.0
Campania . . . . .	7.0	58.0	65.0	57.1	17.2	21.6	40.0	100.0	140.0
South:									
Abruzzi . . . . .	6.0	29.0	35.0	45.0	14.0	19.3	27.0	40.5	67.5
Molise . . . . .	2.6	10.0	12.6	38.5	13.0	18.3	10.0	13.0	23.0
Puglia . . . . .	.5	6.5	7.0	32.0	10.8	12.3	1.6	7.0	8.6
Basilicata . . . . .	.9	16.0	16.9	33.3	12.5	13.6	3.0	20.0	23.0
Calabria . . . . .	.8	16.0	16.8	37.5	13.1	14.3	3.0	21.0	24.0
Islands:									
Sicily . . . . .	.1	1.3	1.4	40.0	8.0	10.0	.4	1.0	1.4
Sardinia . . . . .	1.0	.5	1.5	60.0	15.0	45.0	6.0	.8	6.8
Total . . . . .	734.1	223.5	2/957.6	55.0	18.3	2/46.5	4,040.0	410.0	2/4,450.0

<sup>1/</sup> Native, open-pollinated varieties.<sup>2/</sup> These figures are based on an earlier estimate than those of table 17.

Source: (30).

increased total corn area since 1965-67, while nearly all other regions have registered decreases. The readiness of these regions to expand hybrid seed use is largely explained by the greater summer rainfall and availability of irrigation in the north combined with more progressive and commercialized farming practices.

Significant gains are also being made in central Italy where there has been a considerable shift from nostrano to hybrid in recent years. In Umbria and Marche, almost all corn planted is now hybrid; only in Lazio is nostrano still dominant (in terms of area). In addition, total corn area appears to be holding relatively stable in certain regions such as Tuscany and Umbria since the midsixties.

A comparison of Mangum's (35) projections for 1970 with actual Italian corn production, area, and yields gives further insight into the developments of recent years:



Table 20.--Italy: Total, hybrid, and nostrano 1/ corn area by region, averages 1955-57, 1957-59, 1965-67, annual 1971

Region	1955-57			1957-59			1965-67			1971		
	Hybrid 2/	Nostrano 2/	Total	Hybrid	Nostrano	Total	Hybrid	Nostrano	Total	Hybrid	Nostrano	Total
1,000 hectares												
North:												
Piemonte . . . . .	(70)	(52)	125	75	48	123	97	19	116	115	3	118
Valle d'Aosta . . .	n.a.	(1)	1	n.a.	1	1	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Liguria . . . . .	n.a.	(6)	6	n.a.	6	6	n.a.	5	5	1	3	4
Lombardia . . . . .	(142)	(79)	212	141	74	215	135	27	164	170	9	179
Trentino Alto-												
Adige . . . . .	n.a.	(11)	11	n.a.	11	11	n.a.	8	8	n.a.	6	6
Veneto . . . . .	(73)	(151)	220	79	143	222	153	63	218	234	22	256
Friuli-Venezia												
Giulia . . . . .	(15)	(62)	78	18	57	75	65	7	72	80	1	81
Emilia-Romagna . .	(33)	(34)	73	29	28	57	15	8	23	29	2	31
Central:												
Marche . . . . .	(8)	(52)	59	7	49	56	12	28	41	22	1	23
Tuscany . . . . .	(5)	(55)	60	5	54	59	9	32	41	29	11	40
Umbria . . . . .	(2)	(25)	28	3	24	27	5	13	18	17	1	18
Lazio . . . . .	(5)	(75)	78	5	72	77	12	53	65	18	28	46
Campania . . . . .	n.a.	(122)	121	n.a.	119	120	1	94	95	7	58	65
South:												
Abruzzi . . . . .	n.a.	(40)	41	n.a.	40	40	1	36	36	6	29	35
Molise . . . . .	n.a.	(48)	48	n.a.	48	48	n.a.	48	48	3	10	13
Puglia . . . . .	n.a.	(22)	22	n.a.	22	22	n.a.	12	13	1	7	7
Basilicata . . . . .	n.a.	(20)	21	n.a.	21	21	1	17	18	1	16	17
Calabria . . . . .	n.a.	(35)	34	n.a.	34	34	1	25	25	1	16	17
Islands:												
Sicily . . . . .	n.a.	(5)	5	n.a.	5	5	n.a.	3	3	n.a.	1	1
Sardinia . . . . .	(1)	(3)	4	1	3	3	1	1	1	1	1	2
Total . . . . .	354	898	1,247	363	859	1,222	508	499	1,010	734	224	3/958

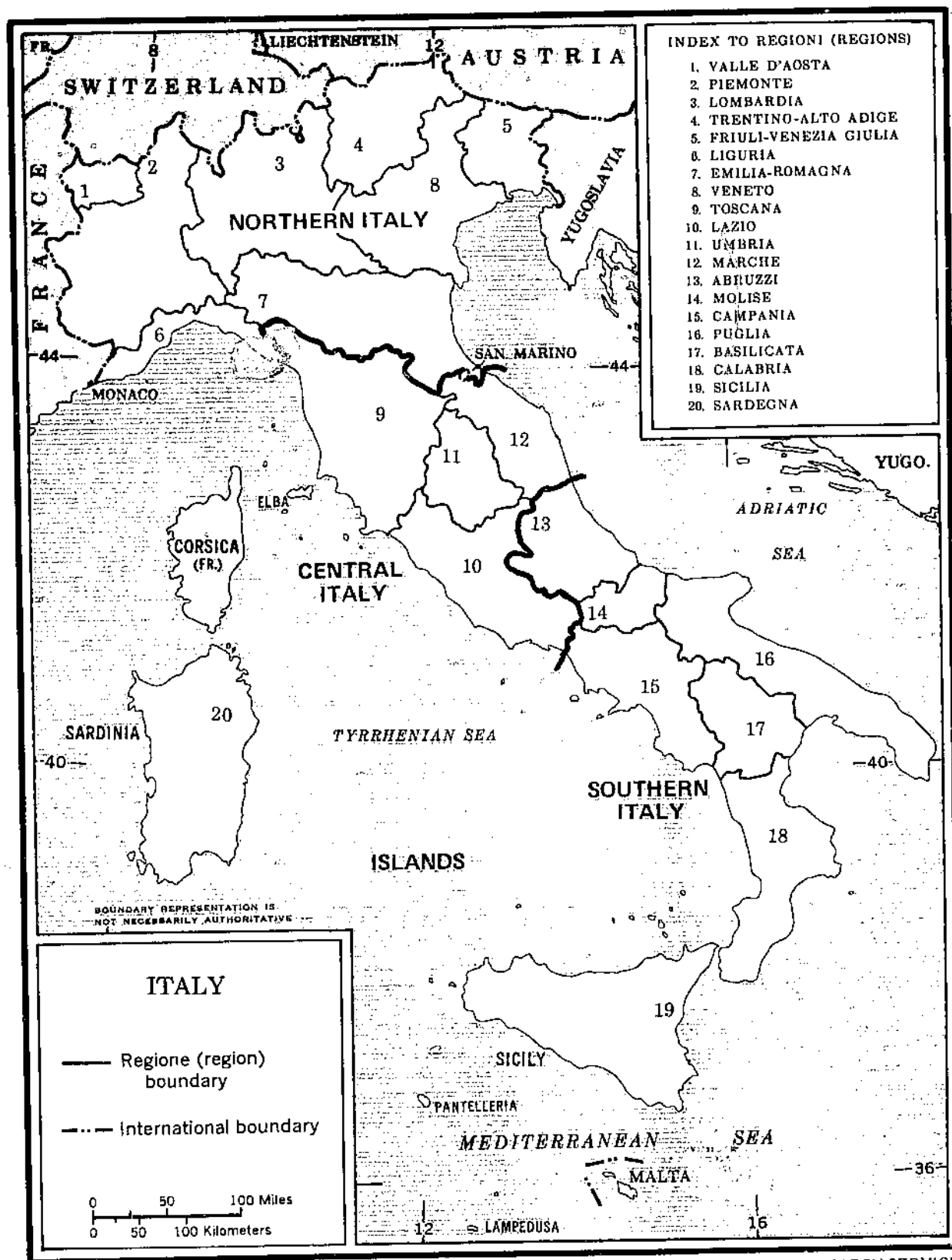
n.a. = not available.

1/ Native, open-pollinated varieties.

2/ Figures in parentheses are for 1957 only.

3/ Based on an earlier estimate than the figure in table 17.

Source: (30).



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Figure 3

Region	Area (1,000 ha.)		Yields (qu./ha.)		Production (1,000 M.T.)	
	<u>M</u>	<u>A</u>	<u>M</u>	<u>A</u>	<u>M</u>	<u>A</u>
North . . . .	602.7	693.0	56.2	54.8	3,387.4	3,797.9
Central . . . .	160.8	138.4	26.7	41.7	429.3	577.3
South . . . .	232.2	194.4	18.3	18.2	425.0	353.9
Italy . . . .	995.8	1,025.9	42.6	46.1	4,241.8	4,728.9

M = Mangum's projections.

A = actual figures.

Based on this analysis, corn area in the north was considerably larger than past observation would have indicated. On the other hand, corn area in central and southern Italy declined at a faster rate than expected. In central Italy, this decline was offset by a much sharper rise in yields--due to the rapid adoption of hybrid varieties--than indicated by past data.

#### Corn Utilization and Imports

Livestock feed is by far the most important use of corn in Italy (table 21) and is responsible for the strong and steady increase in corn utilization. In 1971, close to 95 percent of corn was fed to livestock. The proportions going to other uses have remained stationary or have declined. Corn for human consumption, for example, fell from almost 13 percent of total utilization in 1955/56 to only about 2 percent in 1971/72. Conversely, corn dominates grains fed to livestock in Italy (table 22).

An Italian study (31) estimates the breakdown of corn consumption by class of livestock as follows (for 1969):

	<u>Percent</u>
Cattle . . . . .	46
Hogs . . . . .	26
Poultry . . . . .	24
Other . . . . .	4

The study further estimates that about 16 percent of the corn consumed by livestock is processed by the mixed feed industry; the remainder is utilized directly on the farm. Poultry feed accounts for almost 50 percent of the corn consumed as mixed feed, while hog and cattle feed account for about 26 and 19 percent, respectively.

Corn imports grew tremendously from 1955/56 to 1965/66--the latter a peak year, with almost 5 million tons imported--because demand increased at a much faster pace than domestic supply (table 21). Corn imports have remained at a high level since 1965/66 but have turned downward somewhat, as domestic supply has increased faster than demand. Italy is still, however, the largest West European import market for corn.

Table 21 --Italy: Supply and distribution of corn, 1955/56-1971/72

Year	Supply			Distribution		
	Net change in stocks <u>1/</u>	Production	Net imports	Total	Feed uses	Other
1,000 metric tons						
1955/56.	-124	3,204	284	3,364	2,637	727
1956/57.	+5	3,410	393	3,808	3,092	716
1957/58.	+109	3,496	516	4,121	3,412	709
1958/59.	-53	3,670	792	4,409	3,721	688
1959/60.	-262	3,879	1,640	5,257	4,536	721
1960/61.	+135	3,813	1,562	5,510	4,760	750
1961/62.	-100	3,936	2,043	5,879	5,074	805
1962/63.	+100	3,263	2,958	6,321	5,509	812
1963/64.	0	3,692	4,136	7,828	7,110	718
1964/65.	+200	3,950	3,461	7,611	6,886	725
1965/66.	+200	3,317	4,957	8,074	7,303	771
1966/67.	-100	3,510	4,929	8,339	7,560	779
1967/68.	0	3,860	4,904	8,764	7,947	817
1968/69.	0	3,988	4,677	8,665	7,988	677
1969/70.	-11	4,506	4,255	8,750	8,000	750
1970/71.	-309	4,729	4,484	8,904	8,250	654
1971/72.	-158	4,469	4,689	9,000	8,390	610

1/ Minus sign indicates net increase in stocks; plus sign indicates net decrease.

Sources: (53, 76).

Table 22 --Italy: Total and individual grains fed to livestock, and corn and barley as a percentage of total, 1955/56-1971/72

Year	Total grains fed	Coarse grains used as feed					Wheat fed	Rye fed	Percent of total grain fed	
		Total	Barley	Corn	Oats	Other			Corn	Barley
----- 1,000 metric tons ----- Percent -----										
1955/56. . . :	3,566	3,468	288	2,637	507	36	66	32	74	8
1956/57. . . :	4,034	3,946	310	3,092	508	36	60	28	77	8
1957/58. . . :	4,532	4,434	401	3,412	582	39	67	31	75	9
1958/59. . . :	4,954	4,643	324	3,721	561	37	255	56	75	7
1959/60. . . :	5,708	5,491	366	4,536	541	48	136	80	79	6
1960/61. . . :	6,123	5,833	510	4,760	507	56	120	170	78	8
1961/62. . . :	6,418	6,283	560	5,074	584	65	70	65	79	9
1962/63. . . :	7,160	7,052	841	5,509	647	55	75	33	77	12
1963/64. . . :	8,754	8,656	839	7,110	650	57	65	33	81	10
1964/65. . . :	8,196	8,082	624	6,886	524	48	74	40	84	8
1965/66. . . :	9,217	9,086	1,073	7,303	658	53	96	35	79	12
1966/67. . . :	9,458	9,316	1,066	7,560	620	70	100	42	80	11
1967/68. . . :	9,970	9,729	1,066	7,947	656	60	200	41	80	11
1968/69. . . :	9,928	9,662	1,041	7,988	571	62	230	36	80	10
1969/70. . . :	10,098	9,759	1,063	8,000	650	46	300	39	79	11
1970/71. . . :	10,608	10,265	1,320	8,250	650	45	300	43	78	12
1971/72. . . :	10,767	10,411	1,330	8,390	650	41	320	36	78	12

Sources: (53, 76).

## Factors Influencing Corn Production

### Prices and Policy

Italy's membership in the European Community has had a profound effect on the country's corn import policy. Prior to EC entry, imports of corn were subject to a 4-percent duty (raised as high as 12 percent in times of low international prices). In addition, there were licensing requirements for corn imports from the United States, Canada, and other dollar area countries. This requirement served both to provide a degree of protection for domestic producers and to facilitate the implementation of bilateral trade arrangements between Italy and Argentina and South Africa.

On July 1, 1962, when the regulation providing for the gradual establishment of a common (EC-wide) market organization for grains came into effect, the EC's variable levy system was imposed on Italian corn imports. Because Italy has resisted the high corn prices generated by the EC system, Italian threshold (minimum import) prices were kept at relatively low levels throughout the transitional period (July 1962 to July 1967). Since the unification of the EC grain market on July 1, 1967, Italy has received a special reduction on the levy applied to feed grains--\$10.63 per ton in 1967/68, \$10.00 in 1968/69 and 1969/70, and \$7.50 since the start of the 1970/71 crop year. <sup>13/</sup>

This special levy reduction was justified as compensation for the higher handling costs in Italian ports, but it also reflects the determined Italian opposition to the high feed grain price policy of the EC. This opposition stems primarily from the recognition that this price policy is harmful to the development of the Italian livestock industry--a subject of great concern. Also, it is felt that the benefit of higher corn prices to the Italian farmer is considerably lessened by the fact that most domestic corn (about two-thirds) is fed on the farm where produced. Italy has sought to revise the EC feed-grain price policy so that it would be oriented more towards increasing livestock production; thus far, Italian efforts have been unsuccessful. Although unable to block the 1972 EC round of price increases (decided on March 24, 1972) for feed grains, Italy did gain an indefinite extension of the special levy reduction on feed grains, which was to expire at the end of July 1972. However, on April 30, 1973, the EC decided that Italy should phase out this privilege over the next four years. The amount of the levy discount will be reduced by 1.50 units of account annually until it is finally eliminated at the end of the 1976/77 marketing year.

Despite the concessions wrung by the Italian Government, corn prices have increased considerably as a result of the CAP. The average price in the 5-year transitional period was 11 percent higher than the average in the preceding 3 years. A 12-percent jump in prices was still necessary in 1967 upon unification of the EC market. Subsequently, prices have edged further upwards as a result of cuts in the levy discount, demand pressure, and further EC price increases. The 1970 producer price was more than 40 percent above the pre-CAP (1959-61) average, as shown by the tabulation on the following page.

<sup>13/</sup> The exemptions are actually set in terms of EC units of account (U.A.). Until the official devaluation of the U.S. dollar in early 1972, the unit of account was equal to the U.S. dollar. With the current devaluation of the U.S. dollar (February 1973), the U.A. is now equal to \$1.2063.

Year	Producer prices for corn	Corn/wheat price ratio
	<u>Lire/quintal</u>	
Av. 1959-61 . . . . .	4,070	62
1962 . . . . .	4,380	66
1963 . . . . .	4,460	65
1964 . . . . .	4,630	67
1965 . . . . .	4,400	64
1966 . . . . .	4,790	72
1967 . . . . .	5,510	81
1968 . . . . .	5,630	83
1969 . . . . .	5,760	91
1970 . . . . .	5,740	84

Source: (46).

The adoption of the CAP has also narrowed the price range between corn and soft wheat. Italian wheat prices were previously supported at levels above those set by the EC; consequently, the establishment of common prices has caused a drop in Italian wheat prices. However, these have not dropped to the extent expected and have generally remained above other EC wheat prices. As a result, the corn price moved from 62-67 percent of the wheat price to 81-91 percent.

As noted previously, the response of Italian farmers to the higher corn prices and improved corn/wheat price ratio has been primarily an acceleration of the shift from nostrano to hybrid varieties. Also, the irrigated area planted to corn has been expanded. The accelerated increase in the share of hybrid corn relative to nostrano resulted, of course, in a considerable increase in overall corn yields. Hybrid corn yields averaged about 51.5 quintals per hectare in 1960-66, with no upward trend discernible. During 1967-71, these yields averaged almost 56 quintals per hectare. While much of this increase is due to the expansion of irrigated hybrid corn area, the higher prices have stimulated greater utilization of other inputs (for example, fertilizer) and thus, higher yields.

The Italian response to high EC prices, though visible, has thus far not been nearly as great as expected in some quarters. Total corn area did not increase; at most, the long-term decline in corn area has slowed. Both the 1971 and 1972 crop areas continued the long-term decline. Production declined in 1971, but rose to a record of almost 5 million tons in 1972 despite unfavorable weather conditions in August and September. This rise suggests that the spurt in Italian corn through higher yields is continuing. Compared with the French experience, the increase in Italian corn production seems slight.

There is a widespread feeling that future EC price increases will be relatively small. The new EC members, most of which have maintained farm prices at levels lower than the EC prices, are expected to restrain further price increases, especially for grains. Also, there is some indication that the Community will move towards a more "production-neutral" form of farm income support.

Nonetheless, past experience suggests that some increase in corn prices is likely. For 1972/73, the EC has raised corn target prices 5 percent above those prevailing in the previous crop year. Furthermore, the gradual reduction and final elimination of

the special import levy rebate will tend to increase corn import prices and, most likely, domestic market prices. For purposes of projection, a 15-percent increase in producer prices (above the 1969-71 average) is postulated by 1980.

### Irrigation

The major physical constraint on the expansion of corn in Italy is lack of water. Rainfall is generally most scarce in the summer, the most crucial period of the corn-growing season. As a result, the availability of irrigation is the key factor in considering the possible expansion of corn area. This scarcity of summer rainfall becomes more severe, and the dry season lengthens the farther south one goes--in Sicily and Sardinia it may last 4 months or more. Even in the north, however, supplemental water is usually required to grow hybrid corn.

The drier summers of southern and central Italy and the more limited irrigation facilities there are the major reasons for slowness to adopt hybrid varieties in these regions. Without supplemental water, the locally adapted nostrano varieties provide more constant yields. Even with irrigation, however, the low humidity of the air in the south causes difficulties for the pollination of hybrid corn. In central southern Italy, large areas of irrigated land, potentially suitable for corn production, have not been used because unfavorable climatic conditions hinder proper pollination of the corn plant.

Italy has put a major emphasis on irrigation as a tool of agricultural development. In 1970, approximately 3.4 million hectares were equipped for irrigation, about 18 percent of the total agricultural area. In comparison, only 10 percent of Spain's agricultural area was so equipped; for Greece and France, the shares were only 3 and 8 percent, respectively. This emphasis on irrigation will continue in the future. By 1975, total irrigated land is expected to be in the range of 3.6 to 3.7 million hectares. An additional 300,000 hectares could be irrigated in the last half of the decade.

According to Irrigation Policy in Italy, a study by the Organization for Economic Cooperation and Development, OECD (56), more than two-thirds of Italian hybrid corn is produced on irrigated land. 14/ The increase in this share from 1960 to 1969 is illustrated in the following tabulation using OECD data for area, production, and yields of irrigated corn:

Irrigated corn	1960	1968	1969	1973 <sup>1/</sup>
Area (1,000 ha.) . . . . .	224 (56)	316 (56)	411 (63)	430
Production (1,000 M.T.) . . . . .	1,379 (63)	2,099 (66)	2,764 (73)	2,838
Yield (qu./ha.) . . . . .	61.5	66.5	67.3	68.0

Figures in parentheses give irrigated area and production as a percentage of total hybrid area and production.

<sup>1/</sup> OECD forecast.

<sup>14/</sup> The 1971 study does not distinguish between hybrid and nonhybrid corn; however, it has been assumed that all corn planted on irrigated land is hybrid.

According to the OECD study, the increase in the irrigated area for corn was greater than for any other crop (83 percent from 1960 to 1969). Particularly noteworthy is the spectacular jump of almost 100,000 hectares from 1968 to 1969. However, as shown above, the OECD forecasts only a relatively small increase (less than 5 percent) in irrigated corn area from 1969 to 1973 (possibly because of the concentration of newly irrigated land in the south (p. 18)).

There are several important aspects of the relationship between irrigation and corn production. First, the availability of irrigation determines throughout much of Italy (particularly the south) whether hybrid corn can be introduced or can replace nostrano varieties. Irrigated area is now heavily concentrated in northern Italy; however, the share of central, and particularly southern Italy, is expected to increase. National planning efforts have focused on these two areas; in addition, opportunities for further irrigation in the north are felt to be somewhat limited.

Secondly, corn yields on irrigated land are considerably higher than those on nonirrigated land. In 1967-69, irrigated yields averaged 21 to 25 quintals per hectare higher; in earlier years, this difference appears to have been smaller, about 15 quintals per hectare. Yields on irrigated land are thus going up, while those on nonirrigated land are more or less remaining the same. The substantial increase in hybrid corn yields since 1965-67 can in large part be attributed to a larger share of this corn being irrigated.

Finally, with irrigation, corn becomes competitive for land use, not so much with wheat, but with fruits, vegetables, rice, forage, <sup>15/</sup> and sugarbeets. Consequently, the ability of corn to compete with other crops for irrigated land use will be the major determinant of the future expansion of Italian corn production.

#### Competition for Land Use

Competition between corn and other crops for land use can be divided into distinct components:

(1) Nonirrigated or dryland farming: corn competes primarily with its traditional rival, wheat, and with potatoes, forage, and other grains.

(2) Irrigated farming: corn competes primarily with sugarbeets, rice, forage, fruits, tomatoes, and other vegetables.

Before discussing these two components, we should note that arable crop area in Italy is shrinking. Between 1957-59 and 1969, total agricultural and forested area decreased by over 400,000 hectares; arable land decreased by almost 1 million hectares (or 7 percent). (See table 23). Much of the reduction in arable land came as a result of the return of marginal land (particularly in the hills and mountains) to pasture. This trend will probably continue at a slow rate. In addition, there will be a slow transfer of land from agricultural to nonagricultural use as a result of highway and housing construction. Thus, demand for arable crop area is likely to increase.

Little information is available on the relative profitability of corn compared with the various competing crops. The most detailed data are those presented by Mangum (35, pp.167-171), which compare costs and returns from wheat and corn production in the Po River Valley (nonirrigated production) based on 1963-64 data. These estimates show wheat to be considerably more profitable than corn with respect to dryland farming; if 1968-70 prices and yields are inserted into this analysis, net returns are somewhat closer but still decidedly favorable to wheat. An awareness of the difficulties (and the lower yields) associated with the growing of corn on nonirrigated

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<sup>15/</sup> Forage includes corn silage, alfalfa, improved grasses, and other related crops.



Table 23 --Italy: Agricultural land utilization, selected averages,  
1950-67, annual 1968 and 1969

Land use	1950-52	1957-59	1965-67	1968	1969
	1,000 hectares				
Arable:					
Grain. . . . .	n.a.	6,431	5,574	5,576	5,590
Forage . . . . .	n.a.	3,143	3,371	3,309	3,351
Other. . . . .	n.a.	3,613	3,507	3,342	3,280
Total . . . . .	13,086	13,187	12,452	12,227	12,221
Orchards. . . . .	2,425	2,640	2,805	2,840	2,780
Permanent grass- land . . . . .	5,157	5,139	5,150	5,169	5,226
Other <sup>1/</sup> . . . . .	7,093	6,833	7,121	7,136	7,148
Total . . . . .	27,761	27,799	27,528	27,381	27,375

n.a. = not available.

<sup>1/</sup> Forested and uncultivated area.

Source: (29).

land lies at the base of the general consensus that corn will not increase very much at the expense of wheat. The cost-return data presented by Mangum support this consensus.

Similar cost-return comparisons between corn and the various crops suitable for irrigation are limited. As the previous section pointed out, irrigated corn area has increased dramatically in the past decade; however, most observers seem to share the view that only a modest increase will occur in the 1970's. As noted, the OECD forecasts <sup>16/</sup> only a small increase by 1973. This view is based on the fact that most of the newly irrigated land will be in southern Italy; it is expected that fruits and vegetables and other crops will be grown on this land rather than corn. Also, not much change is expected in the current crop pattern. (See table 24 for evidence of the stability of the Italian crop pattern.) The relative profitability of corn compared with other irrigated crops is apparently not such as to generate an expansion of corn at their expense.

Market disposal problems for certain competing crops could alter this picture significantly. In reviewing the various crops suitable for irrigation in Italy, the OECD study found prospects for the expansion of fruit and rice generally unfavorable in light of the difficulties in market disposal of these products in recent years. The OECD study found prospects for sugarbeets to be more favorable since Italy is a

<sup>16/</sup> The forecasts are actually those of the Italian organization, Istituto Nazionale di Economia Agraria (INEA) (56).

Table 24 --Italy: Area planted to corn and selected competing crops,  
selected averages 1950-67, annual 1968-71

Period	Corn			Wheat			Other coarse grains	Rice	Sugar- beets	Tomatoes	Potatoes
	Hybrid	Nostrano: 1/	Total	Soft	Durum	Total					
1,000 hectares											
1950-52	n.a.	n.a.	1,260	2/3,314	2/1,368	4,710	814	158	198	84	387
1957-59	365	857	1,221	3,420	1,385	4,805	709	132	248	115	385
1965-67	511	500	1,011	2,890	1,301	4,191	603	134	308	130	345
1968.	561	407	967	2,817	1,458	4,275	552	156	306	129	319
1969.	652	348	999	2,692	1,526	4,218	536	169	291	131	306
1970.	734	292	1,026	2,551	1,587	4,138	526	173	281	130	286
1971.	734	224	4/958	2,356	1,596	3,952	508	175	262	120	312
Percentage of total arable land											
1957-59	2	6	9	26	10	36	5	1	2	1	3
1965-67	4	4	8	23	11	34	5	1	2	1	3
1971 3/	6	2	8	19	13	32	4	1	2	1	3

n.a. = not available.

1/ Native, open-pollinated varieties.

2/ 1952 only.

3/ Estimated by source on basis of arable land area in 1971.

4/ This figure is based on an earlier estimate than those of table 17.

Source: (29).

net sugar importer and per capita consumption is increasing. However, Italian production of sugarbeets has consistently fallen below the basic quota assigned under the CAP, while other EC members have exceeded these quotas. Area and production of sugarbeets have been declining since 1968.

On the other hand, Italy's prospects for production of both corn for grain and corn for forage were deemed by the OECD study to be excellent. Italy is a large net importer of corn and livestock products, such as beef and veal, live cattle, and dairy products. Prospects for corn for grain seem to be somewhat more certain than prospects for corn for forage since Italy has experienced considerable difficulty in developing a forage-based livestock industry, and as OECD notes, "the profitability of cattle-rearing on irrigated land has not . . . been resolved at farm level" (56, p. 58). A greater increase in irrigated corn for grain area could take place if certain fruits and vegetables which are produced on irrigated land continue to experience surplus problems.

A further consideration in analyzing the position of corn in Italy's land use pattern is the relationship between corn for grain and corn grown for silage. The amount of corn silage is expected to increase. Numerous studies have shown the feed value of a hectare planted to corn silage to be considerably greater than the value of a hectare planted to corn (for grain) or most other forage crops. One study (5, pp. 909-926) shows the feed units produced per hectare of corn silage in five northern provinces of Italy to be about twice that of grassland and 40 to 45 percent higher than that of corn for grain. Production costs also appear to be quite favorable. In addition, corn silage is preferred to grain in beef production because silage-fed beef tends to be leaner and thus more in line with traditional Italian preferences.

Particularly with respect to the "second corn crop" (planted immediately after the harvest of another crop, generally wheat), weather is also an important factor in determining whether corn or corn silage is produced. Where the growing season is shortened (as it was in 1971 when the harvesting of the wheat crop was delayed for 2 to 3 weeks), the corn may not mature adequately for harvesting as grain.

The major obstacle to the expanded production of corn silage is the generally low levels of mechanization and technology characterizing Italian methods of ensilage. As a result of the heavy labor requirements, the cost of making and storing silage is often prohibitive. Another obstacle--the detrimental effect of silage on the taste and texture of Parmesan cheese--has hampered the use of silage in dairy feeding. However, a continuing increase in corn silage production and utilization is indicated. As Italian ensilage technology improves, the competition of grain corn and corn silage for irrigated land will grow stronger.

No firm figures are available on the area of corn silage harvested. Estimates in recent years have generally been in the range of 280,000 to 330,000 hectares. Harvested area is estimated to have increased considerably in recent years, possibly as much as 50 percent since 1967. In particular, much of the "second corn crop," consisting almost entirely of hybrid corn, is likely to be harvested as silage. This second crop is estimated to account for 200,000 to 300,000 tons.

#### Farm Structure and Technology

There is little information on the number, type, or size of Italian farms growing corn. However, there are very few specialized corn farms, and it appears that Italian corn producers are constrained by the same major structural problem confronting Italian agriculture as a whole--small farm size. An estimated 75 percent of corn producers grow 1/2 to 4 hectares of corn, 20 percent grow 5 to 49 hectares, and only 5 percent grow 50 hectares or more.

In 1970, the average farm size was only 7 hectares, and about 80 percent of the farms were less than 4 hectares. This small average farm size has slowed the adoption of hybrid seed corn, which requires greater technical and capital input than domestic varieties. It has also reinforced the dominance of wheat (which has proved the most dependable income source and the most easily mechanized crop) in the Italian agricultural economy.

Only a very gradual improvement in farm structure can be expected throughout the 1970's. The structural problem will continue to act as a constraint on the expansion of corn production and on technological improvement.

The growth in overall corn yields-- from 27 quintals per hectare in 1955-57 to 43 in 1969-71 (table 18)--would seem to indicate a great improvement in the technology of Italian corn production. However, in fact, the great bulk of this increase is due to one specific trend--the substitution of hybrid seed corn for nostrano varieties. (This substitution, of course, was generally accompanied by improved cultivation practices.) Hybrid corn yields, themselves, have not increased very much. They fluctuated around an average of 51 quintals per hectare from 1957 to 1967; during 1969-71, they increased to an average of over 56 quintals per hectare. Subtracting out the effects of irrigation and increased hybrid seed use, the rise in corn yields due to improved technology over the past 15 years would appear to be modest.

In addition, there is evidence of ample room for technological improvement in Italian agriculture as a whole. The rate of fertilizer application and the level of mechanization in agriculture are much lower in Italy than in the other EC member countries. For the period 1966/67-1968/69, Italian nitrogen application for total agricultural land (in kilograms per hectare), was only 73 percent of that of France and

only 22 percent of that of the Netherlands; for phosphate, the comparable percentages are 52 and 48; and for potash, 27 and 16 (65). Italian application of these three nutrients (combined) for this period was about 50 percent above the level a decade earlier--a rate of increase slightly less than that for the EC as a whole. Similarly, although Italy produced about 45 percent as much grain as France, its grain combine numbers are only 13 percent of French numbers.

With respect to corn, these comparisons are somewhat misleading since technological levels in the north--where most corn is produced--are well above the national average. Nonetheless, experimental results suggest that a greater application of inputs would result in substantial increases in production and returns. The 1965 "launched hectare" demonstration program on irrigated land showed that an increase of about 35 percent in production costs raised yields 97 to 120 quintals per hectare, resulting in a substantial increase in net income. An examination of the potentialities for increased fertilizer use indicated that the application of a "rational dose" to the entire corn area would mean more than a threefold increase in the current rates of application (6).

Despite this evidence of potential increased yields, experience indicates no reason to expect any dramatic increases in yields as a result of improved technology. The continuing substitution of hybrid seed for nostrano varieties as well as the increased utilization of irrigated land will continue to be the major factors in determining yield increases; other technological improvements will provide only a modest contribution.

#### Outlook

Using ordinary least-squares analysis, the following projections of Italian corn area, yield, and production were made:

Corn	Average 1969-71		1975		1980	
	Total	Hybrid	Total	Hybrid	Total	Hybrid
Area (1,000 ha.) . . . . .	988	700	930	840	1,000	980
Yield (qu./ha.) . . . . .	46	57	55	58	59	60
Production (million M.T.) . . . .	4.6	4.0	5.1	4.9	5.9	5.9

Total corn area is seen as dipping in the early 1970's but then moving to the million hectare level by 1980--no real change over the 1969-71 level. More substantial gains will be made in overall yields and production, as a result of the continuing expansion of hybrid corn area. By 1980, nostrano corn production is projected at less than 50,000 tons. Although the projected gain in overall corn yield is substantial, it should be noted that the projected gains in hybrid corn yields are quite modest. Thus, as the total replacement of nostrano by hybrid corn nears completion, the gain in corn yields will slow down.

An examination of the factors influencing corn production seems to support this projection of a moderate growth in corn production. A more significant expansion of total corn for grain area will probably be precluded by the following factors:

- (1) A large hike in corn prices such as occurred in the 1960's as a result of the adoption of the CAP appears unlikely.
- (2) A continued decline in arable land area and a set of competitive relationships between corn and other crops suggests that no large shift to corn is likely.

(3) The limited availability of new irrigated land for corn production in the north and the likelihood that newly irrigated land will be allocated to other crops in much of the rest of Italy, particularly in the south, limits the possibility of expansion.

(4) Increased competition from the production of corn for silage is evident.

On the other hand, market disposal problems for certain competing crops (for example, rice and fruit) along with the growth of poultry and livestock production will probably foster some shifting to corn.

The expected difficulties in increasing the irrigated area devoted to corn also tend to support the projected slow gains in hybrid corn yields, as yields on irrigated land are much higher. In addition, much of the future shift from nostrano to hybrid is likely to take place on farms poorly situated from the point of view of land and management quality; this, too, will have an adverse effect on yields.

The production projections made in this report are higher than the following projections made by Mangum for 1975 but are considerably lower than the estimates for 1981 made by IRVAM/SVIMEZ (32). It should be remembered that Mangum's (35) estimates for 1970 were about one-half million tons too low.

Corn	Mangum, 1975 total	IRVAM/SVIMEZ, 1981	
		Total	Hybrid
Area (1,000 ha.) . . . . .	925	1,125	1,050
Yields (qu./ha.) . . . . .	51.1	60.4	62.0
Production (million M.T.) . . . .	4.7	6.8	6.5

## SPAIN

### Corn Production--Historical Development

Until recently, corn has not been an important grain crop in Spain. The area planted to corn until 1968 was less than that in oats and less than one-third of the barley area. However, both area and production of corn have increased rapidly in the past 15 years (table 25). Between 1955-57 and 1965-67, corn production increased by two-thirds, while area increased by about one-third. By 1972, corn production was up to 2.2 million tons, or 90 percent above 1965-67 average production, and corn area increased 16 percent to 555,000 hectares.

The rapid increase in corn area in recent years has been largely due to shifts in grain policy. Until 1963, national grain policy stressed the production of wheat. Although the National Wheat Service also fixed minimum guaranteed prices for corn, these prices tended to be low compared with wheat prices. As a result, corn area trended slowly upward. Between 1955 and 1962, it increased by an average of almost 9,000 hectares per year. More recently, the Spanish Government has initiated a policy of increasing feed grain production, particularly corn. The result has been a sharp upward trend in corn area. Starting in 1963, corn area began to increase rapidly, reaching 555,000 hectares in 1972--an average annual increase of 11,000 hectares a year.

Despite these substantial gains, corn is still far behind wheat and barley in importance in Spain. The share of corn in total grain area rose from 5 percent in

Table 25 --Spain: Grain area and production, selected averages, 1955-70, annual 1970, 1971, and 1972

Period	Total grains <u>1/</u>	Wheat	Coarse grains					
			Total	Barley	Corn	Oats	Rye	Other
<u>1,000 hectares</u>								
Area:								
1955-57. . . .	7,442	4,323	3,119	1,549	367	605	593	5
1960-62. . . .	7,060	4,122	2,938	1,442	435	562	493	6
1965-67. . . .	6,629	4,232	2,767	1,412	479	482	389	5
1968-70. . . .	7,276	3,801	3,475	2,081	516	492	335	51
1970 . . . .	7,179	3,697	3,482	2,157	525	450	306	44
1971:								
Actual. . . .	7,220	3,600	3,620	2,300	540	440	300	40
Planned <u>2/</u> . . .	7,249	3,321	<u>2/</u> 3,928	2,000	800	<u>3/</u>	<u>3/</u>	135
1972 . . . .	7,148	3,500	3,648	2,350	555	430	270	43
<u>1,000 metric tons</u>								
Production:								
1955-57. . . .	7,798	4,362	3,436	1,716	702	497	500	21
1960-62. . . .	7,639	3,921	3,718	1,822	1,000	480	396	20
1965-67. . . .	9,177	5,063	4,147	2,176	1,163	418	337	53
1968-70. . . .	10,680	4,678	6,002	3,507	1,616	493	320	66
1970 . . . .	9,883	4,062	5,821	3,096	1,868	409	259	189
1971:								
Actual. . . .	13,320	5,455	7,865	4,783	2,058	582	269	173
Planned <u>2/</u> . . .	9,768	3,583	6,185	3,400	2,000	450	251	84
1972 . . . .	11,756	4,559	7,197	4,137	2,200	440	230	190

<sup>1/</sup> Excluding rice.

<sup>2/</sup> Goals set in the Second Economic and Development Plan (1968-71).

<sup>3/</sup> Planned area not specified.

Sources: (38, 76).

1955-57 to 8 percent in 1970-72; the share of corn in total grain production rose from 9 to 17 percent in the same period. Sharp increases in Spanish barley area and production, almost as great as those in corn, have kept the share of corn from rising faster. In 1972, wheat and barley each accounted for more than a third of total grain production.

A factor that adds some complexity to the corn production pattern in Spain is the cultivation practice of interplanting kidney beans with corn. This practice is especially prevalent in the northern regions of Galicia and Asturias-Santander. Nearly 160,000 hectares, or one-third of the Spanish corn area in 1969, were interplanted with kidney beans, but this area contributed only about one-fifth of total corn production. (See fig. 4 for regions.)

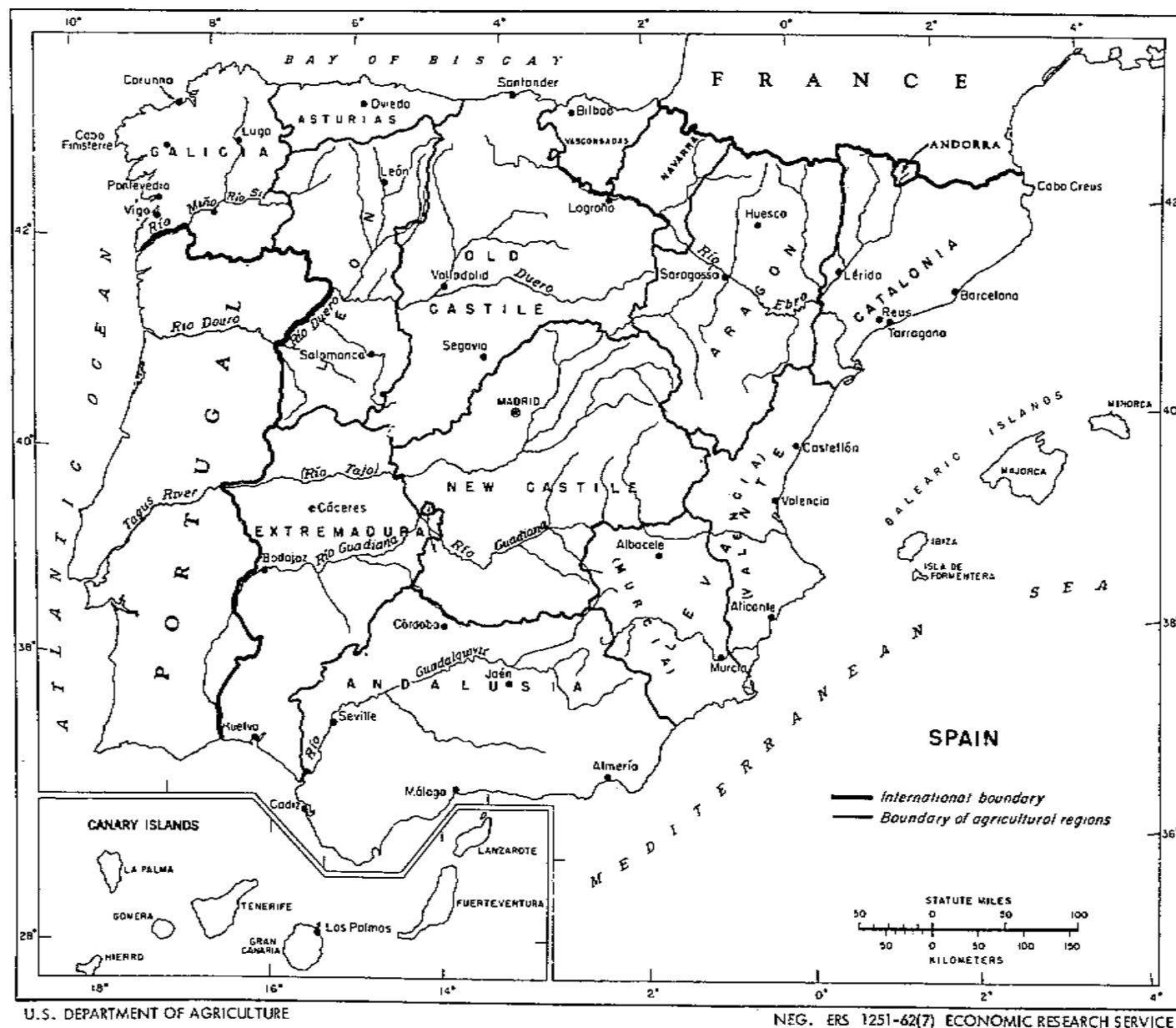


Figure 4

Another complicating factor is that corn is grown partly as forage, particularly in Galicia. Native corn is generally planted very densely, and a portion of the growing plants and tops are cut during the summer months for animal fodder. The remaining plants are allowed to mature for grain.

Corn is grown in nearly all regions of Spain, but the northern regions (Galicia and Asturias-Santander) account for about 40 percent of total area and close to a third of production. They are followed by the two regions of Andalucia (Occidental and Oriental), which account for about 20 percent of both corn area and production (table 26).

In the northern regions, corn is grown mainly on dry or rainfed land. In 1969, corn planted on nonirrigated land in Galicia and Asturias-Santander totaled 187,550 hectares. This area represented 87 percent of the total corn area in the two regions and three-fourths of corn planted on nonirrigated areas in Spain. Andalucia Occidental, the other principal region where corn is planted on nonirrigated area, had only 22,700 hectares (one-third of its total corn area) on nonirrigated land in 1969.

Except in Galicia, Vascongadas, and Asturias-Santander, corn is grown mainly on irrigated land. In 1969, irrigated corn area totaled 254,000 hectares. Andalucia Occidental was the region with the most irrigated corn area (38,000 hectares), followed by Aragon, Extremadura, and Galicia.

Spain's nonirrigated corn area has been trending downward, while irrigated corn area has been increasing rapidly (table 27). In 1971, nonirrigated corn area was about 240,000 hectares, roughly one-tenth below a decade earlier. Meanwhile, irrigated corn area was up to an estimated 300,000 hectares, nearly doubling the average in 1960-62 and representing 55 percent of Spain's total corn area.

The most recent Spanish Government source (38) shows that the increase in irrigated corn area has been particularly significant in Extremadura, Andalucia Occidental, and Aragon (table 28). In 1969, the irrigated corn area in the three regions totaled 111,000 hectares, four times greater than the 1955-57 average, and represented 43 percent of Spain's total irrigated corn area.

Most of Spain's corn production comes from irrigated areas. In 1971, estimated corn production on irrigated area totaled 1.6 million tons, more than double the average in 1965-67, and accounted for 77 percent of total corn production in the country.

Except in a few years of unusually favorable weather, corn production on non-irrigated areas has not deviated much from 450,000 tons. Slight decreases in area have been offset by increased yields.

Much of Spain's increase in corn production is attributable to a sharp increase in yields. During 1965-67, average corn yields were 24.5 quintals per hectare--about 30 percent above a decade earlier. Corn yields have accelerated in recent years as a result of the increase in irrigated area, decrease in mixed-cropping practices, and improvements in production technology, particularly greater use of hybrid seed varieties and fertilizers. In 1971, corn yields reached a high of 37 quintals per hectare. Irrigated corn yields during 1965-67 were more than twice the level of yields on nonirrigated land. Also, irrigated yields have been rising at a much faster rate than yields from nonirrigated areas. From 1955-57 to 1971, irrigated corn yields doubled, while yields on nonirrigated land increased by only 20 percent.

As indicated above, mixed-cropping cultivation practices affect Spain's corn yields. In 1969, yields on corn interplanted with beans were about a third below Spain's average. This practice in large part explains the relatively low production



Table 26 --Spain: Corn area (dry and irrigated), yield, and production by region, 1969

Region	Dry			Irrigated			Total		
	Area	Yield	Pro- duction	Area	Yield	Pro- duction	Area	Yield	Pro- duction
	1,000 ha.	Qu./ha.	1,000 M.T.	1,000 ha.	Qu./ha.	1,000 M.T.	1,000 ha.	Qu./ha.	1,000 M.T.
Castilla la Nueva. . . . .	0.5	10.1	0.5	18.8	46.7	87.9	19.3	45.8	83.3
Castilla la Vieja. . . . .	1.5	17.6	2.6	5.1	37.6	19.0	6.5	33.2	21.6
Leonesa. . . . .	0.6	16.7	0.9	10.4	54.7	56.8	11.0	52.5	57.8
Extremadura. . . . .	1.4	6.6	0.9	36.4	34.6	125.1	37.8	33.4	126.1
Andalucia Occidental . . . . .	22.7	13.6	30.7	37.8	48.2	182.4	60.6	35.2	213.1
Andalucia Oriental . . . . .	1.2	6.5	0.7	24.0	50.0	120.2	25.2	47.9	120.8
Levante. . . . .	4.8	14.3	6.9	23.5	44.0	103.5	28.3	39.0	110.4
Cataluna-Baleares. . . . .	13.0	22.0	28.5	19.3	49.2	94.8	32.2	38.3	123.3
Aragon . . . . .	6.5	11.8	0.6	37.2	35.7	114.8	37.7	30.6	115.4
Rioja-Navarra. . . . .	4.1	16.4	7.8	10.9	52.1	56.6	15.6	41.3	64.5
Vascongadas. . . . .	7.1	24.2	17.4	0.1	28.0	0.1	7.2	24.4	17.6
Asturias-Santander . . . . .	35.2	24.6	86.6	0.3	32.4	1.1	35.6	24.6	87.7
Galicia. . . . .	152.3	18.0	271.8	28.2	29.8	84.0	180.5	19.7	355.8
Canarias . . . . .	1.8	10.0	1.8	2.1	14.2	3.2	3.9	12.8	5.0
Total . . . . .	247.5	18.6	457.7	254.0	41.8	1,049.6	501.5	30.1	1,507.3

Note: The sum of individual items may not equal the total because of rounding.

Source: (38).

Table 27 --Spain: Total, dry, and irrigated corn area, yield, and production, selected averages, 1955-67, annual 1968, 1969, 1970, and 1971, projected 1975 and 1980

Period	Area			Yield			Production <sup>1/</sup>		
	Dry	Irrigated	Total	Dry	Irrigated	Total	Dry	Irrigated	Total
	- 1,000 hectares -	- 1,000 hectares -	- 1,000 hectares -	- Quintals/hectare -	- Quintals/hectare -	- Quintals/hectare -	- 1,000 metric tons -	- 1,000 metric tons -	- 1,000 metric tons -
1955-57. . . . .	262	105	367	16.5	25.4	19.0	423	269	702
1960-62. . . . .	268	167	435	17.5	31.7	23.0	463	530	993
1965-67. . . . .	282	197	479	17.0	35.0	24.5	479	685	1,163
1968 . . . . .	282	241	523	18.8	39.3	28.2	536	937	1,473
1969 . . . . .	248	254	502	18.6	41.8	30.1	458	1,050	1,507
1970 . . . . .	245	280	525	18.0	51.0	35.6	441	1,427	1,868
1971 . . . . .	240	300	540	19.4	51.1	37.0	466	1,592	2,058
1975 <sup>2/</sup> . . . . .	250	370	640	24.6	58.7	45.4	615	2,291	2,906
1980 <sup>2/</sup> . . . . .	250	480	730	32.0	62.8	52.3	800	3,014	3,814

<sup>1/</sup> The sum of individual items may not equal the total because of rounding.

<sup>2/</sup> Projections and estimated breakdown by dry and irrigated land.

Sources: (38, 76).

Table 28 --Spain: Dry and irrigated corn area by region, averages 1955-57  
and 1965-67, annual 1969

Region	1955-57			1965-67			1969		
	Dry	Irrigated	Total 1/	Dry	Irrigated	Total 1/	Dry	Irrigated	Total 1/
	1,000 hectares								
Castilla la Nueva. . . . .	1	4	5	1	13	13	1	19	19
Castilla la Vieja. . . . .	2	1	3	2	5	7	2	5	7
Leonesa. . . . .	1	3	4	1	9	9	1	10	11
Extremadura. . . . .	1	3	4	1	20	21	1	36	37
Andalucia Occidental . . .	43	7	50	46	20	66	23	38	61
Andalucia Oriental . . .	1	12	13	1	21	22	1	24	25
Levante. . . . .	3	17	20	3	27	30	5	24	28
Cataluna-Baleares. . . .	6	12	18	13	15	28	13	19	32
Aragon . . . . .	2	13	15	1	26	27	1	37	38
Rioja-Navarra. . . . .	6	3	9	5	10	15	5	11	17
Vascongadas. . . . .	15	2/	15	14	2/	14	7	n.a.	7
Asturias-Santander . . .	40	2/	40	40	2/	40	35	n.a.	36
Galicia. . . . .	136	24	160	155	29	184	152	28	181
Canarias . . . . .	4	6	10	1	2	3	2	2	4
Total . . . . .	262	105	367	282	197	479	248	254	502

n.a. = not available.

1/ The sum of individual items may not equal the total because of rounding.

2/ Less than 500 hectares.

Source: (38).

in Spain's main corn-producing regions, Galicia and Asturias-Santander. In 1969, the two regions accounted for 43 percent of Spain's corn area but contributed only 29 percent of total production. In 1969, average corn yields for Galicia and Asturias-Santander were one-third and one-fifth, respectively, below the Spanish average. Nearly 150,000 hectares, or 70 percent of the total corn area in the two regions, were interplanted with beans.

Hybrid seed is now used in more than 60 percent of Spain's total corn area, compared with about 40 percent in the early 1960's. Hybrid seed is apparently effective in raising yields only on irrigated land. Nonhybrid yields on dry land were consistently higher than hybrid yields on dry land during 1965-68, while hybrid yields on irrigated land were 14 to 18 quintals per hectare <sup>17/</sup> higher than nonhybrid irrigated yields. Hybrid varieties were planted on 85 percent of total irrigated corn area in 1969.

#### Corn Utilization and Imports

Spain's rapid increase in corn production has been accompanied by even sharper increases in corn utilization. Utilization rose from less than 700,000 tons in 1955/56 to 3.5 million tons in 1965/66 (table 30). In more recent years, this trend has continued, although at a somewhat slower pace. In 1972/73, corn utilization was about 4.3 million tons. The average annual increase in corn utilization during the 18-year period was about 200,000 tons.

Food consumption of corn in Spain has not changed much, with some decreases in per capita consumption being offset by increases in population. The quantity of corn used directly for food is estimated at 100,000 tons a year. Corn seed, waste, and industrial uses are estimated at less than 375,000 tons. However, corn used for feed has rapidly increased, from 625,000 tons in 1955/56 to nearly 4 million tons in 1972/73.

Grains used for feed exceeded 10 million tons in 1971/72, more than three times the level of 1960/61, but declined to 9 million in 1972/73, as a result of decreased barley and wheat production. Coarse grains account for most of the increases in grains fed in the country; however, large quantities of wheat have been fed in recent years as a result of surplus wheat production (table 31).

From 1965/66 to 1970/71, corn replaced barley as the principal grain fed in Spain. In 1971/72, as a result of mounting barley production, the corn share dropped to 36 percent of total grain fed; barley fed exceeded 4.5 million tons, and represented 45 percent of total grain fed in the country. However, in 1972/73, the corn share of total grains fed was up to 42 percent, or the same as the barley share.

The sharp increases in both corn and barley fed have been to a large extent the result of mounting demand for mixed feeds by the expanding poultry and livestock industry. Production of mixed feeds in Spain is currently estimated at 4.5 to 5.0 million tons annually. In 1960, mixed feed production was no more than 1 million tons. In 1970, feed grains used by the mixed feed industry were estimated at 2.7 to 3.1 million tons, including about 1.7 to 2.0 million tons in corn and about 725,000 tons of barley. <sup>18/</sup>

Large quantities of corn are fed directly on the farms. An official source <sup>(14)</sup> estimated direct consumption of corn on the farm (produced or purchased by the farmer)

<sup>17/</sup> Figures derived from tables 27 and 29.

<sup>18/</sup> (76, SP 1013, Feb. 25, 1971; Madrid).

Table 29 --Spain: Hybrid corn area, yield, and production, total and for the 3 major corn-producing regions, average 1965-68, annual 1969

Region	1965-68			1969		
	Area	Yield	Pro- duction	Area	Yield	Pro- duction
	1,000 hectares	Qu./ha.	1,000 M.T.	1,000 hectares	Qu./ha.	1,000 M.T.
Total . . . . .	239.3	31.6	756.8	280.3	38.6	1,082.0
Galicia . . . . .	13.0	31.8	41.4	14.4	31.2	44.9
Asturias-Santander	5.6	31.6	17.7	7.4	32.0	23.8
Andalucia Occidental	56.6	21.1	119.4	59.5	35.7	212.4
Total selected	75.2	23.8	178.5	81.3	34.6	281.3
Total dry . . . . .	73.1	15.1	110.5	63.3	20.7	131.0
Galicia . . . . .	7.8	28.8	22.5	9.4	28.3	26.6
Asturias-Santander	5.0	35.4	17.7	7.3	32.5	23.7
Andalucia Occidental	34.7	10.6	36.9	21.7	13.8	29.9
Total selected	47.5	16.2	77.1	38.4	20.9	80.2
Total irrigated . .	166.1	38.9	646.3	217.0	43.8	951.0
Galicia . . . . .	5.2	36.3	18.9	5.0	36.6	18.3
Asturias-Santander	.6	36.6	1/	.1	42.1	1/
Andalucia Occidental	21.9	37.6	82.3	37.8	48.2	182.3
Total selected	27.7	36.7	101.6	42.9	46.9	201.4

Note: The sum of individual items may not equal the total because of rounding.

1/ Less than 1,000 tons.

Source: (38).

at 2.4 million tons in 1967, compared with 2.1 million tons of barley in the same year. In 1970, assuming corn used by the mixed feed industry totaled nearly 2 million tons, corn fed (produced and purchased) on the farm would have been about 1.5 million tons, about 40 percent below the level in 1967. This decrease in corn fed on the farm is attributable to greater use of mixed feeds and expansion of commercial livestock production in recent years.

The significant increase in Spain's coarse grain production has not been sufficient to cope with expanded feed requirements, particularly for corn. Spain's net imports of coarse grains rose from less than 100,000 tons in 1955/56 to a record 3.3 million tons in 1966/67. In recent years, net imports of coarse grains have been considerably lower, averaging about 2.5 million tons in the 5 years 1967/68-1971/72.

#### Factors Influencing Corn Production

##### Prices and Policy

The Spanish Government is heavily involved in agriculture, primarily through its successive development plans, which have had a strong influence on the pattern of

Table 30 --Spain: Supply and utilization of corn, 1955/56-1972/73

Year	Supply		Utilization		
	Production	Net imports	Total	Feed uses	Other <sup>1/</sup>
	1,000 metric tons				
1955/56. . .	616	62	678	625	53
1956/57. . .	714	53	767	714	53
1957/58. . .	771	29	800	659	141
1958/59. . .	916	67	983	851	132
1959/60. . .	959	87	1,046	863	183
1960/61. . .	1,012	360	1,372	1,170	202
1961/62. . .	1,067	234	1,301	1,200	101
1962/63. . .	920	654	1,574	1,350	224
1963/64. . .	1,171	1,275	2,446	1,700	746
1964/65. . .	1,203	986	2,189	1,825	364
1965/66. . .	1,142	2,367	3,509	2,750	759
1966/67. . .	1,154	2,289	3,443	3,130	313
1967/68. . .	1,195	2,436	3,631	3,295	336
1968/69. . .	1,473	2,206	3,679	3,310	369
1969/70. . .	1,507	2,676	4,183	3,636	547
1970/71. . .	1,868	2,000	3,868	3,461	407
1971/72. . .	2,058	2,079	4,137	3,857	280
1972/73 <sup>2/</sup>	2,200	2,100	4,300	3,910	390

<sup>1/</sup> The large fluctuations in this category are due to changes in stocks. Data on stocks are limited. Except in years of sharp increases in imports, changes in stocks are expected to have been small.

<sup>2/</sup> Preliminary.

Sources: (38, 53, 75, 76).

Spanish grain production. With a grain policy geared towards self-sufficiency, the Government has undertaken several measures to increase grain production. In addition to price supports, these measures include loans and subsidies to grain growers and producer cooperatives for the purchase of seeds and other inputs. Other methods for promoting increased grain production have been import controls (levies), expansion of storage facilities, and more recently, market arrangements between producers and mills.

In the middle and late 1960's, Spain had large and burdensome wheat surpluses--largely due to the effectiveness of the policy measures described above. In an effort to reduce these surpluses, Government policy since 1963 has been aimed at reducing wheat production to normal domestic requirements and promoting feed grain production.

Spain's First Development Plan (1964-67) stressed improvement in grain farm structure and a sharp increase in feed grain production, especially corn and barley. This plan raised the fixed minimum-support prices for corn and barley. According to the

Table 31 --Spain: Total and individual grains fed to livestock and poultry and corn and barley as a percentage of total, 1955/56-1972/73

Year	Total grains fed	Coarse grains used as feed					Wheat fed 1/	Percent of total grain fed	
		Total	Barley	Corn	Rye and oats	Sorghum and mixed grain		Corn	Barley
		-----1,000 metric tons-----						-----Percent-----	
1955/56. . .	2,613	2,613	1,539	625	449	2/	2/	23	59
1956/57. . .	2,634	2,460	1,357	714	389	2/	174	27	52
1957/58. . .	2,782	2,777	1,653	659	465	2/	5	23	59
1958/59. . .	3,063	3,029	1,554	851	624	2/	34	28	51
1959/60. . .	3,426	3,396	1,899	863	632	2	30	25	55
1960/61. . .	3,132	3,057	1,450	1,170	436	1	75	37	46
1961/62. . .	3,291	3,241	1,625	1,200	411	5	50	36	49
1962/63. . .	4,017	3,874	1,900	1,350	623	1	143	34	47
1963/64. . .	4,562	4,484	2,200	1,700	580	4	78	37	48
1964/65. . .	4,651	4,580	2,200	1,825	473	82	71	39	47
1965/66. . .	5,417	5,389	2,000	2,750	457	182	28	51	37
1966/67. . .	6,070	5,980	2,150	3,130	557	143	90	52	35
1967/68. . .	7,612	6,403	2,373	3,295	634	101	1,209	51	31
1968/69. . .	8,073	7,449	3,256	3,395	694	104	624	46	40
1969/70. . .	8,571	7,946	3,456	3,636	638	216	625	46	40
1970/71. . .	8,257	7,539	2,929	3,461	548	601	718	42	35
1971/72. . .	10,102	9,367	4,513	3,657	748	449	735	36	45
1972/73 3/	9,128	8,808	3,799	3,910	567	532	620	42	42

Note: The sum of individual items may not equal the total because of rounding.

1/ As a result of a record wheat crop and large availability of low-quality wheat, large amounts were fed to livestock in 1967. Use of wheat for feed has also been high in recent years as a result of surplus, low-quality wheat.

2/ Less than 500 tons.

3/ Preliminary.

Sources: (75, 76).

plan, higher levels of corn and barley production were to be attained through expanded area, wider use of fertilizers and pesticides, and improved cultural practices.

In 1966, the Spanish Government set new grain regulations offering strong inducement for increases in the country's feed grain production. These regulations provided for higher support prices for the 1966/67 and 1967/68 feed grain crops, production subsidies, and more credit to producer cooperatives. The support price for corn was raised from 4.85 pesetas per kilogram to 5.06 in 1967/68 and 5.40 in 1968/69 (table 32). In addition, in 1967/68, producers' associations were offered subsidies and preferential credit arrangements for the purchase of fertilizers, seeds, and machinery and for silo construction costs. The subsidies were designed to speed grain farm consolidation and farmer cooperation--changes necessary if the country's extremely small grain farms are to become more efficient.

The Government announced in 1967 a special 4-year program for the northern provinces aimed at doubling production of corn and sorghum. These provinces account for 40 percent of total area and nearly a third of total corn production in Spain. The program called for certified hybrid seed and fertilizers to be provided to growers on a loan basis and for certain subsidies to growers who complied with production practices specified by the Ministry of Agriculture.

Table 32 --Spain: Support prices for wheat, corn, and barley  
and price ratios, 1953/54-1971/72

Year	Wheat 1/	Corn	Barley 2/	Corn/wheat	Barley/wheat	Barley/corn
Pesetas per kilogram						
1953/54	3.92	2.30	2.20	.59	.56	.96
1954/55	3.92	2.30	2.20	.59	.56	.96
1955/56	4.17	2.40	2.30	.58	.55	.96
1956/57	4.17	2.40	2.30	.58	.55	.96
1957/58	4.96	n.a.	3.30	n.a.	.67	n.a.
1958/59	5.06	3.50	3.40	.69	.67	.97
1959/60	5.06	3.50	3.40	.69	.67	.97
1960/61	5.06	3.60	3.50	.71	.69	.97
1961/62	5.56	3.60	3.50	.65	.63	.97
1962/63	5.56	3.60	3.50	.65	.63	.97
1963/64	6.16	4.35	4.05	.71	.66	.93
1964/65	6.66	4.35	4.05	.65	.61	.93
1965/66	6.66	4.35	4.05	.65	.61	.93
1966/67	6.66	4.85	4.75	.73	.64	.88
1967/68	6.66	5.06	4.90	.76	.74	.97
1968/69	6.70	5.40	5.30	.81	.79	.98
1969/70	6.70	5.55	5.30	.83	.79	.95
1970/71	7.00	5.70	5.35	.86	.81	.94
1971/72	7.30	5.70	5.35	.85	.80	.94

n.a. = not available

1/ Average of minimum and maximum price for soft and semihard wheat.

2/ Average of the 2 main varieties: 2-row type and 6-row type (named for arrangement of grains on the ear).

Sources: (1, 37, 76).

The subsidies provided for were to cover up to 50 percent of seed cost and 20 percent of fertilizer cost during the first 2 years of the program and 25 to 20 percent, respectively, in the remaining 2 years. Similar subsidies paid for wheat production prior to 1965 were reduced or eliminated. Also, corn-drying facilities were to be made available to eligible farmers. In addition, the Government continued to scale support prices to encourage production of feed grains, particularly corn, at the expense of wheat production.

Spain's Second Development Plan (1968-71) continued to stress feed grain production, while aiming at cutting back wheat production in an effort to reduce or eliminate surpluses. The plan called for a 300,000-hectare increase in corn and sorghum. Farmers continued to be partly reimbursed for their investments in seeds, fertilizers, insecticides, and storing facilities. Price supports for feed grains were continued.

More recently, the Government has adopted additional incentives to encourage expansion in corn production. In February 1971, the Government introduced the following

benefits for the northern provinces (Alava, Coruna, Guipuzcoa, Lugo, Orense, Oviedo, Pontevedra, Santander, and Vizcaya): (1) Loans at one-half percent interest per month for the procurement of seeds, fertilizers, and pesticides; and (2) subsidies representing 75 percent of the cost of seeds, 50 percent of the cost of fertilizers, and 40 percent of the cost of pesticides and silo construction. This program covers the 4 years 1971/72 through 1974/75.

Feed-grain prices moved closer to wheat prices during 1953/54 to 1972/73 (table 32). The corn price moved from less than 60 percent of the wheat price in the midfifties to about 85 percent in recent years; the barley price showed a comparable improvement--from about 55 percent to 80 percent. This movement was particularly pronounced after 1965/66, as the average price support for wheat remained relatively stable, while feed grain prices sharply increased.

The corn support price for 1970/71 to 1971/72 was 5.70 pesetas per kilogram, compared with 3.60 pesetas per kilogram in the 1960/61-62/63 period--an increase of nearly 60 percent. Support prices of other feed grains had comparable increases; however, the increase in the corn support price were greater than those for barley, sorghum, and rye (although less than that for oats).

Spain has several goals for agriculture during the 1970's. Within these goals, corn production will continue to be encouraged. The corn support price will probably continue to increase, but the Government will rely more on other measures such as subsidies and improvement of farm structure to stimulate production in selected areas so as to avoid encouraging inefficient corn production. Production increases are expected to take place on newly irrigated area and on irrigated area now producing surplus crops such as wheat, cotton, and rice. Irrigation of wheat eventually could be prohibited, with producers being further urged into corn production. Expansion of corn production, especially in Galicia, will be aided by the Government programs, which will no doubt continue to provide subsidies on inputs through most of the seventies.

#### Irrigation

As in Italy, the major physical constraint on expansion of corn production in Spain is lack of water. Except in Galicia and other northern regions, limited precipitation makes irrigation necessary for all corn production, particularly hybrid. Except in the humid zone of the north and the Pyrenees Mountain ranges, rainfall averages only 18 inches a year. The central plateau and southern Spain receive little rain, especially during the hot summer months. Rainfall in many areas is markedly seasonal, being virtually confined to September through March. Because of inadequate rainfall, about 5 million hectares of potential cropland lie fallow every year.

Spain's total irrigated area has been increasing rapidly. During the 1960's, nearly 600,000 hectares were brought under new irrigation, and improvements in irrigation were made to 400,000 hectares. The total irrigated area rose to an estimated 2.5 million hectares by the end of 1972. Of this, 1.7 million hectares are now in cultivated crops, or about a third above the level in 1960.

About a third of Spain's irrigated area is in grains, with corn accounting for a third of irrigated grain area. In addition to grains, other uses of irrigated area in 1969 were as follows: 20 percent for vines, fruits, and olive trees, 13 percent for fodder crops, 12 percent for industrial crops (mainly cotton and sugarbeets), 9 percent for vegetable crops, and 7 percent for potatoes. A more detailed breakdown of irrigated crops is presented in the following tabulation (52):



Crop	Irrigated area	
	1956	1969
	1,000 hectares	
Wheat . . . . .	309	344
Barley . . . . .	72	84
Corn . . . . .	109	254
Rice . . . . .	66	59
Other grains . . . . .	21	28
Total . . . . .	578	769
Pulses . . . . .	107	85
Industrial crops . . . . .	210	264
Vegetable crops . . . . .	140	190
Potatoes . . . . .	146	163
Fodder crops . . . . .	117	273
Total . . . . .	720	975
Total arable crops . . . . .	1,298	1,744
Vines and fruit . . . . .	329	432
Total area . . . . .	1,627	2,176

As shown above, irrigated grain and fruit and vegetable area has been increasing, while pulse and rice area has been declining. Irrigated area in fodder crops shows a sharp increase (57).

Preliminary data on Spain's Third Development Plan (1972-75) show irrigation goals in the 1970's to be just as ambitious as in the past decade. The plan allocated \$556 million, or a third of the funds programmed for agriculture, to irrigation alone. By 1975, irrigated area is to be increased by at least 100,000 hectares (nearly 70,000 hectares were irrigated in 1972), and existing irrigation on 90,000 hectares is to be improved. In addition, work will begin on several major irrigation and reclamation projects covering nearly 200,000 hectares. These projects are expected to be completed during the 1970's.

The preliminary data do not give the eventual use of new irrigated land. At various times, Spanish economists have commented that the major portion of the irrigated land could be used to the greatest advantage by growing deciduous fruit and vegetables, particularly in view of Spain's preferential agreement with the Common Market. The current development plan projects a 50-percent growth in exports of fresh citrus and vegetables and a 20- to 30-percent increase in exports of preserved vegetables, table grapes, wine, and tomatoes by 1975. This would require a significant increase in irrigated fruit and vegetable area since most of Spain's exports of fruits and vegetables are grown on irrigated land. However, recent surplus developments in certain of these export markets would suggest a reassessment of these goals.

Spain's Third Development Plan (1972-75) calls for a 300,000-hectare increase in corn area during the 1970's. As indicated earlier, the potential for an increase in nonirrigated corn area is limited by the lack of water. The only section of the country with sufficient rainfall--the northern belt (Galicia, Asturias-Santander, Vascongadas)--does not have available land. Also, the northern belt, particularly Galicia, is a leading cattle-producing region, where a large percentage of the land will continue to be devoted to pasture and fodder crops if cattle expansion is to be attained. These

factors would imply that most of the projected increase in corn area in the third plan would have to be on irrigated land. Using the 1970 base, irrigated corn area would more than double to about 580,000 hectares by 1980, if the goal of the third plan were achieved.

There is reason to believe that the increase in irrigated corn area will fall considerably short of the 300,000 hectares. In Galicia and other northern regions, there is not much chance of increasing corn area on irrigated land. Spain's livestock expansion is tied to expansion of forage on irrigated area, particularly in the northern provinces. At present, corn production is not considered a high priority use for irrigated land in other areas. In the Badajoz region, eucalyptus trees, fruits and vegetables, and sugarbeets appear to be favored over corn. Many farmers consider cultivating early vegetables and fruits on irrigated land to be a better alternative than cultivating corn.

Some of the increase in irrigated corn area could come from switches in irrigated land uses. In recent years, Spain has been discouraging wheat production on irrigated land. Spain's Second Development Plan (1968-71) had set a goal of reducing irrigated wheat area to 190,000 hectares by 1971. This would have been 154,000 below the level in 1969, a goal that most likely was not attained. Unless wheat growing on irrigated land is prohibited, sharp decreases in irrigated wheat area are not likely. Farmers prefer sowing wheat, which is harvested early in the season and leaves water available for other crops throughout the summer.

Because of surplus production, the irrigated area planted to other crops such as cotton, potatoes, and rice could probably be decreased. However, much of this land will probably go into sugarbeets and forage, with alfalfa and corn silage also given high priority. These crops will be needed to meet the needs of a planned expansion in the livestock sector.

Thus, the eventual increase in irrigated corn area will more likely be 90,000 hectares by 1975 and another 90,000 hectares by 1980. This would raise irrigated corn area in 1980 to 480,000 hectares rather than the 580,000 hectares needed to reach the 1980 total corn area projected by Spain's Third Development Plan. In 1980, total corn area would be about 730,000 hectares rather than the 825,000 hectares projected by the plan.

Irrigation also has a very pronounced effect on yields since the higher yields are associated with hybrid seed varieties which cannot usually be grown without irrigation (table 27). Thus, continued improvement in corn yields is largely dependent upon irrigation.

#### Competition for Land Use

Except in the northern regions of Spain, the competitive position of corn compared with other crops on nonirrigated land is not very favorable. On nonirrigated land in the north (Galicia, Asturias-Santander, and Vascongadas account for more than 80 percent of dry area for corn), corn competes with other grains (mainly rye), potatoes, pulses, pasture, and fodder crops. As mentioned earlier, nonirrigated corn area has declined somewhat in recent years; however, it is expected to hold at about 250,000 hectares in the 1970's. The encouragement given to corn production in the northern regions by Government subsidy programs makes any significant reduction of nonirrigated corn area unlikely.

On irrigated land, corn competes with other grains (wheat and barley), fruits and vegetables, potatoes, industrial crops (sugarbeets, cotton, tobacco, and spices), and fodder crops. Competition varies widely with regions. In the north, corn competes mainly with pulses, pastures, fodder, and root crops; in the east, with fruits and

vegetables and other grains; in the Center and Ebro valley, with grains, pulses, industrial crops, and fruits and vegetables; in Andalucia, with other grains and industrial crops.

Recent information is limited for the cost-return structure of irrigated corn production. However, for 1960-62, the average relative profitability of corn compared with other crops in selected irrigated areas is presented in the following tabulation (27):

Crop	Gross returns	Net returns
	1,000 pesetas per hectare	
Oranges . . . . .	100.0	51.5
Pears . . . . .	100.0	40.3
Tomatoes . . . . .	35.0	8.9
Peppers . . . . .	32.0	7.7
Alfalfa:		
Mechanized . . . . .	18.0	6.4
Nonmechanized . . . . .	18.0	3.3
Cotton . . . . .	25.6	5.5
Corn:		
Mechanized . . . . .	19.0	5.4
Nonmechanized . . . . .	19.0	3.6
Sugarbeets . . . . .	26.5	5.3
Wheat . . . . .	12.0	2.2

Oranges and pears gave substantially greater returns per hectare than did other crops. Vegetable crops of tomatoes and peppers also were more profitable than most other crops, but the difference was not as great. Corn (mechanized) in 1960-62 appeared to be competitive with cotton and sugarbeets.

To supplement these 1960-62 data, average gross returns per hectare for selected crops on irrigated land were calculated for 1955-57 and 1968-70 and are presented in the following tabulation:

Crop	Gross returns <sup>1/</sup>		Increase
	1955-57	1968-70	from 1955-57
	1,000 pesetas/ha.		to 1968-70
			Percent
Corn . . . . .	6.1	23.6	287
Barley . . . . .	5.0	16.0	220
Potatoes . . . . .	19.4	61.0	214
Oats . . . . .	5.9	13.0	119
Wheat . . . . .	9.3	17.6	90
Sugarbeets . . . . .	<sup>2/</sup>	47.6	--

<sup>1/</sup> Since these returns were derived from average yield and average producer price, they are not strictly comparable to the returns for 1960-62 shown in the previous tabulation.

<sup>2/</sup> Negligible area.

As the tabulation indicates, the relative profitability of corn has increased most rapidly for the crops selected. Although corn's gross returns are higher than for the other grains, they are still considerably lower than for potatoes and sugarbeets. Gross returns do not fully explain corn's competitive position, but in the absence of more complete data, they serve as a rough approximation of corn's relative profitability.

As noted in the previous section, irrigated corn area may expand at the expense of wheat, rice, cotton, and potatoes. Spain has experienced surplus disposal problems with these crops in recent years and will no doubt direct its policies towards minimizing production. The increase in barley area will probably slow down, but it is unlikely that any decrease in this area will occur. Although the support price for barley is below corn, the advantage to the farmers in producing barley is that yields on dry land are higher, and on irrigated land, barley can be harvested earlier, thus making land available for other crops.

Corn will face strong competition for irrigated land from fruits and vegetables, sugarbeets, and certain forage crops. The value of production per hectare is generally higher for these crops (particularly fruits and vegetables) than for corn. Smaller farmers often find it necessary to raise an intensive, high-value crop to recoup the costly investments associated with irrigation. In addition, fruit and vegetable growers can usually raise more than one crop per year. However, rapid increases in production of fruits and vegetables, along with surplus problems in the export market, are causing some reassessment of irrigated land uses in fruits and vegetables.

Under the impetus of Spanish plans for development of the livestock industry, expansion of irrigated forage area is likely. In 1969, forage crops grown on irrigated land exceeded 100,000 hectares; corn grown for silage accounted for about a quarter of this area. Total corn silage area--irrigated and nonirrigated--was 55,000 hectares. Production of corn silage totaled 1.7 million tons, green-weight basis. Galicia is the most important producer (24 percent in 1969), followed by Asturias-Santander (16 percent), and Andalucia Occidental (11 percent). If a farmer has cattle and a silo, he will produce corn silage over corn for grain because of the greater returns of feed value per hectare. Corn silage in the central plateau will continue to be produced on a limited scale because the grain yields are low. Where good grain yields are obtained, little silage will be produced.

Sorghum is of interest as a possible expansion crop, but the area now cultivated is small (45,000 hectares in 1972). In the areas of Huesca, Valencia, and Valladolid, yields of sorghum are attractive. Most of sorghum production is and will be on dry land, although a small quantity is produced on irrigated land.

#### Farm Structure and Technology

Farm structure in Spain has no doubt hindered progress in corn production. Small farm size has adversely affected gross returns and the adaptation of technical inputs. Two-thirds of the 836,000 farms planting corn in the most recent census (1962) were less than 5 hectares (table 33). These farms had an average of 3.4 hectares planted to corn. Less than 1 percent of the farms had 100 or more hectares, and their average area planted to corn was 7.2 hectares. The problem of small farms is particularly acute in the northwestern area of Spain, where about one-third of Spain's corn is produced. The 1962 census showed that 311,000 farms in Galicia planted corn, including 65,000 which had corn interplanted with pulses. About 30 percent of those farms were less than 5 hectares, and their average area planted to corn was 0.4 hectare.

The problem of fragmentation, which is also particularly acute in northwestern Spain, aggravates the situation. The 1962 census showed the average plot (not just corn) in Galicia to be 0.25 hectare. In Asturias-Santander, the average size of a plot was only 0.82 hectare. Fragmentation is less a problem in western Andalucia, where corn

Table 33 --Spain: Area and number of farms planted to corn, alone or with pulses, 1962

Item	Size of farm (hectares)				
	0-5	5-20	20-100	100 over	Total <sup>1/</sup>
	<u>1,000 hectares</u>				
Area:					
Corn with pulses. . . . .	105.0	74.2	10.9	1.6	191.6
Corn alone. . . . .	81.3	90.8	53.2	46.7	272.0
Total. . . . .	186.3	164.9	64.1	48.2	463.6
	<u>Thousands</u>				
Farm numbers:					
Corn with pulses. . . . .	311.3	105.3	10.9	.5	428.0
Corn alone. . . . .	241.8	126.5	33.5	6.2	408.0
Total. . . . .	553.1	231.8	44.4	6.7	835.9

<sup>1/</sup> The sum of individual items may not equal the total because of rounding.

Source: (40).

growing is also important. In 1962, average size of farm there was 29.3 hectares; plot size averaged 9.9 hectares. There were 24,000 farms planting corn, with area in corn averaging about 2.4 hectares.

The Government has been promoting land consolidation for many years. About 2.5 million hectares were consolidated by the end of the 1960's. However, Galicia's farms are not believed to have greatly increased in size. A steady but gradual enlargement is expected in Spanish farm size, but shortcomings in size and fragmentation will continue to hinder efficiency in corn production.

Changing technology has greatly contributed to the increase in Spain's corn production in recent years. Tillage, planting, and fertilizer operations are mostly mechanized, except in regions such as Galicia, where the holdings are excessively small. Cultivators, rollers, and spreaders are also in common use. At present, there is about one tractor for every 10 farms. Corn harvesting is being increasingly mechanized under a Government program.

Picker-shellors encounter problems during the October to December harvesting period because it is generally rainy. In recent years, Spanish farmers have formed producer association cooperatives to share machinery, driers, and grain elevators. In southern Spain, very little drying of corn is needed since it is harvested at 15- to 16-percent moisture content. Further north, 20- to 30-percent moisture corn is harvested, and driers are needed.

Fertilizer utilization in Spain has increased sharply, partly as a result of Government programs which provide low-cost fertilizers for certain crops, particularly corn. Between 1960 and 1969, Spain's total use of fertilizers doubled to 1.3 million tons of plant nutrient. Data for average fertilizer and pesticide uses in corn production are not available. Plant and pest control in 1969 extended to over 3 million

hectares, but data for corn area treated are not available. Government subsidies and advances to corn producers in the north for the purchase of pesticides and pesticide equipment encouraged expanded use of pesticides.

Spain's use of hybrid seed has been increasing rapidly and in 1969 extended to an area of 280,300 hectares, about one-fifth above the average in 1965-68 (table 29). This area represented 57 percent of Spain's total corn area in 1969. Spanish Government sources estimate that about 360,000 hectares (or 60 percent of total corn area) were planted with hybrid seed corn in 1971.

Despite the sharp increase in corn yields in recent years, there is still room for substantial improvement through greater use of hybrid seed varieties, particularly in the northern corn-producing belt. However, gains resulting from the increased use of hybrids are likely to be gradual rather than dramatic.

Most of the expansion of the hybrid seed area has taken place on irrigated area. In 1969, nearly 220,000 hectares of irrigated area were planted with hybrid seed. This represented 87 percent of Spain's total irrigated corn area and was 30 percent above the 1965-68 average. These percentages are estimated to have increased in the past 3 years. Thus, in the irrigated sector, the shift to hybrid corn is nearly complete.

The use of hybrid seeds on nonirrigated areas is still quite limited and appears to be decreasing. In 1969, about 63,000 hectares of nonirrigated area, including 16,000 hectares associated with pulses, were planted with hybrid seed. This represented only one-fourth of nonirrigated corn area and was 21 percent below 1968 and 11 percent below the 1965-67 average.

Throughout most of Spain, hybrid corn seed apparently cannot be effectively used without irrigation. Average yields of hybrids grown on nonirrigated land in the period of 1965-69 were actually lower than those of nonhybrid varieties (16.2 quintals per hectare versus 18.2). This result is due largely to the heavy concentration of non-irrigated hybrid corn in Andalucia Occidental, where yields are very low--an average of 11.2 quintals per hectare during 1965-69. Also, changes in weather, particularly drought, increase the risks of planting hybrids as compared with the more resistant nonhybrid varieties. Also, planting of hybrids is more expensive, requiring more fertilizers and other inputs. Consequently, there would appear to be no real incentive to expand hybrid seed in the absence of irrigation. Even if hybrid seed use expands in those areas, the effect on yields is likely to be small.

The regions of the northern belt--Galicia, Asturias-Santander, Vascongadas, and part of Navarra--provide an important exception to the general conclusion of using hybrid seed only in irrigated areas. Here, precipitation is more than sufficient to justify the use of hybrid seeds, particularly when they are being heavily subsidized by the Government. The first two regions alone, Galicia and Asturias-Santander, which account for about one-third of Spain's corn production, had less than one-tenth of their 187,500 hectares of nonirrigated corn area planted with hybrids. The total non-irrigated corn area for the northern belt was 200,000 hectares, and only slightly more than one-tenth, or 21,500 hectares, was planted with hybrid.

In 1969, average yields in Galicia for hybrids planted in nonirrigated areas were about 65 percent above the nonhybrid varieties (28.3 quintals per hectare, compared with 17.2). Similarly, hybrid yields on nonirrigated land in the Asturias-Santander region were almost 45 percent higher (32.5 quintals per hectare, compared with 22.5). A comparison of actual production (359,000 tons) on nonirrigated land in 1969 in the same region (Galicia and Asturias-Santander) with a hypothetical production based on 1969 area times 1969 hybrid yields (545,000 tons) gives an idea of the potential gain from shift to hybrid in this particular region.

Several factors restrain the greater use of hybrid seed in this northern area. In Galicia, where corn is planted for both forage and grain, farmers complain that hybrid seed corn does not provide as much forage. Also, corn is often interplanted with pulses. Since the stock of the corn plant is used to support the pulses' vine, farmers prefer the local corn varieties which grow taller than hybrids. In addition, hybrid corn requires more intense care, better drainage of soil, lower seeding rates, more uniform seeding, greater mechanization, and greater use of herbicides. The limited resources available to many Spanish farms, particularly the small farms and the fragmented farm plots, do not encourage improvements of this nature. These factors will continue to slow the shift to hybrid seed. Nevertheless, a steady increase in the use of these varieties, along with more fertilizers and better production techniques, can be expected.

#### Outlook

Spain has considerable potential for further increases in corn production, assuming substantial increases in irrigated corn area, greater use of hybrid seed in the north, and improved technology of production--more machinery, more fertilizers and pesticides, and better cultivation practices, including less area interplanted with beans.

Using ordinary least-squares analysis, the following projections of Spain's corn area and production were obtained:

Corn	Actual average	Projected	
	1969-71	1975	1980
Area (1,000 ha.) . . . . .	520	640	730
Yield (qu./ha.) . . . . .	35	45	52
Production (million M.T.) . . . . .	1.8	2.9	3.8

Spanish Government sources predict even greater increases in Spain's corn production. The current Third Development Plan projects an increase of 300,000 hectares in corn area from 1970 to 1980, raising total corn area to about 825,000 hectares. If this goal is to be attained, most of the increase will have to come on irrigated area. This would raise total irrigated area to about 580,000 hectares by 1980, more than double the level in 1969, the latest available official data on irrigated corn area. Assuming the upward trend in irrigated corn yields reaches 62.8 quintals per hectare in 1980, irrigated corn production would rise to 3.6 million tons, compared with 1.4 million tons in 1970. Assuming that nonirrigated area will remain stable at about 250,000 hectares while yields improve to 32.6 quintals per hectare in 1980, corn production on nonirrigated area would be about 800,000 tons. Thus, realization of the Third Development Plan's goals for corn would probably mean an increase in Spanish corn production to about 4.4 million tons.

Several reasons why the plan's goal for increased corn area will almost certainly not be reached are as follows:

- (1) No sizable expansion of nonirrigated corn area is likely to occur. The low yields associated with nonirrigated corn production throughout much of Spain will continue to make such production relatively unattractive. In addition, much of the dry land expected to go out of other crops (particularly wheat) is marginal and not suitable

for corn production. Finally, in Galicia and the other northern regions where non-irrigated corn production is more profitable, the forage needs of the area's livestock industry along with the continued practice of interplanting corn with pulses preclude significant expansion of the corn in grain area.

(2) Although corn area can be expected to expand on newly irrigated land and on irrigated land now producing surplus crops such as wheat, cotton, and rice, it will face stiff competition, particularly from fruits and vegetables, sugarbeets, and forage crops. The planned expansion of the beef and dairy sector will require a considerable expansion of forage production. In addition, Spanish economic plans also set ambitious goals for increased fruit and vegetable production.

While the goals set for corn production in the third plan are felt to be excessive, a sizable gain in corn area is still projected by 1980--nearly 200,000 hectares above the current level.

Spain's corn yields in the 1970's will continue the upward trend, though at a slightly slower pace than in the past decade. Nearly all the irrigated area is already planted with hybrids, and increases of hybrids in nonirrigated areas will continue to be restricted by farm structure and practices in northern regions and by lack of water in other parts of Spain. The high cost of labor will continue to speed mechanization of corn production, but at a slower pace than in recent years. On the other hand, small farm size will continue to slow mechanization and hinder greater use of technological improvements.

Spanish corn production is thus projected to increase to about 3.8 million tons by 1980, more than double the 1969-71 average (table 27).

#### OTHER WESTERN EUROPE

Other Western Europe (OWE)--Austria, West Germany, Portugal, Greece, Switzerland, Belgium, the Netherlands, and the United Kingdom--produces about one-seventh of Western Europe's corn output <sup>19/</sup> This share has increased only slightly since the midfifties. Based on linear trend analysis for 1955 to 1971, the following tabulation was compiled for the total of the minor--OWE--corn producers:

<u>Item</u>	<u>Area</u>	<u>Yield</u>	<u>Production</u>
Average annual increase (percent) . . . .	0.0	6.6	6.9
Coefficient of determination $r^2$ . . . . .	0.0	0.84	0.76

No increasing trend is evident for corn area, and for the aggregate OWE, expanded corn output is essentially the result of improved yields.

In the following section, a brief discussion of corn production in each of the OWE corn-producing countries is presented.

<sup>19/</sup> British corn production has started only recently. Thus, analysis for the aggregate of OWE is based on the other seven countries.



## Mediterranean Area

### Greece

Despite decreasing corn area--resulting largely from small, inefficient farms ceasing activity--Greece has been increasing corn production, especially since the midsixties. Average 1969-71 corn output, 514,000 tons, was 80 percent above the midsixties level and twice the level of the midfifties. Corn area had declined continuously from the midfifties until 1967, when it began a slight upswing. It reached 165,000 hectares in 1972, but the 1969-71 average was still nearly a third below the 1955-57 level. However, an almost 12-percent average annual increase in yields has more than offset this area reduction.

Corn is widely grown, but production is concentrated in the humid zone that extends along the northern part of central Greece through Epirus, Macedonia, and Thrace, where the largest and most productive plains are situated. Macedonia and Thrace accounted for over one-half of the total area planted to corn and three-fifths of output in 1967.

Corn is interplanted with other crops, particularly beans in some regions of Greece. In 1967, more than one-fifth of the total corn area was interplanted with beans and other crops.

The recent uptrend in corn area can be largely attributed to Greek Government policy. A "15-year economic plan" outlining broad goals was prepared in 1972. The plan urges a shift away from wheat production and a move towards feed grains--especially corn--since wheat has become a surplus commodity. In 1966, the support price for corn was raised to equal the wheat price, and further increases beyond the wheat price were made in 1967 and 1969. Since then, the Government-guaranteed minimum support price for corn has been constant at \$93 per ton (2,800 drachmas). In addition, since 1967, income-support payments have been made to farmers who grow hybrid corn as a second crop on irrigated land. This support payment reached a maximum of \$67 (2,000 drachmas) per hectare in 1969 but was reduced to \$34 (1,000 drachmas) per hectare for the 1970 crop.

Irrigation is having a major impact on corn production. One-half of the corn area, producing two-thirds of the output, was irrigated in 1969. Ten years earlier, only one-third of the corn area was irrigated. During 1960-68, irrigated corn area was largely unchanged from 70,000 hectares. However, in 1968, it began to increase and by 1969 was up to 92,400 hectares, 30 percent more than the average in 1966-67. Plans are being implemented to increase the area of irrigated land, and it appears that Greece is rapidly moving towards irrigation of all the land in corn.

In addition to irrigation, increased use of hybrid seed varieties has been a major reason for the sharp increase in Greek corn yields. Hybrid varieties are now used on over 90 percent of total corn area. Greater fertilizer use and continuing improvements in farming methods have also raised yields.

Corn area is expected to increase moderately by 1980, recovering to the level of the early 1960's. The decline in area of late-planted corn which usually follows the harvest of winter grain will restrain total increase in corn area. Lower yields and high moisture content at harvest make the production of such corn less profitable. Corn yields will probably continue to register improvement, though at a slower pace, as production practices and varieties improve. Raising yields may become a harder task since the initial impetus of irrigation and hybrid seed use has already been registered. However, yields are relatively low compared with those in other corn-producing countries; therefore, there is still considerable room for improvement. Greek agricultural policy has probably been more effective in encouraging the use of better

inputs--irrigation, hybrid seed, and fertilizer--than in promoting an expansion of corn area. However, with more irrigated land available, Government policy could urge that a greater share of arable land be put into corn.

### Portugal

Following wheat, corn is the most important grain grown in Portugal. From 1955 to the midsixties, corn area remained close to 500,000 hectares; it then declined substantially. Continued increase in yields has kept corn production generally well above 500,000 tons since the early 1960's; however, no upward trend in production is apparent. Production obtained a peak of 632,000 tons in 1961.

The northwest (Viana do Castelo, Braga, and Oporto) accounts for about one-third of the Portuguese corn area and two-fifths of the corn production. The central coastal area, Aveiro and Coimbra, with about 20 percent of the area, produces about one-fourth of the corn. In other regions, corn is less important.

About one-half of the corn area is irrigated; over three-fourths of production comes from the irrigated area. In the north, corn is mainly grown on rainfed areas, while in other regions of the country, irrigation is essential to corn cultivation.

Portugal's corn yields are the lowest in Western Europe, despite the large percentage of irrigated corn area. In 1969-71, yields averaged 13.5 quintals per hectare, which is less than one-half the yields in Spain and less than one-third the yields for total Western Europe in the same period. These conspicuously low yields are mainly due to:

(1) Failure to adopt hybrid seed varieties. Although the Government has been promoting greater use of hybrid seeds for many years, only a very small portion of the corn area--no more than 10 percent--is planted with hybrids. The small size of the farms and the requirements of greater use of machinery have discouraged greater use of hybrid seeds. Also, part of the explanation may be that farmers resist the heavy fertilization rates recommended for hybrids--135 to 180 kilograms of nitrogen per hectare, instead of the 45 to 90 kilograms of nitrogen used for nonhybrid corn. Potash is also necessary for the cultivation of hybrid corn unless large quantities of manure are applied.

(2) Mixed-cropping cultivation practices. Corn for forage and beans are interplanted with corn for grain. Although relatively important in Portugal, this practice is also important in Spain and to a lesser extent in other Mediterranean countries. This practice predominates on the smaller Portuguese farms and affects corn area and yields in two ways: (1) These other crops compete for space and soil nutrients, thus lowering yields, and (2) mixed cropping greatly adds to the difficulties in calculating actual corn for grain area. Native corn is generally planted very densely, and a portion of the growing plants and tops are cut during the summer for animal fodder. The remaining plants are allowed to mature for grain. Beans, usually kidney, are often grown together with corn, particularly in the northern region. The cornstalks serve as stakes for the bean vines. Even continuing the practice of interplanting corn with beans, yields could double with use of hybrid corn seed and proper fertilization. Research has shown that the increase in bean yields would alone pay for the incremental cost of hybrid corn seed and fertilizer.

The farm structure limits improvements in corn productivity. A large part of the corn cultivation is concentrated in the north, where holdings are too small and fragmented to permit either corn mechanization or efficient use of farmers' time. These farmers resist adoption of new technology. Area, yield, and production would all be favorably affected if less traditional production practices were carried out. Although the knowledge is available to improve yields, greater incentives will have to be made and accepted before the situation significantly improves.

The decrease in Portugal's corn area in recent years is mainly attributable to rural exodus of marginal farmers whose small plots were either converted to other uses or abandoned. Also, Government policy continues to favor greater output of the food grains wheat and rye compared with feed grains.

In 1970, however, a new grain policy was adopted with a strong emphasis on providing greater production incentives to grain farmers instead of relying entirely on guaranteed producer prices. While the new policy was directed mainly toward increased production of wheat and rye, corn cultivation was to benefit also. The average corn support price was retained at about \$95 per ton. The price of fertilizers used in feed grain production was reduced 9 percent. Subsidies for using hybrid seed corn were maintained at \$18 per hectare for grain production and \$26 per hectare for forage production. The subsidies for use of hybrid corn seed were limited to 10 hectares. However, this restriction was not very important since the larger farmers are more progressive and tend to use hybrid seed anyway. More recently, the subsidy paid on 10 hectares was eliminated, and unlimited quantities of hybrid seed can be purchased at a lower price of 4 escudos per kilogram. Other measures introduced with the new grain policy include subsidies and technical assistance for land clearance, drainage, fencing of land for grain protection, and provisions for interest-free loans for certified seed and farm equipment facilities.

This new grain policy is expected to increase corn production, particularly on newly irrigated areas. Also, the Government hopes that some of the irrigated area producing surplus tomatoes will be diverted to corn production. On the other hand, corn production on rainfed areas, particularly where "minifondios" (small farms) predominate, is expected to continue to decrease. Thus, a potential net decrease in corn area during the 1970's is estimated.

Although corn area is expected to decline, corn production is expected to increase as a result of higher yields. While small farm size and cultivation practices will continue to thwart major increases in corn yields, some increase is expected as a result of the adoption of nontraditional farming practices and use of more production inputs.

#### Northern Area

##### Austria

With corn output reaching over 700,000 tons in 1971, Austria ranked as the fourth largest producer in Western Europe. Output has increased sharply, especially since the midsixties. Corn production in 1972 was up to 805,000 tons. Average output in 1969-71 was more than four times the 1955-57 average. This increase is the result of both larger area and greater yields, although area did not expand substantially until after 1967. Corn area in 1972 totaled 132,000 hectares, double the 1967 level.

Of the total land area of Austria (8.3 million hectares), three-fourths is either in alpine regions or in regions climatically influenced by the Alps. Grassland farming and livestock predominate in these regions. In the eastern parts of Austria, climatic conditions are the most favorable for grain production. The northeastern States of Steiermark, Niederoesterreich, and Oberoesterreich account for about 80 percent of corn output.

The recent increase in corn area is the result primarily of higher corn prices relative to wheat and of the development of varieties of corn with a shorter growing season. While the producer price for wheat decreased 4 percent from 1957/58-1959/60 to 1967/68-1969/70, the comparable price for corn increased 16 percent. Thus, the corn/wheat price ratio rose from 0.76 to 0.92 during this 10-year period. Although feed-grain prices are not supported directly like wheat prices, the domestic market prices are protected from imports by official selling prices for imported feed grains.

In addition, subsidies for freight costs on feed grains are granted in certain cases, and selected purchases of feed grains are made by the Government when the market is overburdened. These price incentives, coupled with the development of quicker maturing corn varieties which became available in 1967 (and which were evidenced by the boosted corn areas from 1968 on), have led to a dramatic expansion in corn area and output. By way of comparison, a 1964 study (4) projected corn area at 65,000 hectares in 1975 and corn production at 260,000 tons. These figures are about one-half and one-third of 1971 corn area and production, respectively. This divergence points up the impact that policy and technology can have in a short time span.

Associated with and in part responsible for this unprecedented expansion has been the strong upward swing in yields. Austrian corn yields have tended to be the highest in Western Europe and have doubled since the midfifties. These better yields have been the result of use of improved hybrid varieties and proper cultivation techniques and the adaptation and selection of the proper variety to match the local soil and climatic conditions.

As a result of these factors, Austria has moved from a considerable net importer of corn to a producer near self-sufficiency. Small quantities of corn for industrial uses may continue to be imported, but feed requirements of corn will be met almost entirely from domestic supplies.

#### West Germany

West German corn production, which was insignificant in the 1950's, has expanded rapidly since then, totaling about 600,000 tons both in 1971 and 1972. While significant gains in yields have been made, rapid expansion of area has been the major cause of the increased output.

Until recently, varieties of corn adapted to the German climate and growing conditions were used mostly in Baden-Wuerttemberg and Bavaria, the two southernmost States. The distribution of corn output among the main corn-producing States is shown below:

	Av. 1963-65	Av. 1968-70
	<u>Percent</u>	
Bayern (Bavaria) . . . . .	30	37
Baden-Wuerttemberg . . . . .	59	35
Nordrhein-Westfalen . . . . .	2	11
Niedersachsen . . . . .	1	8
Hessen . . . . .	5	5
Rheinland-Pfalz . . . . .	3	4
Total . . . . .	100	100

Source: (70).

The shift in corn area is most apparent from observing the situation in Baden-Wuerttemberg, the main corn-producing State. At the beginning of the 1960's, Baden-Wuerttemberg accounted for two-thirds of West Germany's corn output. By 1963-65, this figure had declined to 59 percent, and by 1968-70, 35 percent. Whereas Bavaria and Baden-Wuerttemberg accounted for almost 90 percent of the output in 1963-65, they are expected to produce less than 70 percent in the early 1970's.

In West Germany and other corn-producing countries, corn is harvested and handled according to four different methods, depending on ultimate use. It may be harvested for:

- Grain and dried for regular storage
- Grain, but not dried, and stored in a high-moisture condition
- Silage and stored for winter feeding
- Green chop and fed immediately.

Although most corn for grain is dried before storing, the high moisture content (30 to 40 percent) of corn at harvest makes it costly to dry. This high cost is a major obstacle to the expansion of corn production. However, new storage techniques may reduce this obstacle. For example, the use of propionic acid and special storage facilities allows corn to be handled without drying. This method of handling corn may become more important, but technical and distributional problems would have to be overcome before it could be widely adopted. At present, corn handled this new way is mostly fed to hogs.

A number of factors in addition to the favorable prices under the European Community's CAP have led to the expansion of corn area in West Germany, particularly in the more northerly States. Although nonhybrid corn (Badischerlandmais) has been grown for over 50 years in the southern Rhine valley of Baden, available corn varieties were not generally adapted to the German land and climate until 1968. However, with new varieties, corn has been added to the crop rotation patterns. Root crops--for example, fodder beets--which are traditionally used as break crops, <sup>20/</sup> require much more labor than corn. Shortages of labor have forced farmers to turn to alternative, less labor-demanding crops. Also, labor requirements for corn are distributed better throughout the season than for some other crops. German farmers use corn in the rotation to improve the structure of the soil as well as to break the disease and weed cycle for small grains. No dominant crop rotation plan seems apparent, but corn is produced in rotation with wheat or oats, spring barley, sugarbeets, and forage crops.

Increased yields have resulted from improved technology and improved seed varieties. Essentially all corn produced is hybrid, with German farmers generally adopting the techniques needed for optimum yields. Little irrigation is needed.

Recent research (36) indicates that for certain areas of West Germany, corn yields need to be 1.0 to 1.2 tons per hectare greater than wheat if corn for grain is to be as profitable as wheat. Under good growing conditions, this higher yield can be achieved. However, yields vary, and getting the corn to mature during the short growing season will continue to be a concern.

Aided by improving methods of harvesting, storing, and marketing corn and the continuing development of higher yielding, shorter season varieties, corn's position in the German farm economy will undoubtedly become more important.

#### Switzerland

Although corn is still a minor crop, production has increased markedly in recent years, primarily from expanded area. Corn area as a share of total grain area has increased as follows:

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<sup>20/</sup> Break crops refer to alternative crops to grains in a grain-dominant rotation. These crops are used to break the buildup in soilborne diseases and weeds as well as to improve the soil structure.

	<u>Percent</u>
1950 . . . . .	0.8
1960 . . . . .	0.6
1965 . . . . .	2.5
1970 . . . . .	5.3
1972 . . . . .	11.0

Corn area increased gradually until 1968. However, by 1970, it accounted for over 5 percent of the Swiss grain area, which was more than twice the figure 5 years earlier. By 1972, area was twice that in 1970.

Although new varieties became available in the late 1960's, Swiss feed grain policy was the main impetus to expanding corn area. Swiss agriculture and agricultural policy center around dairying. Other commodities also have very definite policies arranged for them, but these policies are usually ancillary to the dairy policy. To ease the surplus position of milk, crop production programs were revised in 1967 to emphasize feed grains at the expense of pasture and forage area. Although the producer price for feed grains has not materially increased in recent years, subsidies paid to feed grain producers on the basis of area have increased constantly since 1967. Basic subsidies are granted on area cultivated for feed grains, with added payments for areas in mountain regions. The basic subsidy for corn is 7 percent higher than for other feed grains and amounts to almost \$200 per hectare.

The 4th Swiss Agricultural Report called for 1975 feed grain <sup>21/</sup> area to be 20,000 to 30,000 hectares above the 1968 level. This increase would result in a total feed grain area of 66,000 to 76,000 hectares. In 1972, 73,000 hectares of feed grains were harvested, compared with 46,000 hectares in 1968 and 56,000 hectares in 1969. The bulk of this increase was in corn. A share of the added feed grain area is from land previously planted to potatoes. Potato area declined from 36,000 hectares in 1967 to less than 30,000 in 1971, and 26,000 in 1972 (preliminary data). Generally, corn is not used in rotation with potatoes, but rather with small grains and leguminous crops. Thus, it appears the recent grain policy has resulted in a shift in cropping patterns.

Feed grain area will probably continue to increase, but higher subsidies will be required. If special emphasis is given to corn and if continued improvement in varieties is achieved, corn area will expand further. However, the area of productive agricultural land is relatively small in Switzerland. Mountains, forests, altitude, rainfall, quality of soil, and the considerable slope of the land limit the possible grain area. If the Swiss Government continues to encourage corn production, output should at least experience a moderate rise, although production will probably remain relatively small.

#### Belgium, the Netherlands, and the United Kingdom

Corn production in these three countries is quite limited, as Belgian, Dutch, and British climatic conditions do not favor existing varieties of corn for grain. Their climate is generally less favorable for corn for grain than in the other countries presented. Combined output for the three countries totaled about 32,000 tons in 1971. However, interest in corn production has been increasing, and there is some evidence that corn produced for grain is on the verge of becoming a more important crop.

Production of corn for grain is technically feasible in many areas of these countries, but high yields are needed to compensate for the high production and harvesting costs. The reasons for encouraging and attempting greater corn area in Belgium,

<sup>21/</sup>The Swiss Agricultural Report excludes rye from feed grains. The resulting analysis also excludes rye from the feed grain category.

the Netherlands, and the United Kingdom are essentially the same as discussed for the other OWE producers. An additional crop in the rotation would help break the disease and weed cycles, improve the soil structure, and reduce and/or better distribute labor requirements. Also, increased corn production would lower import requirements.

Since Belgium is part of the EC, its grain policy is determined under the regulations of the CAP. High support prices for grains (including corn, although its price is nearly always above the support price) in the Common Market countries have encouraged a continual expansion in grain production. In recent years, corn varieties were developed and adapted to Belgian growing conditions. Although still a minor crop, corn has had sharp increases in production since 1969. Output in 1972 was 2.5 times the 1970 level of 10,000 tons.

The Netherlands, like Belgium, is a member of the EC. The Dutch have more difficulties in growing corn than the Belgians, because of the less favorable climate, but incentives are given to help overcome initial investment problems. The Dutch grant a first-year payment of a maximum of \$3,080 (10,000 guilders) per centre. A centre is a group of producers who collectively farm at least 40 hectares of corn. This financial support was given to 17 centres in 1970, 13 centres in 1971, and an estimated 10 centres in 1972, as interest in corn production is increasing at a less rapid rate.

During the 1950's, some corn was produced in the Netherlands, but as a result of unprofitability, corn for grain production dwindled until 1970. While production in 1971 was only 10,000 tons, a slight growth in output of corn for grain will probably occur as improvements in adopted seed varieties are made.

In the United Kingdom, production of corn for grain is essentially in an experimental stage, with commercial production estimated to be 3,500 tons on approximately 800 hectares in 1971. Thus far, southeastern England, especially the counties of Kent and Suffolk, has been the primary corn area.

The British Government has supported an expansion of corn production by extending the Cereals Marketing Act of 1965 to cover corn and by allocating money for agronomic, engineering, and economic research on corn. Farming groups have been formed to produce corn cooperatively so as to gain expertise and spread the cost of producing corn.

Farmers in the United Kingdom are interested in increasing corn production for the following reasons:

- To diversify grain farming output
- To secure for domestic producers a share of the traditional import market
- To move away from barley monoculture, which technically gives rise to disease and soil structure problems
- To obtain a higher energy value per hectare than can be obtained with wheat or barley.

Also, when the price support arrangements are fully implemented under the enlarged European Community's Common Agricultural Policy, grain prices in the United Kingdom will undoubtedly be higher than at the present. Higher prices for barley may lead to overproduction. Thus, corn may be encouraged as an alternative crop.

Increased output will not be without problems. Harvested corn moisture is between 35 to 40 percent, which can lead to grain damage and loss of grain through harvesting and storage problems. Thus, heavy expenditures for drying are usually necessary.

### Outlook

Although the rate of growth in corn production will vary among the eight OWE countries, corn production is expected to increase in all. In the aggregate, it is estimated that the OWE countries will more than double their production by 1980 compared with 1969-71. Output will be almost 5 million tons, representing a percentage increase second only to the one projected for France.

Projected corn (for grain) area for each of the OWE countries is shown below:

Country	1969-71	Estimated 1975	Estimated 1980
		1,000 hectares	
Portugal . . . . .	410	375	350
Austria . . . . .	123	165	200
West Germany . . . . .	98	150	200
Greece . . . . .	156	170	180
Switzerland . . . . .	11	30	35
Belgium . . . . .	2	10	15
Netherlands . . . . .	1	5	10
United Kingdom . . . . .	<u>1/</u>	<u>5</u>	<u>10</u>
Total . . . . .	801	910	1,000

1/ Less than 500 hectares.

For the aggregate, corn area is projected to increase 14 percent by 1975 and 25 percent by 1980 compared with 1969-71. Within the 1 million hectares estimated for 1980, Portugal would still account for the largest share, with Austria, West Germany, and Greece accounting for almost all of the remaining area.

All countries except Portugal are expected to increase their corn area but at different rates. Portugal's corn area is expected to decline to 350,000 hectares by 1980 as many small, marginal farms cease production. However, more vigorous efforts to improve yields are anticipated on the remaining farms. This estimated area for Portugal would be about equal to the level in the late 1920's. Portuguese corn area reached a high shortly after World War II and since then has trended slowly downward, although fluctuations have occurred.

Austrian and West German corn areas are expected to each be about 200,000 hectares in 1980. A considerable shift into corn area has occurred in Austria, but there is still potential for a larger area. West Germany's corn area in 1969-71 was less than Austria's, but West Germany has a considerable arable land base, which could allow a greater shift into corn than could Austria's arable land base. Also, as varieties adapted to a shorter growing season become available, the possibility for expanding corn area becomes greater in West Germany than in neighboring Austria.

In Greece, corn area will increase slowly as land improvement practices are carried out and small farms are consolidated into more efficient operations. The projected rise in Greek corn area assumes a reversal in the long-term downward trend (since 1955) and a rise to approximately the level of the early 1960's.

Switzerland, Belgium, the Netherlands, and the United Kingdom are expected to remain minor producers through 1980. Even with new varieties that will be better adapted to their growing conditions, the possible corn area is limited. Although greater corn



production will occur in these four countries, grain cropping is not of primary concern to most farmers. A large share of the farming is oriented toward dairying. Thus, it is expected that corn will largely substitute for other grains in the cropping rotation rather than cause pastureland or land in other crops to be put into corn. Even a dramatic increase in corn area would still leave these producers as minor, however, because potential corn area is relatively small when viewed in terms of total Western Europe.

In these eight OWE countries, as in the three major corn-producing countries in Western Europe, future expansion in corn production hinges on how rapidly new varieties become available and what policy incentives are given for corn production (and alternative crops). Becoming familiar with new corn varieties and the techniques that are needed for corn production appears to pose few problems for West European farmers.

#### PROJECTIONS FOR 1975 AND 1980

##### Production

The quantitative analysis of corn production was divided into two integrated sections--area and yield. Factors affecting area and yield, or production, may be classified into four categories:

- (1) Economic--price relationships; market conditions
- (2) Technological--improved seed varieties adapted to a wider range of growing conditions; better farming techniques; increased use of fertilizer, herbicides, irrigation, and other such inputs
- (3) Institutional--policy; farm structure
- (4) Environmental--climate; geography.

Environmental factors are essentially fixed and were not considered in the analysis except as a major limiting factor. Institutional factors were not considered separately; instead, it was generally assumed their impact would be reflected in changed price relationships (in the case of policy) or in technological changes (in the case of farm size and fragmentation).

Corn area was assumed to be determined by the price received for corn and by technology, which has given rise to new corn varieties capable of being economically grown in new areas. In the initial projections, yield was assumed to be determined by the "level of cultivation" and weather. "Level of cultivation" means the level of technology and the cultivation methods associated with corn production. On a national basis, factors such as percentage of hybrid seed area planted, quantity of fertilizer used per hectare of arable land, amount of herbicide and pesticide applied, and percentage of corn area irrigated would be involved.

Ordinary least-squares analysis was used to examine the factors affecting corn area and yield in each of the three major corn-producing countries of Western Europe--France, Italy, and Spain (table 34). For the equations concerned with corn area, prices that producers receive for corn were deflated by the cost of ammonium nitrate fertilizer (the fertilizer most commonly used). In the absence of more specific quantitative data on the technology involved with the developments in improved corn varieties, tractor numbers were selected as a proxy variable. In the case of France, winter wheat area was also used as an independent variable. Poor fall planting conditions or a severe winter frost can sharply reduce winter wheat area in France. This results in a shift of area to corn. In Italy, hybrid corn and nonhybrid corn areas were analyzed separately, since opposite trends were apparent. Italian nonhybrid corn area was fitted to a linear trend line.

Table 34 --Summary of ordinary least-squares analysis of corn area and yield in France, Spain, Italy, and Other Western Europe (OWE), 1955-71

Item	Multiple regressions 1/	Function	R <sup>2</sup>	F-value	s	Durbin-Watson statistic
Area:						
France. . . . .	log FAC = 2.38251 + 0.29304 FP' - 0.04523 FAW (1.37699) (2.47116) + 0.4746 FFR (9.68512)	semilog	0.89	34.078***	0.054	0.658
Italy (hybrid).	log IAHG = 1.80849 + 0.50861 log IP' + (2.26576) 0.43890 log ITR (8.36798)	double-log	0.94	113.605***	0.029	1.087
Italy (nonhybrid)	IANG = 3451.75682 - 44.82614T (32.85966)	linear	0.99	1079.75***	27.555	0.399
Spain . . . . .	SAC = 2.59540 + 0.13685 log SP' + (1.77949) 0.15792 log STR (13.28290)	double-log	0.94	116.432***	0.015	2.03573
Yield:						
France. . . . .	FYC = 84.45147 + 1.90539 T (6.31130)	linear	0.73	39.832***	6.098	2.258
Italy 2/(hybrid)	IYHC = 24.54500 + 0.44485T (3.30683)	linear	0.42	10.935	2.717	1.511
Spain . . . . .	log SYC = 1.16484 + 0.00253 SOF + 0.00209 SPH (4.79589) (2.03188)	semilog	0.92	77.114***	0.026	0.607
OWE 3/. . . . .	log OYC = 0.49891 + 2.72783T (11.62498)	semilog	0.95	135.140***	0.047	0.646

\*\*\* represents significance at the 1-percent level.  
s = standard error of estimate.

(Notes to table 34--continued)

1/ The figures in parentheses below the partial regression coefficients are "t" values. 2/ As indicated, regression applies to hybrid corn only. No increasing or decreasing trend was apparent in yield of nonhybrid corn. Thus, the average for non-hybrid corn for 1955-71 was selected--20.2 quintals/hectare. This compares with the following 5-year averages: 1956-60 = 20.9 quintals/hectare; 1961-65 = 20.0 quintals/hectare; 1966-70 = 20.2 quintals/hectare. 3/ As indicated, regression applies to yield only.

FAC = corn area in 1,000 hectares, France.

FP' = French producer price for corn in current francs per quintal ; French wholesale price of ammonium nitrate in current francs per quintal, previous year.

FAW = winter wheat area in 1,000 hectares, previous marketing year, France.

FTR = number of tractors, thousand, France.

IAHC= hybrid corn area in 1,000 hectares, Italy.

IP' = Italian producer price of corn in current lira ; Italian wholesale price of ammonium nitrate current lira per quintal, previous year.

ITR = number of tractors, thousand, Italy.

IANC= nonhybrid corn area in 1,000 hectares, Italy.

FYC = yield of corn in quintals per hectare, France.

IYHC= yield of hybrid corn in quintals per hectare, Italy

SYC = yield of corn in quintals per hectare, Spain.

SQF = quantity of fertilizer used per hectare of arable land, Spain.

SPH = percentage of corn area planted to hybrid seed, Spain.

OYC = yield of corn in quintals per hectare, Other Western Europe.

T = time.

SAC = corn area in 1,000 hectares, Spain.

SP' = Spanish producer price of corn in current pesetas per kilogram ; Spanish wholesale price of ammonium nitrate in current pesetas per kilogram, previous year.

STR = number of tractors, thousand, Spain.

For the equations involved with yield, ordinary least-squares analysis involving fertilizer quantities, weather, and other factors failed to adequately meet statistical tests for significance or were judged to give unacceptable projection results. Consequently, trend analysis was employed. The exception to this approach was Spain, where the average quantity of fertilizer applied per hectare of arable land and the percentage of corn area planted to hybrid seed were used as independent variables. The linear trend function for French corn yield assumes yields will increase at the past rate. Although a large share of available technology has already been adopted by French corn producers (for example, essentially all seed that is used is hybrid, and fertilizer application on corn is generally adequate), it was felt that increases in yields would continue to be as rapid as in the past. Improved varieties, more effective and widespread use of herbicides and insecticides, and fewer marginal farmers should boost yields. A linear trend function was used for Italian hybrid corn yield. Italian nonhybrid corn yield was assumed to remain at 20.2 quintals per hectare (average for 1955-71) since no increasing or decreasing trend was apparent. The semilog trend function for the eight-country aggregate of OWE <sup>22/</sup> assumes yields will increase at an increasing rate. As low-yield countries like Portugal and Greece adopt available technology, and as higher yielding countries increase their share of production within OWE, yield increases in OWE should progress more rapidly than in the past.

The following tabulation summarizes the assumptions made concerning the independent variables used in the projection:

Variable	Percentage change from 1968-71	
	1975	1980
	Percent	
For area:		
France:		
Producer price for corn . . . . .	+10.0	+15.0
Wholesale price of ammonium nitrate . . . . .	+2.5	+5.0
Area of winter wheat . . . . .	-5.0	-10.0
Tractor numbers . . . . .	+40.0	+60.0
Italy (hybrid):		
Producer price for corn . . . . .	+10.0	+15.0
Wholesale price of ammonium nitrate . . . . .	+2.0	+4.0
Tractor numbers . . . . .	+60.0	+120.0
Spain:		
Producer price for corn . . . . .	+15.0	+25.0
Wholesale price of ammonium nitrate . . . . .	-33.3	-33.3
Tractor numbers . . . . .	+25.0	+66.7
For yield:		
Spain:		
Kilograms of fertilizer per hectare . . . . .	+40.0	+50.0
Percentage of corn area planted . . . . .		
with hybrid seed . . . . .	+18.6	+35.6

<sup>22/</sup> British corn production essentially only started in 1970 and is therefore not included in the trend function.

The starting point for formulating these assumptions was the past trend evident for the different independent variables. Adjustments to these trends were based on anticipated developments in technology or in policy. The changes for the independent variables were chosen with regard to what was most probable and most consistent with past observation. It was felt this approach would generate estimates that would most approximate the actual situations in 1975 and 1980.

The producer price for corn in France and Italy in 1975 is expected to stay at the price level that the EC commission set for 1972/73, which is about 10 percent above the 1969-71 price. By 1980, the producer price is expected to rise 15 percent above the 1969-71 price. This dampening in the rate of price increase is likely since the new EC members--the United Kingdom, Denmark, and Ireland--should have a stabilizing effect on prices.

Better marketing and distribution of fertilizer in Western Europe should continue to keep the producer purchasing price increasing at only a slight rate. Bulk handling of fertilizer, more concentrated forms of fertilizer, and other technological developments will continue to help offset the inflationary push in nitrogen fertilizer wholesale prices. The Spanish wholesale price for ammonium nitrate is expected to decline by one-third as a result of the large Government subsidization of production costs for corn. Some Spanish corn producers in certain regions receive subsidization equal to one-half their costs. It is estimated that for all of Spain, Government subsidization would cause a one-third reduction in fertilizer costs through 1980.

As noted, tractor numbers were selected as a proxy variable for developments in improved corn technology. <sup>23/</sup> New varieties of corn have allowed corn to be grown in areas previously not suitable for its cultivation. This increased area, to a large degree, has been associated with the need for more tractors. Corn cultivation and harvesting is greatly facilitated by the use of tractors as opposed to horses or smaller "garden-type" tractors. Along with hybrid corn cultivation comes more modern techniques of farming. Essentially all new corn area in Western Europe during the 1960's was hybrid, and this development will continue. Thus, a farmer producing corn is much more likely to be adding tractors to his operation than a farmer producing the more traditional crops. Also, some farmers first produce corn for silage, then as they gain experience, produce corn for grain. Producing corn for silage would greatly increase the need for tractor power. The percentage increases for tractor numbers for 1975 and 1980 reflect a judgment concerning the most likely increase in corn technology as well as a possible level tractor numbers could reach.

In the case of Spain, an additional area was added to the ordinary least-squares equation results. By 1975, an estimated 100,000 hectares will be added to the overall irrigated land base. From previous observations and from trends towards a greater share of Spain's corn area being irrigated, it was estimated that an additional 50,000 hectares of new corn area would result in 1975--that is, one-half of the newly irrigated land that will become available. This area would be in addition to any increased area brought about by a higher producer price, Government subsidization, and increased mechanization. A similar 50,000-hectare addition was assumed for 1980, giving a total increase in corn area of 100,000 hectares between 1970 and 1980 as a result of the Spanish Government irrigation policy.

<sup>23/</sup> Constructing an index to show the development of corn production technology was hindered by a lack of readily available data. If data could have been found that showed the number of new varieties of corn with the growing-season length they need to mature, an index possibly could have been constructed.

Yields, except for Spain, were based on trend as indicated in table 34. For Spain, the assumed percentage change in the share of corn area planted with hybrid seed (+18.6 percent for 1975 and +35.6 percent for 1980) results in hybrid seed area accounting for 70 and 80 percent of total corn area for 1975 and 1980, respectively.

Least-squares analysis was not used for the minor corn-producing countries (referred to as Other Western Europe (OWE) in table 34). Trend analysis was used in projecting OWE yields. Projecting corn area for OWE posed problems. In the aggregate, corn area for these countries showed no increasing or decreasing trend for 1955-71. Increasing area in Austria and West Germany tended to offset the decreasing trend in Portugal and Greece. However, with the current developments that have occurred in corn production technology and the emphasis being given to expanding corn output, it would appear that corn area will expand. Area has risen slightly in the last few years for the aggregate of minor producers.

Based on an examination of the factors affecting corn production in each OWE country and on discussions with researchers in most of them, corn area was estimated for each of the eight OWE countries. Britain's future potential was considered in the 1975 and 1980 estimates for OWE. However, since corn for grain production is in the developing stage in Britain, time series data are not available. Using the equations in table 34, the assumptions presented in this section, and the estimated areas for the OWE producers, the results obtained are shown in table 35. (Also see fig. 5.)

Total West European corn production is projected to rise from an average of 16.1 million tons in 1969-71 to 33.4 million tons in 1980--a 107-percent increase. (From 1959-61 to 1969-71, corn output in Western Europe expanded from 8.3 tons to 16.1 million tons, or 94 percent.) Area and yield are projected to increase 46 and 42 percent, respectively, during this time period. On a percentage basis, total corn output would increase the most in France, followed by OWE, Spain, and Italy.

A definite change in pricing and land improvement policy, along with a halt in technological developments, could result in a 1980 production level lower than 33.4 million tons. However, it appears that policies will remain essentially unchanged, and the adoption of better technology will increase at least as fast as in the 1960's. The projected 33.4 million tons output should be obtainable, and, given the incentives, production could rise to a slightly higher level by 1980. Assigning a confidence level to this figure is hazardous. In addition to the error terms in the least-squares equations, the future values of the independent variables are subject to error. Realizing these shortcomings, it is estimated that there is a 75-percent chance that by 1980, West European corn production will be 33.4 million tons  $\pm$  3.3 million tons.

#### Consumption

As stated in the introduction, this report is primarily concerned with corn production rather than consumption. However, to gauge the impact of increased West European corn output on U.S. corn exports, consumption must also be taken into account. Several recent and comprehensive studies project future grain consumption in Western Europe. <sup>24/</sup> However, corn is generally not considered separately in these studies, but it is aggregated into the category of feed grains.

<sup>24/</sup> One of these studies is World Demand Prospects for Grain in 1980 With Emphasis on Trade by the Less Developed Countries, published by the Economic Research Service (73). This study presents five alternative levels of coarse grain consumption in Western Europe in 1980: (continued).

Various levels of coarse grain consumption for 1980 have been projected by the Economic Research Service, U.S. Department of Agriculture. <sup>24/</sup> For the present report, the projected consumption level of 110.3 million tons (Projection Set I) was considered as an appropriate approximation of future coarse grain consumption since the trend from the base period 1964-66 to 1980 approximates the recent trend in coarse grain utilization in Western Europe. Moreover, the assumptions associated with this projection appear reasonable in light of current and expected developments.

Although demand for poultry and livestock products is expected to increase substantially in Western Europe, the increase is not expected to be reflected fully in a corresponding rise in coarse grain consumption. At the expense of grains, grain substitutes will increase their share in livestock and poultry feedstuffs. Grain by-products, oilseed meals, manioc, beet pulp, feed peas, and other feeds will become more competitive and acceptable than relatively higher priced coarse grains. This assumption gains added validity as the European Community's Common Agricultural Policy expands its force in the enlarged Community. Thus, it appears likely that coarse grain consumption will be in the range of Projection Set I (110.3 million tons) by 1980, so subsequent calculations in the following section are based on the Projection Set I utilization level.

<u>Projection Sets</u>	<u>1980 projected consumption</u> Million metric tons
I	110.3
II	111.3
II-A	114.7
II-B	118.0
III	109.6

A second study is Agricultural Commodity Projections 1970-1980, published by the Food and Agricultural Organization (<sup>20</sup>). This study projects a 1980 consumption level of 108 million tons.

All the projections for Western Europe in the ERS study are based on the assumptions that population will expand at 0.7 percent annually and national income will increase at 4.1 percent annually. Projection Sets II, II-A, and II-B are based on higher rates of agricultural productivity and economic growth in the less developed countries than is Projection Set I; Projection Set III is based on a lower rate than Projection Sets II, II-A, and II-B. Projection Set II-A is based on the assumption that the major developed exporters (countries) will adopt a rigid policy to maintain their traditional share of the world market; Projection Set II-B on the assumption that developed importers (countries) will become more sensitive to world grain prices and adjust their high internal prices. A further discussion of the assumptions and approach used are presented on pages 63-77 of the ERS study.

Point A in the FAO study is based on more broad assumptions than the previously discussed study. The rate of population increase is assumed to continue at the past trend but with a slight acceleration of the rate of increase in the developing countries. Income assumptions are generally based on past trends. Constant 1970 prices are assumed, except for certain commodities that were considered to have seriously untypical price relationships in 1970. National policies are assumed to remain as they were in late 1970 and early 1971. Further discussion of the assumptions and approach used are presented in pages 8-11 in the FAO study.

Table 35 --Summary of corn production projections 1/

Country	Actual 1969-71	Projected 1975	Projected 1980	Percentage change from 1969-71 to 1980
				Percent
France:				
Area. . . . .	1,434	2,380	2,760	+92
Yield . . . . .	50	58	68	+36
Production. . . . .	7.4	13.8	18.8	+154
Italy:				
Area:				
Hybrid . . . . .	700	840	980	+39
Nonhybrid. . . . .	288	90	20	-93
Total. . . . .	988	930	1,000	+1
Yield:				
Hybrid . . . . .	57	58	60	+5
Nonhybrid. . . . .	20	20	20	0
Total. . . . .	46	55	59	+28
Production. . . . .	4.6	5.1	5.9	+28
Spain:				
Area. . . . .	520	640	730	+40
Yield . . . . .	35	45	52	+49
Production. . . . .	1.8	2.9	3.8	+111
Other Western Europe:				
Area. . . . .	801	910	1,000	+25
Yield . . . . .	29	36	49	+69
Production. . . . .	2.3	3.3	4.9	+113
Total:				
Area . . . . .	3,752	4,860	5,490	+46
Yield. . . . .	42.9	50.6	60.8	+42
Production . . . . .	16.1	25.1	33.4	+107

1/ Area = 1,000 hectares. Yield = quintals/hectare. Production = million metric tons.



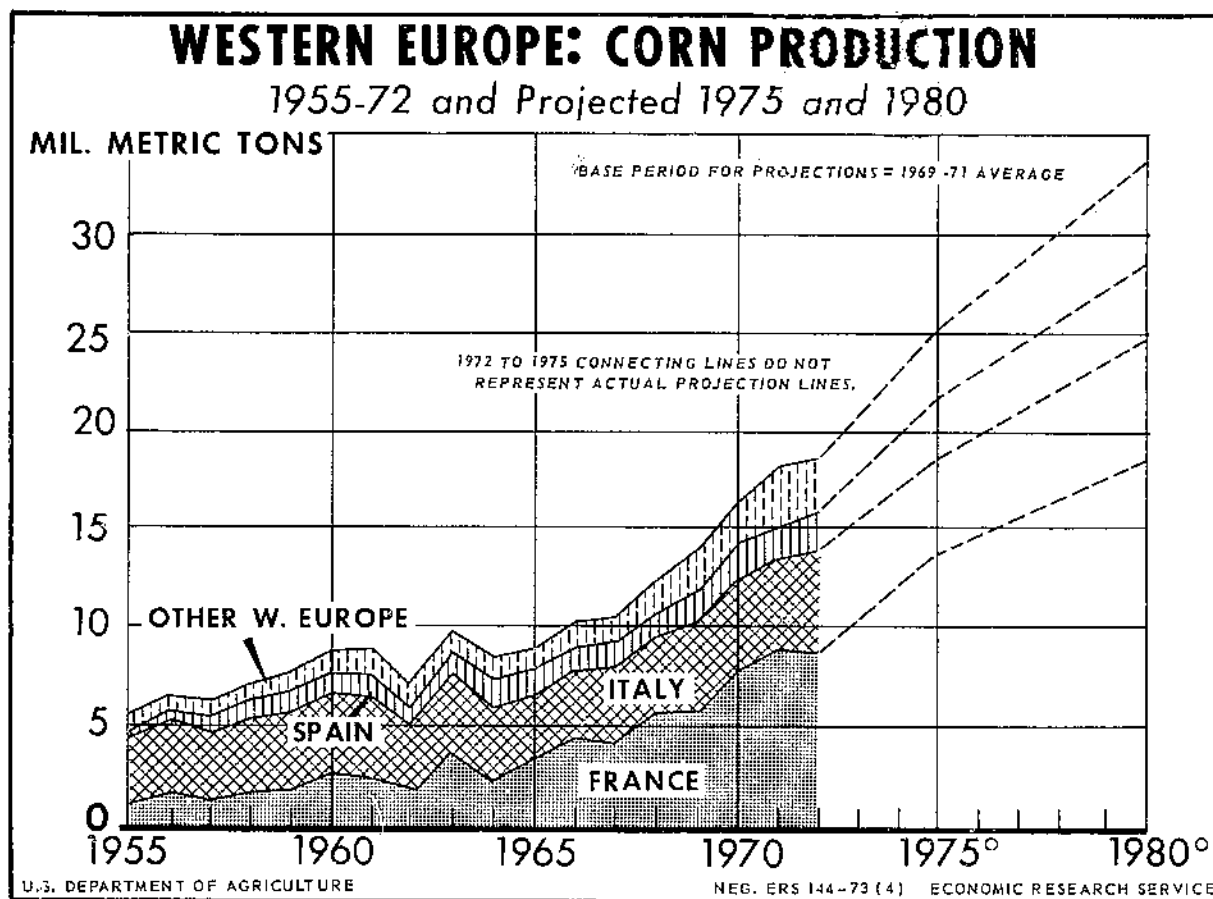


Figure 5

Implied in the consumption projection is the overwhelming dominance of animal (especially poultry and hogs) feed use in determining the demand for corn. While this dominance will no doubt continue, larger quantities of corn are also being channeled into industrial use and direct human consumption. The relative importance of corn for its different uses varies from country to country. Policy changes are more likely to affect corn for feed use than corn for other uses. Corn used for seed, estimated to be about 2 percent of West European production, is derived from the market for corn for other uses. Since parental inbred lines must be used to obtain the hybrid seed, this market is supplied by a specific segment of the corn producers. Thus, when considering the demand for corn for all uses, more factors are involved than for grains which are less diverse in use.

One underlying aspect in considering the consumption of corn is that corn is assumed to be a homogeneous product—that is, that the increased output of domestic corn will substitute in quality and characteristics for imported corn. The two main types of corn produced are dent and flint. Dent varieties are generally higher yielding, but flint varieties have a higher food value and are more resistant to adverse growing conditions. Most West European production is from dent varieties. However, flint-type corn is preferred in Italy and Spain because the xanthophyll content in this corn gives poultry a yellow cast to the skin and more yellow color to the yolk of the eggs, which consumers in these countries prefer. Coloring agents, carotene, and other ingredients can be added to dent-type corn to give these desired pigmentation qualities.

No distinction is made in this analysis between these two types of corn. Dent-type varieties, however, are expected to become much more predominant by 1980, since the premiums paid for flint-types do not offset their lower yields. Thus, treating corn as an essentially homogeneous commodity should not pose any serious problems.

#### Corn Utilization

Since the demand projections presented consumption levels for the aggregate grouping of coarse grains instead of corn alone, a two-step procedure was used to derive an estimate for corn utilization levels for France, Italy, and Spain. In the first step, each of the three countries' share of West European coarse grain consumption was determined. In the second step, the share of corn use relative to coarse grain use was calculated. Tables 36 and 37 show the results obtained by this method.

The French share of West European coarse grain consumption in 1975 and 1980 was projected to rise above the average share in the period 1960/61-1971/72. Although France's share remained remarkably constant throughout that period; it seemed reasonable to assume it would expand as its larger corn output would, in part, be channelled into the home market. Thus, a trend function was used to estimate the future share.

Italy's share rose sharply in the early sixties but then steadied around 12.5 percent. The Italian share of West European coarse grain consumption in both 1975 and 1980 was estimated to remain at the average for 1960/61-1971/72. The potential for increased livestock production (and thus increased coarse grain consumption) in Italy would appear to be somewhat less than that of the lesser developed countries of southern Europe but perhaps somewhat greater than the northern countries. Consequently, the rate of increase in coarse grain consumption is likely to be close to that of Western Europe as a whole.

Trend analysis was used to project Spain's share of coarse grain consumption in 1975 and 1980. Livestock production is expected to rise more rapidly in Spain than in the rest of Western Europe; as a result, Spain's share of coarse grain requirements is projected to rise to 11.0 percent by 1980 (up from an average of 8 percent in 1960/61-1971/72). The projected Spanish consumption of 12.2 million tons of coarse grains in 1980 is in line with official Spanish estimates of 1980 livestock consumption.

The share for the aggregate of all other West European countries <sup>25/</sup> was computed as a residual and shows, by 1980, a decline to 60.0 percent, compared with 65.0 percent for 1960/61-1971/72. Most of the countries with this group already have well-developed livestock industries and can expect only moderate gains in production. In addition, the adoption of EC grain price levels by several of these countries, particularly the United Kingdom, will tend to slow the increase in coarse grain consumption.

Trend analysis was used to compute the share of corn in the coarse grain consumption of France and the group of all other West European countries, except Italy and Spain. The share in both France and the other West European countries is expected to continue to increase, in part due to increased domestic availabilities.

It was assumed that the share of corn in Italian coarse grain consumption in the 1970's would stay near the average level of the 1960/61-1971/72 period. The dominant position of corn in the Italian feed-livestock economy is strongly entrenched. With increased domestic production and the possibility of increased corn imports from within the Community (that is, from France), there is little reason to expect this situation to change appreciably. Corn's share of coarse grain consumption in Spain rose above 50 percent in the midsixties but then declined. With increased corn output,

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<sup>25/</sup> OWE countries plus countries in Western Europe that do not produce corn.

Table 36 --Projected share of coarse grain and corn utilization in 1975 and 1980, for France, Italy, Spain, and all other West European countries and 1960/61-1971/72 average

Country	Share of West European coarse grain utilization			Data used for determination
	Average 1960/61-1971/72	Estimated 1975	Estimated 1980	
	Percent			
France . . . . .	14.5	15.5	16.5	1960/61-1971/72 trend function, log share = time
Italy . . . . .	12.5	12.5	12.5	1960/61-1971/72 average
Spain . . . . .	8.0	1/10.5	1/11.0	1960/61-1971/72 1/
All Other Western Europe 2/	65.0	61.5	60.0	difference 3/
Total . . . . .	100.0	100.0	100.0	
	Corn as percent of coarse grain use			
France . . . . .	28	43	49	1963/64-1971/72 trend function, log share = time
Italy . . . . .	80	80	80	1960/61-1971/72 average
Spain . . . . .	45	50	54	1960/61-1971/72 linear trend function, share = time
All Other Western Europe 2/	20	24	28	1960/61-1971/72 trend function, log share = time
Total . . . . .	31	37	41	weighted average

1/ Reflects the goals of the Spanish Third Economic and Development Plan, especially the section termed "Horizon 1980."

2/ OWE countries plus nonproducing countries of Western Europe.

3/ Estimated percentages also approximate linear trend for Western Europe, excluding France, Italy, and Spain, that is, the aggregate of all Other Western Europe.

USDA/FAER-88

GROWTH POTENTIAL OF CORN PRODUCTION IN WESTERN EUROPE THROUGH 1975 AND 1980. (Foreign Agricultural Economic Report). / William P. Roenigk (and others). Washington, DC: Economic Research Service. Jul. 1973.

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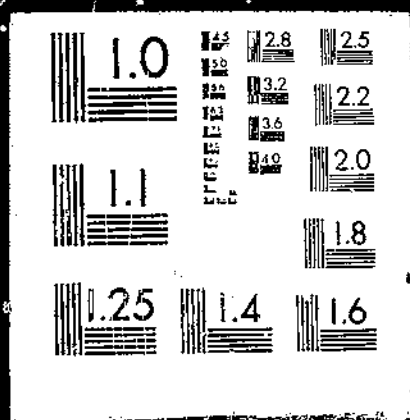


Table 37 --Estimated coarse grain and corn utilization <sup>1/</sup> for France, Italy, Spain, and all other West European countries, average 1969/70-1971/72, annual 1975/76 and 1980/81

Country	Average		1975/76		1980/81	
	1969/70-1971/72					
	Coarse grain	Corn	Coarse grain	Corn	Coarse grain	Corn
Million metric tons						
France . . . . .	12.7	4.4	15.6	6.7	18.2	9.0
Italy . . . . .	11.1	8.9	12.6	10.0	13.8	11.0
Spain . . . . .	8.9	3.8	10.5	5.2	12.2	6.5
All Other Western Europe <sup>2/</sup>	57.6	12.4	61.7	14.8	66.1	18.5
Total . . . . .	90.3	29.5	100.4	36.7	110.3	45.0

<sup>1/</sup> Estimates calculated by using Projection Set I from (73) and percentages in table 36.

<sup>2/</sup> OWE countries plus countries in Western Europe that do not produce corn.

corn's share of the coarse grain market is expected to rise. Increased domestic supplies of barley are expected to keep corn's share from rising faster than the projected trend that is presented in table 36.

These share projections for the three major corn producers, combined with those for the remaining countries, show that West European consumption of corn will rise in 1980 to about 15.5 million tons above the average 1969/70-1971/72 level, or to a total level of corn consumption of 45 million tons in 1980, or slightly above 41 percent of total coarse grain consumption. Thus, corn would account for the bulk of the increase in coarse grain consumption, which is estimated to increase by about 20 million tons from 1969/70-1971/72 to 1980/81 (table 37).

#### Implications of Expansion of Corn Production

The projected increase of 107 percent in corn output between 1969-71 and 1980 will have a significant effect on the pattern and level of trade in Western Europe. The boost in output will have repercussions at both the country and regional level.

With utilization and production of corn estimated to be 45.0 and 33.4 million tons, respectively, in 1980, a net import requirement of 11.6 million tons into Western Europe is implied (table 38). This import need compares to annual net imports of 13.3 million tons in 1969/70-1971/72 and 16.6 million tons for the recent 3-year high of 1965/66-1967/68. Thus, by 1975/76 through 1980/81, imports into Western Europe from the world will be less than the 1969/70-1971/72 average, or more than 30 percent below the recent 3-year high of 1965/66-1967/68. Assuming the United States shared proportionately in this decreased import requirement (the U.S. share of net corn imports averaged about 60 percent for 1960/61-1971/72); imports from the United States in 1975/76 and 1980/81 would be about 3 million tons below the 1965/66-1967/68 average-- that is, decreasing from 8.2 million tons to 7.0 million in 1975/76 through 1980/81 (table 38). Considering that the consumption of corn is expected to rise by more than 15.5 million tons from 1969/70-1971/72 to 1980/81, this decrease in U.S. exports to Western Europe seems all the more excessive.

Table 38 --Western Europe: Corn consumption, production, net import needs, and imports from the United States, averages 1965/66-1967/68, 1969/70-1971/72, and projections 1975/76 and 1980/81

Corn	Average		Projected	
	1965/66- 1967/68	1969/70- 1971/72	1975/76	1980/81
	Million metric tons			
Consumption <u>1/</u> . . . . .	26.3	29.5	36.7	45.0
Production . . . . .	9.9	16.1	25.1	33.4
Net import needs . . . . .	16.6	13.3	11.6	11.6
From the United States <u>2/</u> . . . . .	10.1	8.2	7.0	7.0

1/ Production plus net import needs for averages 1965/66-1967/68 and 1969/70-1971/72 may not add to consumption because of net changes in stocks.

2/ 60 percent in 1965/66-1967/68; 62 percent in 1969/70-1971/72; assumes 60 percent in both 1975/76 and 1980/81.

The projection also implies that corn will continue to become a more important part of the agricultural economy of Western Europe--accounting for more of the production resources, contributing more to farm returns, and enlarging intra-West European trade. More of Western Europe's corn needs will be met from indigenous output as production increases outpace consumption increases. Using the analysis previously presented, the self-sufficiency rates for corn would develop as follows:

Country	Average 1969/70-1971/72	Estimated 1975/76	Estimated 1980/81
	Percent self-sufficiency		
France . . . . .	166	206	209
Italy . . . . .	51	51	54
Spain . . . . .	45	56	58
OWE . . . . .	19	22	26
Total Western Europe	55	68	74

The West European self-sufficiency ratio for corn increases from an average of 55 percent in 1969/70-1971/72 to 68 percent in 1975/76 and 74 percent in 1980/81. All four areas--France, Italy, Spain, and OWE--are projected to have greater increases in production than in consumption.

Although production projections to 1980 were not calculated for the other feed grains, it would appear production of some other feed grains might also increase through 1980. However, the rate of increase for these other grains would undoubtedly be lower.

The ERS study (73) that was used as the basis for the consumption analysis in this study also projected coarse grain production to 1980. According to that study,

production of coarse grain in Western Europe will rise to 93.3 million tons by 1980 under Projection Set I. <sup>26/</sup> The level of coarse grain production compares to an actual output of 83 million tons in 1971 and 82 million tons for 1972. Comparing actual production of coarse grains in the base period 1969-71 (75.3 million tons) with 1980 would result in a projected net production increase of 18.0 million tons for coarse grains (93.3 million tons for 1980 minus 75.3 million tons for 1975). Comparing this increase of 18 million tons with the increase in corn production projected in this present analysis for the same time period--that is, that West European corn production will grow from 16.1 million tons in 1969-71 to 33.4 million tons in 1980 or an increase of 17.3 million tons--suggests that essentially all of the net coarse grain increase would be in corn production. The authors of this present report would estimate that the coarse grain production projections under Projection Set I by the previous ERS study (73) are too low. Corn would more likely account for 75 to 80 percent of the net increase in coarse grain production between 1969-71 and 1980. Barley, the major feed grain in Western Europe, would undoubtedly account for the bulk of the remaining increase in production. Sorghum production will probably also increase, but sorghum will remain a minor crop. Production of oats, mixed grains, and rye appears to be stabilizing or trending downward.

The three main corn-producing countries are also the three main consumers of corn in Western Europe. Following closely as the fourth largest consumer is the United Kingdom. Thus, three of the four most important corn markets will be in the European Community by 1980. The EC's Common Agricultural Policy will thus be a key factor in determining the situation in 1980.

There are certain key questions whose resolution will have a significant influence on the future of corn production, consumption, and trade. It is impossible to answer these questions as they depend upon the advance of technology and/or the decisions of people. The following questions appear to be the most important:

- How far and to what extent will the corn-producing boundary be pushed northward? The development of quicker maturing varieties has thus far allowed corn to be grown for grain as far north as 50° north latitude and for green chop and silage as far north as 56° to 58° north latitude.
- Will monoculture or continuous rotation of corn become more prevalent? Although continuous corn cropping is used on some farms, it appears the problems and benefits of this practice have not been fully assessed for the West European situation.
- What advances will be made in the production technology of competing grains? Will a hybrid barley be developed? Also, new varieties of corn, barley, and wheat may be developed that have higher protein content and thus could encourage the expansion of one grain at the expense of other grains.
- Finally, what will the future development of policy be in the West European countries. The analysis in this report shows, for Western Europe as a whole, divergent trends of expanding corn production and dampening demand for corn. Will grain or livestock policies be altered to modify this situation?

<sup>26/</sup> See discussion on Projection Set I in footnote 24, pp. 70-80 of the present report. for the assumptions underlying Projection Set I.



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