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SUPPLY EQUATIONS OF CEREALS FOR NORTH AFRICA, ETHIOPIA, KENYA, NIGERIA AND SOUTH AFRICA

By

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CHAPTER I

INTRODUCTION

Objectives of the Study

The need for this study stems from the problem of grain shortage in these parts of the world. The regions included in this study are: North Africa (Morocco, Algeria, Tunisia, Libya, United Arab Republic and Sudan), Ethiopia, Kenya, Nigeria and the Republic of South Africa. The North Africa region was chosen to conform with previous analysis which was done on the demand side in a project of the Department of Agricultural Economics of Michigan State University. Other countries were also included in order to make the analysis comparable to the demand study. The methodology was basically determined by the data available. Therefore, an analysis on existing time series data was undertaken.

It is not the purpose here to examine specific policies, but rather to study the general principles and factors considered of primary importance in the supply of cereals. More specifically, the purposes of this study are:

1. To examine some important economic variables that affect the supply of cereals for these regions.
2. To generate projections of cereals production based upon supply equations derived in the analysis.

At this stage, however, the results of the analysis are not complete and may not provide sufficient background to establish policies, since the analysis is restricted to the supply and the data is crude.

Furthermore, the fact that our projections (especially for North Africa and Nigeria) involve data collected during the Middle East and Civil wars respectively, suggests that these projections may be unduly affected by unusual events in the period of analysis.

CHAPTER II

A REVIEW OF CEREAL PRODUCTION

We have intended to give a review of cereal production for each region included in this study; but unfortunately, the lack of reports on cereal production in these regions did not allow us to cover systematically all regions, and has thus restricted ourselves to review that production in those regions for which the reports were available. The following descriptions are designed to provide a background for understanding the time series analysis and some of its deficiencies.

A. Nigeria

Nigeria's four major climatic and vegetational regions entail a fairly high degree of specialization in agricultural production. The northern area, formed by the North Central and the North Eastern states and parts of the North Western and Kano states, is characterized by low rainfall, a short wet season, and low relative humidity. Most of the country's millet, sorghum, cowpeas, groundnuts and cotton is grown in this region, with the latter two products being the region's most important cash crops.

The Nigerian system of agriculture is based on numerous small farms. The 1970-71 rural survey indicates that

in that year about 55 percent of all producing farms were smaller than 2.5 acres.[1]

Despite the importance of export crops, Nigerian agriculture is primarily oriented toward the domestic market. Food imports consist essentially of wheat, sugar, and milk and account for only a small proportion of domestic consumption, although they have been rising rapidly in recent years. The government is aware that many imported food items could be successfully grown locally and started programs to encourage their production.

Crop Production Policies

This is a broad outline of policy which the Federal and state governments will follow from now on in their agricultural development programs which in particular will change the present emphasis on production of export crops.

The earlier seventies' shortage on food supplies and the accompanying high prices of foodstuffs arising purely from the after-effects of the civil war have been aggravated by crop failure and decimation of livestock caused by severe drought which the country experienced between 1970 and 1973. Feed grains which have equally become scarce and expensive are insufficient to meet the demand of the rapidly expanding livestock industry. These factors, together with the fall

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[1] I.M.F.: Surveys of African economies, Vol. 6, pp. 288-290.

in the traditional importation of live animals from neighboring Niger, Chad and the Cameroons, have aggravated protein shortage in the country.

The situation, therefore, calls for a National Food and Nutrition Policy in which the primary role of agriculture would be to provide sufficient nutritious food for the country. In order to fulfill this task, it is necessary to establish policies and programs for expanding the production of food crops. The production programs should be based on an estimation of the present food consumption levels and projections of future demand. While such estimates cannot be made with a high degree of accuracy at the present time, they do provide targets for nutritional agricultural development planning.

The national food balance sheet shows that the average daily calorie intake at present is only about 2,000 calories, while the average for high-quality protein from animal sources stands at about 8 gr. per day.

The food crops considered here were divided into five groups. In the first group were the cereals, comprising maize, millet, sorghum, rice, wheat and acha or findi. The production targets of these cereals were expected to increase at annual compound rates of 8%; 8%; 8%; 11.5%; 11.5%, and 8% respectively. The targets shown in Table 1 have taken into account the need to modernize the livestock industry through the provision of least-cost rations. It was possible to

Table 1. Nigeria: Production Targets for Cereals ('000 tons)

Year	Maize	Millet	Sorghum	Rice	Wheat	Acha	Total
1973	3,215	4,236	5,137	471	17	108	13,184
1974	3,472	4,512	5,547	526	20	116	14,193
1975	3,750	4,808	5,991	588	23	126	15,286
1976	4,051	5,119	6,470	656	26	137	16,459
1977	4,376	5,454	6,987	732	29	147	17,725
1978	4,728	5,809	7,548	818	34	160	19,097
1979	5,106	6,188	8,151	753	38	173	20,409
1980	5,518	6,590	8,805	1,015	42	188	22,158
1981	5,960	7,020	9,508	1,134	46	201	23,869
1982	6,437	7,476	10,115	1,262	50	217	25,557
1983	6,955	7,692	11,091	1,408	57	238	27,441
1984	7,511	8,482	11,978	1,569	64	260	29,864
1985	8,115	9,032	12,935	1,748	71	283	32,184

Source: Nigerian Agricultural Development 1973-1985 p. 475.

overshoot these targets because the national aggregates on which they were based did not give figures for certain states whose outputs were less than 1,000 tons or where the production data were not available.

The other four groups were: starchy food (yams, cassava, Irish potatoes, sweet potatoes, cocoyams, and plantains); grains legumes (ground-nuts, cow peas, and soya-beans); oil seeds and nuts (melonseed), and finally, vegetables, fruits, copra, etc.

B. Kenya

1. Structural Development in Agriculture

The agricultural sector comprises two distinct subsectors, large farms and small farms, corresponding to the previously known scheduled area (European) and nonscheduled area (African). In 1960 the Kenyan government introduced the One Million Acre Settlement Scheme for purchasing about 1.2 million acres of largely mixed farming land from the formerly scheduled area and for redistributing the land to Africans. This program distinguished between a high-density scheme, covering about a million acres, and a low-density scheme covering the other 0.2 million acres. The former scheme was designed to relieve population pressure in overcrowded African areas by settling unemployed and landless individuals and their families on plots, averaging 28 acres each, where they could earn a minimum net cash income of K sh 500 a year per plot. The low-density scheme was designed, on

the other hand, to accommodate better qualified African farmers with some capital of their own and with demonstrated agricultural ability. For this scheme, the planned average plot was 35 acres, and the minimum net cash income target was K sh 2,000 a year.

2. Agricultural Production

Unlike many developing countries in Africa which cultivate only one or two major cash crops, Kenya produces a variety of cash crops, making its economy less vulnerable to changes in world prices. The main crops are coffee, maize, tea, sisal, wheat, pyrethrum, and cotton. Except for maize and some wheat raised for food, crops are mainly produced for export. Livestock and dairy production also are important agricultural enterprises for both domestic consumption and export.

Main Food Crops

Kenya's principal food crop is maize. About 1 million of the 1.2 million tons normally produced are consumed by the subsistence sector. Most of the rest is delivered to the Maize and Produce Marketing Board for sale in towns and maize-deficit areas. The principal function of the Board is to ensure sufficient supplies of maize for domestic consumption. The methods it has used to achieve this end consist primarily of setting the produce price at a level higher than the export price, storing the surplus production

for lean years and importing from overseas when domestic supplies are in deficit. When surplus production has exceeded the Board's storage facilities, the Board has been compelled to export part of its surplus at a loss.

A little less than half of the Board's domestic maize purchases have traditionally come from small farms; the rest come from large estates.

Wheat is grown chiefly on large estates, which are shifting production from maize to wheat. Consequently, wheat production has increased rapidly in recent years. However, a sudden upswing in local demand, due to both the shortage of maize and a change in taste, necessitated some import from overseas.

Rice production has also been increasing rapidly. However, Kenya still has to import several thousand tons annually, mainly from Tanzania, to fill domestic requirements. Asian community is the largest consumer of rice and many Africans in rice-producing areas are gradually shifting to rice as their staple food.

3. Recent Development

a. Maize

In 1972 maize growers responded to the first favorable weather in several years by planting and harvesting a record crop. By the end of the year, Kenya was once again in the position of being able to export maize to less fortunate

neighbors and to fulfill the objectives of the 1970-1974 Development Plan of becoming a maize exporter.

The Ministry of Agriculture considered the record maize production of 1972 an important step toward the goal of producing surplus maize for export. High maize production is of the greatest importance for the Kenya economy, and the government will continue in the future to promote even greater production. Government will assist in several ways.

(1) Prices will remain high enough to give farmers a reasonable income and to encourage sales to the Maize and Produce Board. Despite the usefulness of price changes in calling forth needed levels of production, large price fluctuations will be avoided in the interest of orderly growth.

(2) Agricultural extension services will continue to provide the necessary technical advice, with increased emphasis in 1973 given to small farmers.

(3) Loan facilities for mechanization on large farms will continue to be available.

(4) The use of agricultural inputs such as fertilizer will continue to be assisted through appropriate pricing and marketing policies.

There were no maize imports during 1973 while in 1972 imports amounted to 155,600 bags (90 kilos/bag). Maize exports during 1973 were over 11 times the exports for 1972.

b. Wheat

Kenya wheat policy under the 1970-1974 Development Plan is to produce sufficient wheat for the internal needs for Kenya and Uganda, with any surpluses to be exported in the form of wheat flour. However, in recent years, production has dropped below the Kenya and Uganda requirements, necessitating imports from overseas. Several factors seem to have contributed to the decline in production:

(1) Price policy measures, coupled with an increase in the producer price of maize.

(2) A decision to not grant short term credit to wheat growers in marginal areas.

(3) A decline in area planted in the traditional growing areas resulting from changes in farm ownership.

Government has already taken measures to alleviate the situation,beginning with a price increase to wheat growers.

Other developments which should benefit growers include extensive road construction and the creation of two bulk wheat stores in Masailand.

c. Barley

Most of the barley grown in Kenya is purchased by Kenya Breweries Ltd. The Breweries purchase all of their malting barley from contract growers.

The price paid to farmers for the 1972 malting barley crop was quite high, with grade 1 bringing Shs. 56/-per 80

kilogram bag. Prices paid for grades 2, 3, and 4 were Shs. 54/-, 45/-, and 30/- respectively,

In 1972 the Breweries completed the expansion of the malting facilities which would require approximately 250,000 bags of barley in 1973. Barley area was also increased between 1972 and 1973 to approximately 20,000 hectares. This is approximately twice the area planted to barley in 1970.

d. Rice

Over 90 percent of all the paddy presently produced in Kenya is grown on three irrigation schemes; Mwea, Ahero, and Bunyala. All of the schemes are under the management of the National Irrigation Board. Production on the schemes since 1966/67 has increased by 140 percent, with production in the 1971/72 crop year totalling 31,749 metric tons. This was an increase of 3,644 tons over the previous year. The principal reasons for the increase were a 350 hectare extension at Mwea Scheme and double cropping at Bunyala.

At Mwea Scheme the average yield per hectare increased by approximately 5 percent compared with the previous season. Sindano is the main variety grown at Mwea.

At Ahero and Bunyala the Sindano variety has been replaced with Basmati which is superior quality but yields lower. The switch-over was necessitated by severe attacks of blast and yellow rice mottle virus in the Sindano variety which resulted in an average yield of less than 1.4 metric

tons per hectare at Ahero during the 1970/71 season. Basmati was introduced in the second half of the 1971/72 season at Bunyala.

The Maize and Produce Board serves as marketing agents, purchasing both from the National Irrigation Board (which operates Mwea, Bunyala and Ahero schemes) and from farmers outside the N. I. B. schemes.

For the 1971/72 season a farm gate price of 48.5 cents per kilogram paddy was paid for Sundano and 65 cents per kilogram for Basmatic. The disparity in price was due to the quality difference between the two varieties.

C. North Africa

1. Algeria

The Algerian agriculture is made up of two sectors; an automanaged sector or socialist and a traditional sector or private.

The socialist sector encompasses the Orania with 1,124,274 ha or 48.91 percent of the total area under cultivation. In eastern region, the socialist sector holds 22.80 percent of cereal area. In the "Algerois," the 121,750 ha automanaged represent only 5.29 percent of the regional agricultural sector.

Extracted from "Renseignements Statistiques Agricoles du Ministère de l'Agriculture et de la Reforme Agraire [1964, Series B], that is, from statistic reports of the Ministry of Agriculture and Land Reform [1964, Series B]" Table 2 allows

Table 2: Land Distribution & Type of Enterprises

	Private Sector Area in ha	%	Socialist Sector Area in ha	%	Total area in ha
Total area	40,147,090	100	2,302,970	100	42,450,060
Arable land in cereal crops	4,648,040	11.6	1,484,380	64.5	6,132,420
Vineyards and orchards	217,540	0.5	403,210	17.5	620,750
Pasture land	34,067,490	84.9	343,710	14.9	34,411,200
Land not used in any of the above categories	1,214,020	3.0	71,670	3.1	1,285,690

Source: la céréaliculture en Algérie, p. 17.

to locate the repartition of areas and respective dimensions of private and socialist sectors in each of stated regions. Table 3 summarizes cereal production in Algeria (in quintal) for the period 1963-1967.

2. Tunisia

For many centuries, grains have been the basis of agriculture in Tunisia. On the average, they account for about one-third of the income from agriculture, or one-tenth of gross domestic product. The principal grain crops grown in the country are wheat and barley, with hard wheat holding the first place because of its resistance to drought. It is mainly cultivated by Tunisians but European farmers also grow it. Soft wheat, on the other hand, is grown mainly by Europeans. In general, the amount of land planted to cereals varies from year to year with variations in climatic conditions. The only grain farmers with a reasonably regular production pattern from year to year are those on the northern and Upper Tell plains.

Cereals in Tunisia are usually grown on two-year rotations, with a fallow period when the land is used for pasture whenever necessary, for traditional livestock breeding is largely separated from crop production.

Barley constitutes the second major crop in Tunisia and is widely grown throughout the country. Being more drought resistant than wheat, barley can be grown in many parts of the country but it is mainly grown in the central

Table 3. Algeria: Cereal production (1963-1967)

	1963	1964	1965	1966	1967
Wheat	15,896,642	11,624,560	13,226,000	7,216,640	12,655,060
Barley	6,910,835	2,780,210	3,776,800	1,358,280	3,396,190
Oats	309,114	355,210	205,700	88,680	264,410
Sorghum	182,870	--	41,800	--	13,610
Corn	406,891	584,000	12,732	--	42,150
Rice	66,900	50,140	41,930	--	44,580
TOTAL	23,773,252	15,394,120	17,304,962	8,663,600	16,416,000

Source: Agricultural Statistic Reports (1964-1965, Series B)

and southern regions of the country. In areas of scant precipitation, barley will outyield all other cereals. It forms the principal food grain, though wheat is usually preferred when it can be afforded.

Grain cultivation, moreover, is characterized by great differences in yield per acre. These differences are due to: (a) differences in the fertility of land in different regions of the country, and (b) differences in the methods of production applied in the modern (mainly European) and traditional sectors.

3. United Arab Republic

The agricultural year in the Egyptian Region is divided into three seasons. In the winter season, which extends from mid October to later December, the main crops that may be sown are wheat, clover, barley, beans, flax, onions and lentils. The summer season lasts from mid January to mid June, and during it, cotton, rice, sugar cane, sesame and millet are sown. By the beginning of July starts the "Nili" season (the term refers to the flood season of the Nile), which lasts to mid August and through it; rice and maize are the chief crops sown. Crop cultivation mostly follows a two or three-year rotation. In the first a given crop is grown on the same plot every other year, while in the latter, two years elapse before it is again cultivated in the same plot.

Wheat is the principal winter crop and accounts normally for 15 percent of the crop area and makes up 9 percent of the value of the agricultural output. Rice is the second largest agricultural export item.

Maize generally accounts for an area similar to that of cotton, but makes up only 9 percent of the agricultural output value. It is the principal staple food crop in the rural areas and is largely produced for home consumption. Sorghum normally occupies 4 percent of the crop area and accounts for 3 percent of the output value.

CHAPTER III

SUPPLY ANALYSIS

This chapter will be devoted to statistical and economic models for measuring supply relationships for each region. We will, later on, deal with measurement of supply projections under certain assumptions.

We considered it necessary to explain the justification of the variables or relevant factors to the models; the source, quality and nature of the data and the period covered.

The Data

Secondary data will be used in this analysis from various sources, e.g., Food and Agriculture Organization of the United Nations; U.S. Department of Agriculture; IMF (International Financial Statistics), etc. Area, yield, and production data were obtained from a recent compilation of U.S. Department of Agriculture[2]. These data included the major food and feed grains. Rice was included on a "paddy weight" basis.

The prices (Implicit Import Prices) were computed by dividing annual values of imports for each region by the corresponding quantity of imports.

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[2]U.S. Department of Agriculture. Twenty-six years of world cereal statistics. Area, yield, production, 1950-1975, by country and region. July 1976.

We have expressed these prices in common currency, the United States dollar, because it is the most widely used international currency. However, with the occurrence of any devaluation or appreciation of a country's currency, it is best to use a base exchange rate for conversion purposes rather than yearly rates[3]. These authors found that when a deflator is used, the selected indices must have the same base year as that chosen for base exchange rate.

There would be no objection to converting each country's annual price to United States dollars according to the then exchange rate if the so-called "purchasing power parity theory" were in reality perfectly valid. This theory states that the exchange rates move directly with real purchasing power in trading nations of the world.

To delete the influence of devaluation or appreciation of each country's currency on supply functions, we computed the "Real Implicit Import Prices" by dividing, for each country, the annual implicit import prices by their corresponding annual consumer price indexes (cost of living indexes). This procedure had allowed us to avoid the complication of determining the aggregate exchange rates for the north

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[3]Harold F. Bjarnason (Canadian Wheat Board), Michael J. McGarry (I.B.R.D.), Andrew Schmitz (University of California, Berkeley): Converting price series of internationally traded commodities to a common currency prior to estimating national supply and demand equations. American Journal of Agriculture Economics. Vol. 51, No. 1, Feb. 1969, pp. 189-191.

Africa region. For this region, the real implicit import prices were computed by dividing the aggregate implicit import prices by their corresponding aggregate consumer price indexes which, in turn, were determined by simply averaging the consumer price indexes of countries included. The consumer price indexes have been spliced together from various sources.

Method or Technique

The technique used was a formal econometric analysis of historical data presented in Tables 4, 5, 6, 7, and 8. The statistical estimations were obtained by using ordinary least squares.

A number of different formulations were tried; that is, we investigated the following relationships:

(1) $X_1 = f(X_2, X_5)$

(2) $X_3 = f(X_4, X_5)$

(3) $X_6 = f(X_7)$

(4) $X_1 = f(X_2, X_9)$

and

(5) $X_1 = f(X_2, X_5, X_8)$

where X_1 = cereal area in the year t

X_2 = cereal area in the year t-1

X_3 = cereal production in the year t

X_4 = cereal production in the year t-1

X_5 = the ratio between price of cereals in the year t-1 and CPI (Consumer Price Index in the year t-1)

Table 4: North Africa: Area, production, yield, imports and prices for the period 1959-1973

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Area (1,000 ha) (a)	13,682	13,560	11,888	11,861	13,404	12,843	12,577	11,604	13,360	13,509	13,761	14,285	13,925	14,263	13,932
Production (1000 metric tons) (b)	12,161	13,247	9,559	14,517	15,445	13,440	13,612	11,075	14,347	18,350	16,018	16,583	18,188	18,328	15,407
Yield (metric ton/acre) (c)	1.125	.9767	.803	1.224	1.152	1.046	1.082	.954	1.074	1.358	1.164	1.16	1.306	1.285	1.10587
Import quantities (100 metric tons) (d)	23,158	25,561	32,060	28,962	32,143	29,697	34,131	45,603	54,827	45,209	29,178	32,279	48,591	40,996	47,684
Import values (10,000 U.S. dollars) (e)	15,715	16,153	20,458	18,464	21,421	21,634	23,241	31,425	38,277	29,224	19,344	20,922	33,886	29,606	49,661
Implicit import prices (dollar/ metric ton)	67.78	63.19	63.81	63.75	66.64	72.85	68.09	68.91	69.81	64.64	66.29	64.81	69.74	72.21	104.14
Consumer price index (1970 = 100) (f)	71.11	72.11	74.19	74.72	78.07	80.90	85.17	88.66	91.57	91.60	97.24	100.00	103.76	107.9	115.54
Real prices (based on 1970 U.S. dollar)	.95	.87	.86	.85	.85	.90	.80	.78	.76	.71	.68	.65	.67	.67	.90
Exchange rate (g)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: (a), (b), and (c): U.S. Department of Agriculture
Economic Research Service
Foreign Demand and Competition Division
Statistics Program Area
(26 years of World Cereal Statistics), July 1976

(d), (e): F.A.O. Tradebooks: 1960-1973

(f),(g) IMF (International financial statistics, January 1967 Jan.-April 1971
April 1967 Jan.-April 1972
Sept.-Dec. 1969 Nov.-Dec. 1975

Table 5: Kenya: Area, production, yield, imports and prices for the period 1959-1973

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Area (1,000 ha) (a)	1,476	1,534	1,530	1,618	1,604	1,615	1,613	1,691	1,660	1,713	1,761	1,763	1,757	1,727	1,727
Production (1,000 metric tons) (b)	1,554	1,695	1,815	1,828	1,870	1,762	1,771	1,987	2,207	2,202	2,010	2,127	1,916	2,276	2,147
Yield (metric ton/acre) (c)	1.053	1.105	1.186	1.130	1.166	1.091	1.098	1.175	1.330	1.285	1.141	1.206	1.090	1.318	1.243
Import quantities (100 metric tons) (d)	259	62	1211	856	135	10	1039	1725	145	112	66	265	628	718	510
Import values (10,000 U.S. dollars) (e)	284	82	828	682	167	18	849	1278	129	161	70	262	675	530	443
Implicit import prices (dollar/ metric ton)	109.65	132.25	68.37	79.67	123.70	180	81.71	74.08	88.96	143.75	106.06	98.86	107.48	73.81	86.86
Consumer price index (1970 = 100 (f)	81.7*	82.5	84.1	86.5	88.4	88.3	91.4	95.9	98.2	98.1	97.9	100.0	103.8	109.8	120.0
Real prices (based on 1970 U.S. dollar)	1.34	1.60	.81	.92	1.40	2.03	.89	.77	.90	1.46	1.08	.99	1.03	.67	.72
Exchange rate (g) (Kenya shillings per u.s. dollar	7.143	7.143	7.143	7.143	7.143	7.143	7.143	7.143	7.143	7.143	7.143	7.143	7.143	7.143	6.900

*Estimation

Source: (a), (b), and (c): U.S. Department of Agriculture
Economic Research Service
Foreign Demand and Competition Division
Statistics Program Area
(26 years of World Cereal Statistics), July 1976

(d), (e), F.A.O. Tradebooks: 1960-1973

(f), (g) IMF (International Financial Statistics, January 1967 Jan.-April 1971
April 1967 Jan.- April 1972
Sept.-Dec. 1969 Nov.-Dec. 1975

Table 6: Ethiopia: Area, production, yield, imports and prices for the period 1959-1973

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Area (1,000 ha) (a)	6,370	6,521	6,594	6,686	6,805	6,880	6,944	7,062	7,177	7,265	7,354	7,453	7,551	6,710	6,164
Production (1000 metric tons) (b)	4,717	4,722	4,802	4,825	4,969	5,030	5,207	5,321	5,487	5,923	6,053	5,893	6,051	4,913	4,921
Yield (metric ton/acre) (c)	.741	.724	.728	.722	.730	.731	.750	.753	.765	.815	.823	.791	.801	.732	.798
Import quantities (100 metric tons) (d)	-	-	-	74	82	107	275	614	318	242	300	770	477	83	
Import values (10,000 U.S. dollars (e)	-	-	-	46	53	92	176	418	231	159	210	593	407	98	
Implicit import prices (dollar/ metric ton)	-	-	-	62.16	64.63	85.98	64	68.07	72.64	65.70	70	77.01	85.32	118.07	
Consumer price index (1970 = 100) (f)					69.9			88.7	89.4	89.5	90.8	100.0	100.5	94.4	102.8
Real prices (based on 1970 U.S. dollar)				.97*	.92	1.12*	.77*	.76	.81	.73	.77	.77	.84	1.25	
Exchange rate (g) Ethopian $'s per U.S.$	2.484	2.484	2.484	2.484	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.500	2.320	2.320	

*Estimation

Source: (a), (b), and (c): U.S. Department of Agriculture
Economic Research Service
Foreign Demand and Competition Division
Statistics Program Area
(26 years of World Cereal Statistics), July 1976

(d), (e): F.A.O. Tradebooks: 1960-1973

(f), (g): IMF (International financial statistics, January 1967 Jan.-April 1971
April 1967 Jan.-April 1972
Sept. -Dec. 1969 Nov.-Dec. 1975

Table 7: Nigeria: Area, production, yield, imports and prices for the period 1959-1973

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Area (1,000 ha) (a)	9,075	10,060	10,478	10,443	10,872	11,112	12,021	10,386	10,666	10,668	11,718	11,629	11,865	12,012	11,640
Production (1,000 metric tons) (b)	6,869	7,814	7,911	8,309	8,155	8,218	8,359	6,333	7,370	6,342	9,190	3,101	7,332	8,257	6,907
Yield (metric ton/acre) (c)	.757	.777	.755	.796	.750	.740	.695	.610	.691	.594	.784	.783	.618	.687	.593
Import quantities (100 metric tons) (d)	736	880	872	1,099	545	402	583	1,840	1,258	1,080	1,967	3,179	4,493	3.555	4,418
Import values (10,000 U.S. dollars) (e)	790	926	929	1,296	1,033	706	1,024	1,694	1,349	1,020	1,900	2,651	3,710	4,404	5,505
Implicit import prices (dollar/ metric ton)	107.3	105.2	106.54	117.92	189.54	175.62	175.64	92.06	107.23	94.44	96.59	83.39	82.57	123.88	124.60
Consumer price index (1970 = 100) (f)	60.4*	63.8	67.3	70.2	71.1	71.9	74.8	81.9	78.9	79.9	87.8	100.0	116.1	119.3	126.5
Real prices (based on 1970 U.S. dollar)	1.78	1.65	1.58	1.68	2.66	2.44	2.35	1.12	1.36	1.18	1.10	.83	.71	1.04	.98
Exchange rate (g) (U.S. dollars per Nigeria Pound	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	2.80	3.04	3.04	3.04

*Estimations

Sources: (a), (b), and (c): U.S. Department of Agriculture
Economic Research Service
Foreign Demand and Competition Division
Statistics Program Area
(26 years of World Cereal Statistics), July 1976

(d), (e), F.A.O. Tradebooks: 1960-1973

(f), (g) IMF (International Financial Statistics, January 1967, April 1967, Sept.-Dec. 1969, Jan.- April 1971, Jan.-April 1972, Nov.-Dec. 1975

Table 8: South Africa: Area, production, yield, imports and prices for the period 1959-1973

	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
Area (1,000 ha) (a)	5,676	6,573	6,687	6,768	7,254	6,817	6,885	6,570	7,356	7,393	7,274	7,262	7,572	7,689	6,634
Production (1,000 metric tons) (b)	5,140	5,446	6,644	7,037	7,403	5,778	5,791	6,113	11,799	6,923	6,971	8,065	10,957	11,884	6,433
Yield (metric ton/acre) (c)	.906	.829	.994	1.040	1.021	.848	.841	.930	1.602	.936	.958	1.111	1.447	1.546	-970
Import quantities (100 metric tons) (d)	4,118	2,412	1,665	1,145	3,780	2,510	732	9,960	6,162	827	4,000	4,212	1,796	1,095	1,051
Import values (10,000 U.S. dollars) (e)	2,784	1,791	1,355	1,173	3.074	2,236	1,115	6,962	5,009	1,597	3,128	3,289	2,235	1,658	1,951
Implicit import prices (dollar/ metric ton)	67.60	74.25	81.38	102.44	81.32	89.08	152.32	69.89	81.28	193.10	78.2	78.08	124.44	151.41	185.63
Consumer price index (1970 = 100) (f)	75.4*	76.8	78.4	79.1	80.6	81.8	85.1	88.2	91.1	93.0	96.0	100.0	105.6	112.5	123.2
Real prices (based on 1970 U.S. dollar)	.89	.96	1.03	1.29	1.00	1.08	1.79	.79	.89	2.07	.81	.78	1.17	1.34	1.50
Exchange rate (g) U.S. dollars per Rand	2.790*	2.791	1.398	1.395	1.392	1.392	1.389	1.396	1.389	1.386	1.394	1.390	1.3068	1.2774	1.4900

*Estimation

Source: (a), (b), and (c): U.S. Department of Agriculture
Economic Research Service
Foreign Demand and Competition Division
Statistics Program Area
(26 years of World Cereal Statistics), July 1976

(d), (e): F.A.O. Tradebooks: 1960-1973

(f), (g) IMF (International financial statistics, January 1967 Jan.-April 1971
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X_6 = cereal yield in the year t

X_7 = time variable

X_8 = cereal yield in the year t-1

X_9 = the product of X_5 and X_8

However, the results from (4) and (5) were not more significant (statistically) than those selected for presentation in this study.

Furthermore, the selection of the variables was largely a matter of necessity, i.e. other data were not available.

A. Supply Analysis

In this study we tried to express, first, the current cereal area (X_1) as a function of the area and the real price in the previous period, (X_2) and (X_5) respectively. In other words, dependent variable was lagged one time period as an independent variable[4]; or that the dependent variable "lags behind" independent variable by one period[5]. Specifically, we used geometric lag structure which is used to estimate the distributed lag hypothesized between a change in price and a change in area or production. This was done for each region using linear regression.

Secondly, we investigated the relationship of the current cereal production (X_3) as a function of the production

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[4]William G. Tomek and Kenneth L. Robinson, Agricultural Product Price, Cornell University Press, Ithaca and London, 1972, p. 326.

[5]Harry H. Kelejian, (University of Maryland, College Park) and Oates, Wallace E. (Princeton University): Introduction to Econometrics, Harper and Row, Publishers, 1974, p. 111

and the real price in the previous period (X_4) and (X_5) respectively. This was also done for each region.

Finally, we investigated the relationship between the yield in the current period (X_6) as a function of time (X_7). Again this was done for each region.

Again, as it was stated earlier, we made the assumption that the price of imported cereals in a given country is representative of prevailing cereal prices in that country. This is only possible if price is determined by market forces, i.e. by supply and demand, and if a competitive market prevails. This precludes, by the same time, the existence of price setting system for domestically produced cereals; the system which is the government agricultural policy in most developing countries.

By using this approach in such countries, we generally overestimate the domestically produced cereal prices.

This similarity between the prices of imported and domestically produced cereals can also be challenged by the fact that these cereals are not in the market at the same moment: the imported cereals coming into the market during the period of shortage in domestically produced cereals.

B. Result and Discussion

It is worth noting that the study was conducted in order to investigate the relationships among variables rather than selecting the more meaningful equations that is, a selection based on the correctness of the relationship

between dependent and independent variables, and on the significance of these relationships. However, until sufficient data are available and further investigations have been undertaken, we have to be content with something less than satisfactory statistical results.

The above equations assume that supply is affected by previous year's price and production. This seems to be a valid assumption for the commodities under study.

The above models are estimated on the basis of yearly data for the period 1959-1973. Prices are deflated with 1970 as a base year. Ordinary least squares method is applied to estimate the supply model.

Tables 9, 10, and 11 present the results of estimation for each equation. The numbers in parenthesis under the estimated coefficients are estimates of standard errors and the corresponding absolute values of the 't' ratios. The strength or significance of each of the coefficients will be obtained by readily comparing with its standard error.

The immediate observation one can make from the tabulated results is that only Kenya and probably South Africa and Nigeria show consistent, that is, positive, relationships between dependent and independent variables (Table 9). Specifically, this means that the current areas (X_1) are positively related to both previous areas (X_2) and real prices (X_5); that is, an upward or downward trend in the previous areas and prices will cause an upward or downward trend in the current area respectively.

North Africa and Ethiopia, on the other hand, show a negative relationship between the current area (X_1) and the previous year's price (X_5). In other words, for these two regions, an upward or downward trend in the previous year's prices will cause a downward or an upward trend in the current area respectively, contrary to a priori expectations. However, the current year's area (X_1) is positively related to the previous year's area (X_2) and the coefficients on lagged price are not significant.

From Table 9, we see that only the supply function for Kenya has a high degree of explanatory power (R^2=0.834).

From Table 10, one can observe that only South Africa exhibits a positive relationship between production (X_3) and the independent variables of lagged production (X_4) and price (X_5). For South Africa, the current production (X_3) is positively related to both the previous year's production (X_4), and the previous year's price (X_5).

North Africa, Kenya and Ethiopia show a negative relationship between the current cereal production (X_3) and the previous year's price (X_5), which is not expected; while Nigeria, on the other hand, shows a negative relationship between the current cereal production (X_3) and the previous year's cereal production (X_4). This negative relationship between X_3 and X_4 is probably due to the decrease in production during the last three years of this time series data.

None of the equations from Table 10 show a high degree of explanatory power, i.e. "R^2" values very small. The coefficients on lagged price are not significant for all regions.

Referring to Table 10, we can comment that results using production as dependent might differ from those using area as dependent because of the fact that yield/ha depends more on weather than on prices in the short run. Over the longer run, of course, yields as well as area could be influenced by past prices.

From Table 11 we observe that all regions, except Nigeria, exhibit a positive relationship between the current yield (X_6) and the variable time (X_7); although for all regions the coefficients of the variable time are very small (but significant for North Africa and Nigeria). The results suggest that there has been a slight change in yield through time.

For Kenya, the fact that the previous year's price (X_5) affects cereal area (X_1) positively and current cereal production (X_3) negatively suggests a logical contradiction in our result. The random effect of weather may be the reason for this difference. However, "t" values in X_5 in both equations is not significant at the 95 percent level of confidence.

The case of Ethiopia should not be emphasized because of lack of data for the estimation of these supply equations. The price series was incomplete and three of the twelve

years in the analysis had to be interpolated. The regression equations show the previous year's price (X_5) negatively related to both the current area (X_1) and the current cereal production (X_3).

From Table 11, we see also that only the supply equation for North Africa has a fairly high degree of explanatory power with $R^2 = 0.627$.

Table 9: Estimated regression coefficients for the equation $X_1 = A_o + A_1X_2 + A_2X_5$

Regions	Dependent variable	Regression coefficients for independent variables (standard errors and "t" values in parenthesis) Constant	X_2	X_5	R^2
North Africa	X_1	8272.474	0.418	-0.871	0.310
	standard errors	(3858.559)	(0.272)	(0.914)	
	"t" values	(2.143)	(1.537)	(0.953)	
Kenya	X_1	337.857	0.797	0.025	0.834
	standard errors	(179.266)	(0.107)	(0.028)	
	"t" values	(1.884)	(7.433)	(0.874)	
Ethiopia	X_1	3860.043	0.466	-0.082	0.223
	standard errors	(2343.934)	(0.329)	(0.410)	
	"t" values	(1.646)	(1.415)	(0.200)	
Nigeria	X_1	5294.549	0.526	0.133	0.412
	standard errors	(2263.716)	(0.196)	(0.615)	
	"t" values	(2.338)	(2.681)	(0.217)	
South Africa	X_1	4347.487	0.375	0.169	0.229
	standard errors	(1507.427)	(0.207)	(0.288)	
	"t" values	(2.884)	(1.809)	(0.585)	

Number of observations = 15

Method of estimation = Ordinary least squares

$t = \frac{b}{S_b}$, value (absolute) over 2 can be considered highly significant.

Table 10: Estimated regression coefficients for the equation $X_3 = b_0 + b_1 X_4 + b_2 X_5$

Regions	Dependent Variable	Regression coefficients for independent variables (standard errors and "t" values in parenthesis)			
		Constant	X_4	X_5	R^2
North Africa	X_3	10346.032	0.469	-3.487	0.367
	standard errors	(3833.229)	(0.231)	(2.377)	
	"t" values	(2.699)	(2.026)	(1.466)	
Kenya	X_3	802.779	0.630	-0.085	0.470
	standard errors	(381.405)	(0.201)	(0.125)	
	"t" values	(2.104)	(3.125)	(0.680)	
Ethiopia	X_3	2487.324	0.574	-0.201	0.346
	standard errors	(1656.488)	(0.299)	(0.607)	
	"t" values	(1.501)	(1.921)	(0.331)	
Nigeria	X_3	8123.384	-0.048	0.176	0.004
	standard errors	(2362.870)	(0.302)	(0.988)	
	"t" values	(3.437)	(0.158)	(0.178)	
South Africa	X_3	5274.102	0.255	0.917	0.084
	standard errors	(2457.727)	(0.280)	(1.706)	
	"t" values	(2.145)	(0.911)	(0.537)	

Number of observations = 15

Method of estimation = Ordinary least squares

$t = \frac{b}{S_b}$, value (absolute) over 2 can be considered highly significant.

Table 11: Estimated regression coefficients for the equation $X_6 = Co+C_1X_7$

Regions	Dependent Variable	Regression coefficients for independent variables (standard errors and "t" values in parenthesis) Constant	X_7	R^2
North Africa	X_6	0.915	0.024	0.627
	standard errors	(0.046)	(0.005)	
	"t" values	(19.738)	(4.499)	
Kenya	X_6	1.115	0.009	0.209
	standard errors	(0.043)	(0.005)	
	"t" values	(25.685)	(1.781)	
Ethiopia	X_6	0.736	0.005	0.249
	standard errors	(0.022)	(0.003)	
	"t" values	(32.817)	(1.630)	
Nigeria	X_6	0.779	-0.009	0.304
	standard errors	(0.0368	(0.004)	
	"t" values	(21.134)	(2.289)	
South Africa	X_6	0.850	0.030	0.234
	standard errors	(0.133)	(0.016)	
	"t" values	(6.352)	(1.915)	

Number of observations = 15

Method of estimation = Ordinary least squares

$t = \frac{b}{S_b}$, value (absolute) over 2 can be considered highly significant.

CHAPTER IV

PROJECTION OF SUPPLY OF CEREALS (1974-1985)

A. Supply Projection

For all regions included in the study, the projections were made for the period of 1974-1985. We made the following assumptions in order to project the area and production for the stated period.

1. The prices that will materialize during that period are similar to the average of 1971-1973 period prices.
2. The rate of growth (either for the area or for the production) will remain constant through the period of 1974-1985.
3. All other variables will remain constant, such as weather conditions and government policies.

B. Area Projection

For each region, the area was projected by using the following formula:

$X_1=a_3+a_1X_2$; with $a_3=a_o+a_2X_5^*$ and where X_5^* is the simple average of the real prices during 1971-1973 period. The values of a_3 are summarized in Table 12. X_1 and X_2 have the same meaning as above. a_1 has the same value as

Table 12: Estimated a_3 and b_3 values

Regions	a_3	b_3
North Africa	8271.890	10,343.731
Kenya	337.878	802.702
Ethiopia	3859.978	2,487.165
Nigeria	5294.654	8,123.535
South Africa	4347.672	5,275,110

Source: Computed by Lotanga O. Dimandja.

previously. The figures for area projection for all five regions are given in Table 13.

C. Production Projection

As for area, the production was projected for each region. These projections were computed using the following formula:

$X_3=b_3+b_1X_4$, with $b_3=b_o+b_2X_5^*$ and where X_5^* has the same meaning as earlier. The values of b_3 are also summarized in Table 12. X_3 and X_4 have the same meaning as above. b_1 has the same value as in the previous equation. The figures for production projection are given in Table 13.

These projections, at least for Nigeria, can be compared to production targets for cereals established for Nigerian Agricultural Development 1973-1985 given in Table 1.

Table 13: Area/production projections (1974-1985)
Area (1,000 ha) and production (1,000 MT)

		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
North Africa	Area	14,095	14,164	14,192	14,204	14,209	14,211	14,212	14,213	14,213	14,213	14,213	14,213
	Production	17,570	18,584	19,060	19,283	19,387	19,436	19,459	19,470	19,475	19,478	19,479	19,479
Kenya	Area	1,714	1,704	1,696	1,690	1,685	1,680	1,677	1,675	1,673	1,671	1,670	1,669
	Production	2,155	2,161	2,164	2,166	2,167	2,168	2,169	2,169	2,169	2,169	2,169	2,169
Ethiopia	Area	6,732	6,997	7,121	7,178	7,205	7,218	7,223	7,226	7,227	7,228	7,228	7,228
	Production	5,312	5,536	5,665	5,739	5,781	5,806	5,820	5,278	5,832	5,835	5,836	5,837
Nigeria	Area	11,417	11,300	11,239	11,206	11,189	11,180	11,175	11,173	11,172	11,171	11,171	11,170
	Production	7,792	7,750	7,752	7,751	7,751	7,751	7,751	7,751	7,751	7,751	7,751	7,751
South Africa	Area	6,835	6,911	6,939	6,950	6,954	6,955	6,956	6,956	6,956	6,956	6,956	6,956
	Production	6,916	7,039	7,070	7,078	7,089	7,081	7,081	7,081	7,081	7,081	7,081	7,081

Source: Computed by Lotanga O. Dimandja

CHAPTER V

CONCLUSION AND SUGGESTIONS FOR FURTHER STUDY

A. General Conclusion

The objective of this study is to identify a supply function for cereals for each of the regions and to make projections for the period of 1974-1985 based on a set of assumptions. The estimations of the area and production of cereals are of particular interest. The study is not sufficient for any policy decisions on how much to encourage cereal production because of nonexistence of a similar study on the demand side.

The supply equations were estimated by Ordinary Least Square estimation procedure with distributed lag of one year period. The supply functions were assumed to be linear.

The results of the analysis different from function to function, and for a given function, they differ from one region to another.

We kept all functions whatever the values of their "R^2" and "t" because the purpose of the study was to get information on the usefulness of this type of data in analyzing response for cereals in each of the regions involved.

Moreover, what we did should not be ignored for not providing statistically significant conclusion, but at least, it shows what we cannot expect from this type of time series data.

B. Suggestion for Further Study

Further study on the supply relationship is needed. More studies have to be done on specific cereals individually. They may focus on investigating whether the price variability of a given imported cereal may explain the variation in its domestic production and, hopefully, explain in what circumstances such variations are possible. Specifically, the further studies must be conducted to explain the process of decision-making of a farm unit whether it bases its decisions on the price of the imported cereals or on the price it really receives; and if there is relation, explain in what kind of market structure (free market or market regulated) this relationship can be established.

Furthermore, more detailed works have to be done for each region in order to get more information which we could not get from time series data.

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