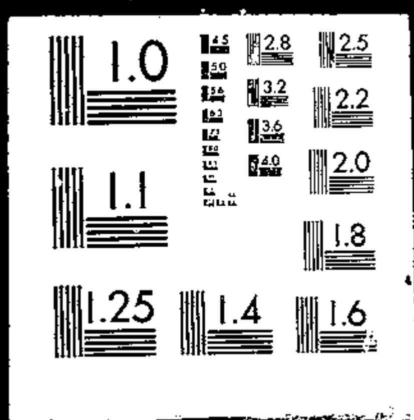
USDA/FAER-145

FACTORS AFFECTING IMPORTS OF GRAINS, OILSEEDS, AND OILSEED PRODUCTS IN IRAN. (Foreign Agricultural Economic Report). / Dyaa K. Abdou (and others). Washington, DC: Economic Research Service. Apr. 1978.

1 OF 1

USDA

FAER-145



Factors Affecting Imports of Grains, Oilseeds, and Oilseed Products in Iran

U.S. Department of Agriculture
Economics, Statistics, and Cooperatives Service
Under Cooperative Agreement With
Iowa State University

Foreign Agricultural Economic Report No. 145

FACTORS AFFECTING IMPORTS OF GRAINS, OILSEEDS, AND OILSEED PRODUCTS IN IRAN. By Dyaa K. Abdou and Arnold A. Paulson, Iowa State University under cooperative agreement with the Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture. Foreign Agricultural Economic Report No. 145.

ABSTRACT

The study quantifies the factors affecting production, consumption, and imports of wheat, rice, corn, barley, oilseeds, and oilseed products in Iran and presents and econometric model to make yearly projections to 1982 and beyond. The projections indicate that despite efforts toward greater self-sufficiency in food production, Iran is moving toward greater reliance on imports of main food and feed products. The U.S. share of the market in these commodities will remain predominant. By 1982, Iran is likely to import over 800,000 tons of wheat, over 350,000 tons of rice, close to 400,000 tons of corn, barley and vegetable oil each, and a substantial quantity of oilseeds. The estimated model can be used to make intermediate term projections under alternative assumptions and economic situations.

Key words: Iran, agricultural imports, production, consumption, commodity projections, wheat rice, coarse grains, corn, barley, oilseeds, oilseed products, projection model.

ACKNOWLEDGMENTS

The authors thank Michael E. Kurtzig, Project Leader and Regional Economist, Foreign Demand and Competition Division, for sharing his valuable knowledge about Iran's agriculture and providing data and information needed for this study. Thanks are also extended to W. Scott Steele, former Acting Deputy Director, Foreign Demand and Competition Division, and Francis S. Urban, Project Coordinator for the Foreign Market Studies, Foreign Demand and Competition Division, for their suggestions and help.

Robert Remmele, Agricultural Economist, Commodity Economics Division, developed the computer model used in this study. Shida Rastegari, Research Assistant in the Department of Economics, Iowa State University, helped analyze the effect of rainfall on wheat yield.

Thanks are also extended to Paul Ferree, U.S. Agricultural Attache in Tehran, and his assistants, M. Ali Ellini and Mohamed Beigy, for their help during the field trip taken by Dyaa K. Abdou and Michael E. Kurtzig to Iran. A word of thanks is also due to Carol C. Enquist and Kathy Becker for their excellent typing of this manuscript.

Washington, D.C. 20250 April 1978

FOREWORD

This publication is one of a series of foreign market studies conducted by the Foreign Demand and Competition Division (FDCD), Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture. These studies focus on countries that are major markets for U.S. agricultural exports and on countries whose farm exports compete with U.S. farm exports. The studies aim at providing a systematic and consistent basis for evaluating agricultural policies in these countries and projecting agricultural trade. They are being carried out either by outside research institutions under contracts or cooperative research agreements, or as inhouse projects.

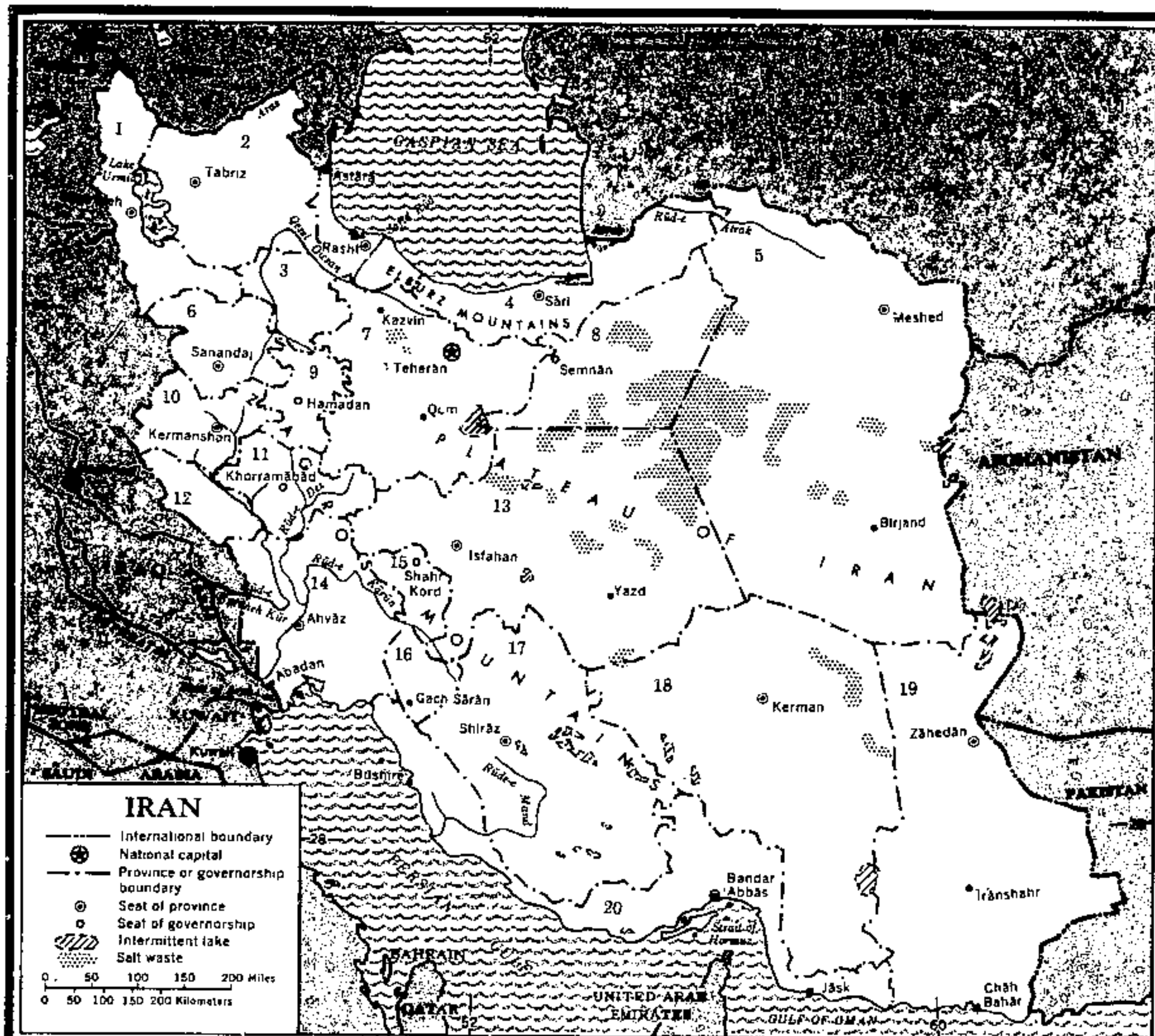
Because of recent trends toward rapidly changing situations in U.S. and world agricultural trade, the Economics, Statistics, and Cooperatives Service has assigned the following objectives to the studies:

1. To identify and, to the extent possible, quantify factors within each country which affect, or may affect, changes in its agricultural trade, especially trade with the United States.
2. To improve the capability of the U.S. Department of Agriculture to project the volume and value of agricultural trade in the short and medium term, and
3. To enable the U.S. Department of Agriculture to better analyze and test fluctuations occurring in agricultural trade in response to changing economic conditions and policy considerations.

The studies concentrate on, but are not confined to, commodities in the grains-oilseeds-livestock sector, which constitute the most important commodities in the world agricultural trade. These studies necessarily depend on the quality and quantity of available data. Hence, some of the studies contain mainly descriptive and qualitative analysis. However, most include quantitative analysis involving econometric models.

Joseph W. Willett

JOSEPH W. WILLETT, Director
Foreign Demand and Competition Division
Economics, Statistics, and Cooperatives Service



KEY TO PROVINCES AND GOVERNORSHIPS

1. ĀZARBAIJĀN-E GHARBĪ
2. ĀZARBAIJĀN-E SHARQĪ
3. GĪLĀN
4. MĀZANDARĀN
5. KHORĀSĀN
6. KORDESTĀN
7. TEHRĀN
*8. SEMĀN
*9. HAMADAN
10. KERMĀNSHĀHĀN
*11. ĪLĀM
*12. LORESTĀN
*13. ESFAHĀN
14. KHŪZESTĀN
*15. BAKHTĪĀRĪ VA CHAHĀR MAHĀLL
16. BOYER AHMADĪ-YE SARDSĪR VA KOHKĪLŪYEH
17. FĀRS
18. KERMĀN
19. BALŪCHESTĀN VA SĪSTĀN
20. SĀHELĪ-YE JAZĀYER VA BANĀDER-E KHALĪJ-E FĀRS VA DARYA-YE 'OMĀN

*Governorships

CONVERSIONS USED

1 hectare = 2.471 acres

1 metric ton = 1,000 kilograms

1 metric ton = 2204.662 pounds

1 metric ton = 36.744 bushels of wheat (60 lb./bu.)

1 metric ton = 39.368 bushels of corn (56 lb./bu.)

Gregorian Calendar March 21-March 20	Iranian Solar Calendar	Exchange Rate: Iranian Rials/$1 U.S.
1960/61	1339	75.75
1961/62	1340	75.75
1962/63	1341	75.75
1963/64	1342	75.75
1964/65	1343	75.75
1965/66	1344	75.75
1966/67	1345	75.75
1967/68	1346	75.75
1968/69	1347	75.09
1969/70	1348	76.38
1970/71	1349	76.38
1971/72	1350	76.38
1972/73	1351	76.38
1973/74	1352	67.63
1974/75	1353	67.63
1975/76	1354	69.28
1976/77	1355	68.00

Abbreviations used

Tons = metric tons
Ha = hectares
Rls = rials

CONTENTS

TABLES

Page

FIGURES

MAPS

SUMMARY

Iran, the fourth largest producer and second largest exporter of petroleum in the world, is likely to remain less than self-sufficient in food and feed grains and is clearly moving toward greater reliance on imports. The country's agricultural output is highly variable, expanding at an average of just under 4 percent per year while the annual population growth rate has been 2.9 percent. Growth in the domestic supply of agricultural products has been unable to meet the sudden rise in demand that began in 1973. Availability of foreign exchange from oil exports has made it possible to satisfy the expanding food demand through agricultural imports. U.S. agricultural exports to Iran were worth $238.55 million in 1976, compared with $75.98 million in 1972.

This study quantifies the factors affecting Iran's production, consumption, imports, and imports from the United States of wheat, rice, corn, barley, and oilseeds and oilseed products. The established relationships are then used to make projections to 1982.

The projections look reasonable, although the total degree of projected self-sufficiency may be too high. The projected production figures seem to trend upward sharply, even from the 1975-76 level, when weather conditions in Iran were favorable.

Wheat production is projected to reach 6.5 million tons in 1982, which compares with actual production estimated at 5.5 million tons in 1976. Wheat consumption is projected to increase to 7.4 million tons by 1982. Given the yield and economic assumptions, the model estimates Iran's wheat imports at 800,000 tons in 1982, compared with about 1.5 million tons in both 1974 and 1975. Wheat imports from the United States may reach 604,000 tons in 1982, given average weather. If poorer than average weather occurs in one or more years during the 1977-82 period, or if yields should not trend up from the 1975-76 level, wheat and other agricultural commodity imports would probably be higher than projected.

Rough rice production in Iran is projected at 1.5 million tons by 1982, and imports from the United States are expected to be 288,000 tons, compared with 300,000 in 1976.

Iran is projected to import 757,000 tons of coarse grains by 1982, and the U.S. share may reach 487,000 tons, compared with 425,000 tons in 1976.

Vegetable oil consumption is projected to increase over one-third to 462,000 tons by 1982, compared with 336,000 tons in 1976. Vegetable oil production, however, is expected to double, reaching 179,800 tons in 1982, compared with only 89,300 tons in 1976. Nevertheless, substantial vegetable oil imports are expected to continue, and the U.S. share may average 237,000 tons per year by 1982, compared with 157,500 tons in 1974, the previous high.

Accuracy analysis was used to indicate the degree of matching between simulated and actual values of the projected items. Both the average percentage error index and Theil's inequality coefficient indicated the model tracking was better during the 1960-74 sample period than in 1975 and 1976.

The projections are based on a yearly econometric model specified for each of the five commodities and statistically estimated. Historically in Iran, yield is more instrumental than area in causing variations in production for all commodities investigated. A 1-percent change in the yield per hectare, for example, would affect the total production of wheat, rice, corn, and barley by 1.37, 0.92, 0.89, and 1.08 percent, respectively. Yield is subject to wide year-to-year variations in weather, total amount of fertilizer consumed, and total agricultural tractors in use.

Increases in population and private consumption expenditures are highly associated with increases in consumption. Each 1-person increase in population means that about 147.5 more kilos of wheat will be consumed per year. Migration of population from rural to urban areas in Iran has been associated with sharp increases in rice consumption. A 1-person increase in the urban population is associated with a 15.4-kilo increase in vegetable oil consumption. A 1-percent change in the private consumption expenditure would increase total wheat consumption by only 0.2 percent.

The complete simulation model contains 42 endogenous variables and 36 exogenous variables. A set of forecasted values for each of the 36 exogenous variables is obtained for each set of assumptions regarding expected developments in income, population, migration, crop yields, and fertilizer use. Because of a strong past association between increases in the use of tractors and fertilizer and higher yields, the assumed high levels of growth rates lead to rather sharp yield and output increases by 1982 and hence to lower imports.

FACTORS AFFECTING IMPORTS OF GRAINS, OILSEEDS, AND OILSEED PRODUCTS IN IRAN

*Dyaa K. Abdou and Arnold A. Paulson**

INTRODUCTION

Generally, Iran's farm sector is not able to meet domestic requirements for food and other agricultural products, despite the country's efforts to overcome environmental and structural problems. Increased foreign exchange from oil revenues, however, has permitted increased imports to meet the rising demand generated by a growing and more affluent population (2). 1/

From 1957 to 1967, net agricultural imports rose by about 7 percent annually, but between 1968 and 1972, they increased by 554 percent (8) (table 1). By 1975-76, agricultural imports were accounting for 26.9 percent of the total supply (34). From 1965 to 1975, the quantities of wheat and rice imported rose by 180 and 775 percent, respectively.

Paralleling the increase in Iran's total agricultural imports has been an increase in imports from the United States. Iran's purchases of U.S. farm products rose from $7.7 million in fiscal 1969 to $757.2 million in fiscal 1975, boosting Iran from 25th to 10th place as a market for U.S. agricultural products. Between fiscal 1972 and 1975, the value of wheat imports from the United States increased from $14.5 million to $323.6 million (table 1). Iran's total imports of agricultural products, and particularly imports from the United States, have been characterized by great year-to-year fluctuations.

Given the importance of Iran as a growing cash market for U.S. agricultural products, the main objectives of this study are:
To provide an indepth analysis of factors affecting Iran's import requirements for wheat, rice, coarse grains, and oilseeds and products. The study attempts to identify and quantify factors affecting production, consumption, and import requirements of those major products in Iran. It also identifies and, to the extent possible, quantifies factors affecting the U.S. market share in Iran's imports of those products.

To provide reasonably accurate short-term and intermediate-term--3 to 5 years--quantitative projections of Iran's import requirements for wheat, rice, coarse grains, and oilseeds and products, and the U.S. market share.

Quantitative models for wheat, rice, coarse grains, and oilseeds and products are specified and statistically estimated. A computer simulation program is then developed that uses these models, along with certain assumptions concerning the future level of certain economic variables, to provide quantitative forecasts.

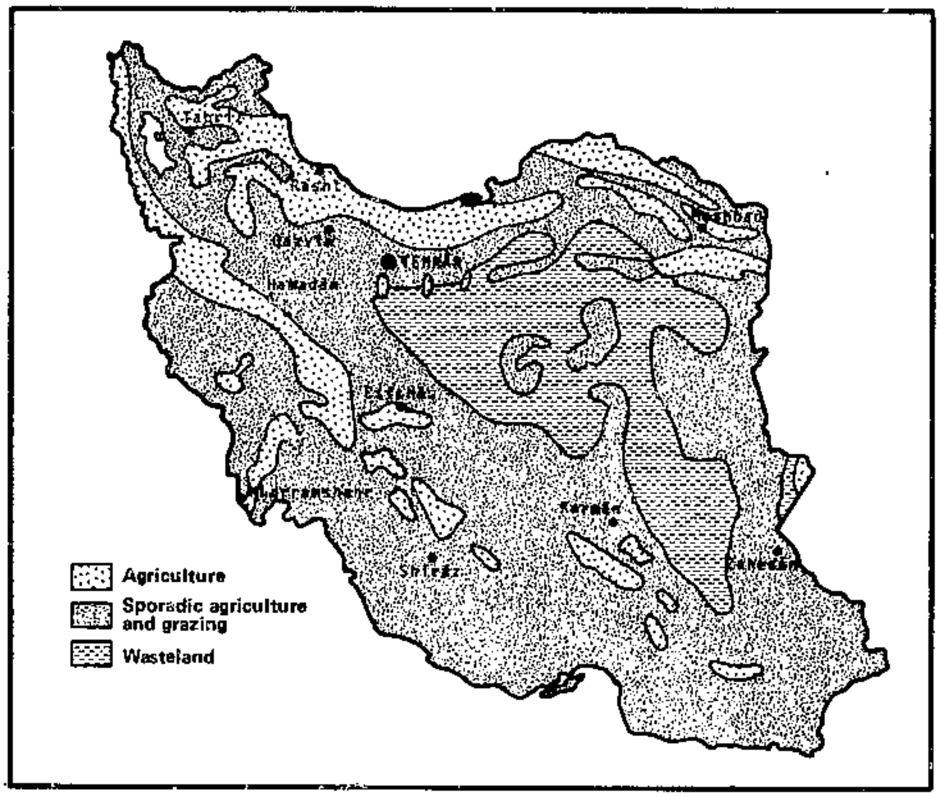
Before the discussion of the individual commodity models and the simulation model, the study discusses the market characteristics of Iran, the methodology used in building the models, and the forecasting results.

MARKET CHARACTERISTICS OF IRAN

Iran, with a population of 35.5 million in 1976, occupies 165 million hectares in southwest Asia on the Iranian Plateau (table 2). It is the world's fourth largest producer and second largest exporter of petroleum, accounting for roughly 10 percent of world oil output. Oil is the major sector in the Iranian economy. At current prices in 1975/76, the oil sector accounted for 37 percent of gross national product (GNP), for 76.7 percent of Government revenue, and for 87.3 percent of foreign exchange receipts on current account.

* Dyaa K. Abdou is an Assistant Professor of Agricultural Economics at Zagazig University, Egypt. He was a Research Assistant at Iowa State University when the research on this study was conducted. Arnold A. Paulson is a Professor of Agricultural Economics at Iowa State University.

1/ Underscored numbers in parentheses refer to source material listed at the end of this study.



Map. 2. Iran: land utilization

Table 1--Total agricultural imports and agricultural imports from the United States, Iran, 1970-76.

Item	1970	1971	1972	1973	1974	1975	1976
	1,000 dollars						
Total agricultural imports 1/	140,980	246,017	313,840	448,751	1,274,000	1,870,000	--
Percentage change from previous year	--	+74.5	+27.6	+43.0	+183.9	+46.8	--
Agricultural imports from the United States: 2/							
Wheat	3,176	26,204	36,034	69,231	257,477	137,589	52,815
Rice	20	--	16,095	3	104,739	165,798	74,155
Corn	10	1,303	1,595	12,815	16,831	8,195	19,061
Barley	--	696	--	1,289	9,395	2,476	13,802
Soybean oil	19,264	22,922	8,311	10,959	107,364	56,347	25,987
Cottonseed oil	711	693	4,257	118	5,614	20,204	6,525
Total	30,426	59,578	75,984	108,856	534,195	423,171	238,549
	Percent						
Percentage change from previous year	--	+95.8	+27.5	+43.3	+390.7	-20.8	-43.6

-- Means not available
1/ Foreign Trade Statistics of Iran, March 21-March 20.
2/ U.S. Census, Commerce Department, calender year data.

Table 2--Iran: Selected economic information, 1970-75

Item	Unit	1970	1971	1972	1973	1974	1975	Percentage change, 1970-75
								Percent
Total population	Mil.	29.1	30.1	30.9	31.8	32.8	33.5	15.0
Urban	do.	11.8	12.4	13.1	13.9	14.6	15.4	30.5
Rural	do.	17.3	17.7	17.8	17.9	18.2	18.6	7.5
GNP at current prices	Mil. dol.	9,775.0	12,056.0	15,611.0	25,625.0	44,045.0	51,276.0	424.6
Exports:								
Oil and gas	do.	1,149.5	2,030.8	2,460.2	4,937.7	18,653.5	19,026.0	1,555.0
Oil as share of GNP	Pct.	11.7	16.8	15.7	19.2	42.3	37.0	216.2
Oil and gas as share of current account of balance of payments	do.	75.4	78.6	77.8	81.0	88.9	87.0	15.4
Nonoil	Mil. dol.	272.6	334.6	439.8	634.7	581.5	594.0	117.9
Agriculture as share of nonoil exports	Pct.	35.4	49.9	49.8	62.5	45.7	51.9	46.6
Imports:								
Total	Mil. dol.	1,677.0	2,061.0	2,570.0	3,737.0	6,614.0	11,300.0	573.8
Agriculture as share of total imports	Pct.	10.4	12.9	12.7	16.0	21.9	17.0	63.5

Source: Bank Markazi of Iran (1).

Table 3--Iran: Total and per capita consumption of selected agricultural products, 1970-75

Year	Wheat		Rice		Red meat		Poultry	
	Total	Per capita	Total	Per capita	Total	Per capita	Total	Per capita
	1,000 M. tons	Kilograms	1,000 M. tons	Kilograms	1,000 M. tons	Kilograms	1,000 M. tons	Kilograms
1970	3,888.0	133.6	705.0	24.2	350.5	11.9	50.0	1.7
1971	4,389.0	145.8	754.0	25.0	383.6	12.7	60.0	2.0
1972	4,800.0	155.3	730.0	23.6	443.2	14.3	71.0	2.3
1973	4,700.0	147.8	710.0	22.3	460.8	14.5	82.0	2.6
1974	5,063.0	155.8	1,147.0	35.0	455.7	13.9	98.0	3.0
1975	5,800.0	173.1	1,029.0	30.7	567.8	16.4	115.0	3.3
				Percent				
Percentage change 1970-75	49.2	29.6	46.0	26.9	62.0	37.8	130.0	94.1

Source: Bank Markazi of Iran (1) and U.S. Agriculture attache reports (34).

From the beginning of 1973 to early 1974, average per-barrel Government oil revenue rose from $1.50 to $10.20. Iran's balance of payments improved from an estimated deficit of $1.0 billion in 1973 to an estimated surplus of $10.0 billion in 1974 (1). In 1975, Iran's oil revenue increased by only 2 percent, but reached $19 billion. During 1970-75, GNP at current prices increased an average of 38.4 percent a year, by about 35.5 percent a year on a per capita basis.

In the fifth 5-year development plan, covering March 1973-March 1978, total development spending is set at $69 billion. This amount is eight times greater than development spending during the fourth plan.

Demand for imports in Iran increased dramatically in 1974 and 1975. In 1975/76, consumption expenditure accounted for only 63 percent of all expenditures but increased by 13.7 percent--in real terms--over the 1974/75 level. In 1974, private consumption expenditure at current prices was 38 percent higher than in 1973, and 33 percent higher on a per capita basis. Between 1960 and 1965, per capita private consumption expenditure rose by only 19 percent. The huge 1973-74 increase illustrates the sudden shift in demand. Total wheat consumption in 1975 was 1.5 times higher than in 1970, while total poultry consumption was 2.3 times higher (table 3).

Not surprisingly, the agricultural sector of Iran was not able to meet the sudden rise in demand in 1974-75;self-sufficiency in food products at that time was estimated at 70 percent. But the gap has a longer history. Per capita food and agricultural production rose by only 1 percent annually during the fourth plan--1968-72.

The agricultural sector's poor performance is due to many factors. Since Iran occupies an arid and semiarid mountainous territory, only 5.3 percent of the country's area is under cultivation (map 2), and 60 percent of that area is not irrigated. The small alluvial farm areas, which are irrigated, customarily are used for fruit and vegetable production, while wheat, lentils, and chick peas are grown in the better rainfed areas. Most of Iran's drylands have been used for seasonal grazing, primarily for sheep. Flocks migrate up the slopes during the winter. Because of the rising food demand, winter grazing lands have been converted into cotton, sugar, and wheat fields. In the mountainous areas, the reduction in winter pastureland has resulted in reduced meat output.

Production of wheat, barley, lentils, chick peas, and other major crops from the large dry farming area makes Iran's agriculture extremely vulnerable to weather conditions (8). Difficult topography, tendencies in some parts to soil salinity, and poor communications are other constraints responsible for low per capita agricultural production.

Agriculture's share in Iran's GNP decreased from 30.3 percent in 1960-62, to about 16 percent in 1972 (table 4). This decrease, however, resulted mainly from the rapid increase in the oil sector's share in GNP. Crop production accounted for about 64.2 percent of total value-added in the agricultural sector, livestock operations for 32.8 percent, with the balance accounted for by forestry and fishing.

Table 4--Value-added as a share of GNP, by main economic groups, at market prices, Iran, selected years 1/

Sector	1959	1968	1970	1971	1972	1973	1974
				Percent			
Agriculture	32.1	22.5	20.0	17.0	16.3	12.4	9.4
Oil	10.4	17.4	18.8	19.8	27.8	40.8	50.6
Industry	17.1	22.4	22.3	23.3	19.9	17.6	14.4
Services	40.5	39.9	41.5	42.5	36.0	29.2	25.6

1/ Some years may not equal 100 due to rounding.

Source: Bank Markazi of Iran (1).

METHODOLOGY AND DATA APPRAISAL

Commodity Models

After the objectives of the study were defined, economic models oriented toward solving those objectives were formulated. By stating the economic models and the assumptions concerning the stochastic term, a structural specification of each model was completed. After the appropriate statistical method is chosen and applied to estimate the coefficients that relate the variables in the model, an estimated structure is obtained.

To achieve the first objective of this study, an indepth analysis for each commodity was made. A quantitative model was specified and estimated to identify and quantify the interrelationships between factors affecting production, consumption, and import requirements for wheat, rice, coarse grains, and oilseeds and products.

Yearly observations are the basic data used. The econometric model presented for each commodity is a grouping of yearly relationships to capture the crucial features of the real sector. Each yearly model is complete because each endogenous variable is specified to be solely a function of lagged endogenous variables, or of both. In this specification, an endogenous variable in one behavioral relation of the current time period can be used as a predetermined variable in another behavioral equation of the same time period, and the recursive relationship can be maintained as long as the functions are ordered in the proper sequence. That is, in the recursive models, the endogenous variables are determined sequentially as a chain through time rather than simultaneously (12).

Because the system of equations for each commodity, namely the recursive system, puts certain restrictions on the parameters, ordinary least squares method is used in estimating each equation. In general, the problem of autocorrelation was encountered at the outset. Whenever the null hypothesis of existence of randomness between successive disturbances (positive autocorrelation = 0) was rejected through the use of the Durbin-Watson statistic, the generalized least squares method was applied. The use of this method in estimating an equation is indicated by the appearance of $\hat{\rho}$ along with the other summary statistics under the given equation.

Several different specifications were stated and statistically estimated for each equation reported. The equations presented are considered to be the best among the set of specified and estimated equations. Several criteria were used in their determination. Strong economic logic, agreement between the sign of the coefficients, *a priori* theoretical expected signs, low standard errors of regression, and high multiple determination coefficients were the main criteria used. Since the main objective for building such econometric models is to provide reasonably accurate projections, more weight was given to the standard error of regression than to other criteria.

Simulation Model

Time paths for 1977-82 for 42 endogenous variables are projected by computer simulation. Values are projected using historical relationships and assumed values of exogenous variables. For wheat, rice, corn, barley, oilseeds, and vegetable oil, the study estimates Iran's domestic production, consumption, total net imports, and imports from the United States. The projected values depend, of course, on the future values assumed for the exogenous variables as well as on the model--that is, the relationships or coefficients estimated from the 1960-74 sample period. Naturally, if different values for the exogenous variables were chosen, the same model would project different values for Iran's imports. Hence, while the projected numbers are of interest, no undue importance should be assigned to them since the main object of the study is to develop a reasonably reliable estimation tool under different policy assumptions and economic situations rather than to create numbers.

The values of the exogenous variables used are given in Appendix D. The projected values of the endogenous variables for 1977-82 are presented in tables 5-11. The values for 1970-76 in these tables are the actual values of the endogenous variables. The actual and estimated values are compared for each historical year for most of the endogenous variables and presented in the appendix along with the simple error index.

Table 5--Wheat: Area harvested, yield, beginning and ending stocks, consumption, and imports, Iran, actual 1970-76 and forecasts 1977-82

Year	Area harvested	Yield	Beginning stocks	Production	Consumption	Imports: Net	Imports: From United States	Ending stocks
	1,000 ha.	Q/ha.	1,000 metric tons					
1970	4,200	9.05	334	3,800	3,888	101	--	347
1971	4,000	8.25	347	3,300	4,389	1,114	588	372
1972	4,300	9.38	372	4,034	4,800	736	503	342
1973	4,300	9.19	342	3,950	4,700	600	584	192
1974	4,270	9.13	192	3,900	5,063	1,571	1,332	600
1975	4,350	11.49	600	5,000	6,000	1,400	958	1,000
1976	4,500	12.22	1,000	5,500	6,400	700	550	800
1977	5,200	11.06	800	5,749	6,457	733	484	825
1978	5,249	11.14	825	5,849	6,735	799	569	739
1979	5,440	11.37	739	6,188	6,948	854	608	833
1980	5,490	11.45	833	6,289	7,095	757	540	784
1981	5,547	11.54	784	6,400	7,232	831	592	783
1982	5,599	11.62	783	6,508	7,423	849	604	717

Table 6--Rice: Area harvested, yield, beginning and ending stocks, production, consumption, and imports, Iran, actual 1970-76 and forecasts 1977-1982

Year	Area harvested	Yield	Beginning stocks 1/	Production		Con-sumption	Imports		Ending stocks 1/
				Rough	Milled		Net	From United States	
	1,000 a	Q./ha	1,000 metric tons						
1970	270	41.1	2	1,111	740	705	-17	0.4	20
1971	280	36.5	20	1,021	680	754	74	14	20
1972	290	34.2	20	991	660	730	65	38	15
1973	310	32.2	15	998	665	710	70	20	40
1974	310	34.7	40	1,077	717	1,147	500	366	110
1975	340	35.3	110	1,201	800	1,060	250	240	100
1976	365	34.9	100	1,276	850	1,300	450	300	100
1977	306	41.4	100	1,266	843	1,175	332	189	100
1978	307	42.4	100	1,303	868	1,192	374	305	150
1979	316	43.6	150	1,379	918	1,244	275	224	100
1980	319	44.3	100	1,414	942	1,256	313	256	100
1981	323	44.9	100	1,450	965	1,281	290	236	75
1982	326	45.4	75	1,479	985	1,289	354	288	125

1/ Exogenous variable

Table 7--Corn: Area harvested, yield, production, consumption, and imports, Iran, actual 1970-76 and forecasts 1977-82

Year	Area harvested	Yield	Production	Consumption			Imports	
				Human	Feed	Total	Net	From United States
	1,000/a	Q/a	1,000 metric tons					
1970	25	14.0	35	7	50	57	22	12
1971	25	14.0	35	7	98	105	70	22
1972	27	14.8	40	8	129	137	97	23
1973	27	14.8	40	8	112	120	80	80
1974	28	17.9	50	10	277	287	237	151
1975	30	21.7	65	13	252	265	200	160
1976	35	22.9	80	16	314	330	250	225
1977	37.0	22.8	84.2	16.8	558	575	490	309
1978	36.0	21.9	78.8	15.8	517	533	453	286
1979	37.2	22.0	81.8	16.4	510	526	444	280
1980	37.1	21.7	80.5	16.1	474	490	409	258
1981	37.2	21.6	80.3	16.0	452	468	388	244
1982	37.3	21.6	80.5	16.1	448	464	384	242

Table 8--Barley: Area harvested, yield, beginning and ending stocks, production, consumption, and imports, Iran, actual 1970-76 and forecasts 1977-82

Year	Area harvested	Yield	Beginning stocks	Production	Consumption			Imports		Ending stocks
					Human	Feed	Total	Total	From United States	
	1,000 ha.	Q./ha.	1,000 metric tons							
1970 ......:	1,500	8.0	74	1,200	305	951	1,256	1	--	19
1971 ......:	1,400	5.7	19	800	238	753	991	206	63	34
1972 ......:	1,400	5.7	34	800	40	790	830	8	0	34
1973 ......:	1,400	6.4	12	900	152	850	1,002	120	40	30
1974 ......:	1,400	5.7	30	800	180	778	958	178	60	50
1975 ......:	1,400	7.9	50	1,100	365	935	1,300	200	160	50
1976 ......:	1,350	8.5	50	1,150	370	980	1,350	250	200	100
1977 ......:	1,447	8.6	100	1,239	253	1,110	1,364	258	169	55
1978 ......:	1,446	8.5	55	1,235	248	1,143	1,391	323	212	40
1979 ......:	1,475	8.7	40	1,278	251	1,200	1,451	326	214	31
1980 ......:	1,548	8.7	31	1,345	279	1,266	1,545	344	226	26
1981 ......:	1,564	8.7	26	1,364	266	1,310	1,576	346	227	13
1982 ......:	1,614	8.8	13	1,414	267	1,369	1,636	373	245	3

Table 9--Coarse grains (corn and barley): Area harvested, yield, beginning and ending stocks, production consumption, and imports, Iran, actual 1970-76 and forecasts 1977-82

Year	Area harvested	Yield	Beginning stocks	Production	Consumption			Imports		Ending stocks
					Human	Feed	Total	Total	From United States	
	1,000 ha.	Q./ha.	1,000 metric tons							
1970	1,525	8.1	74	1,235	312	1,001	1,313	23	12	19
1971	1,425	5.8	19	835	245	851	1,096	276	85	34
1972	1,427	5.9	34	840	48	919	967	105	23	12
1973	1,427	6.6	12	940	160	962	1,122	200	120	30
1974	1,416	6.0	30	850	190	1,055	1,245	415	211	50
1975	1,430	8.1	50	1,165	378	1,187	1,565	400	320	50
1976	1,385	8.9	50	1,230	386	1,294	1,680	500	425	100
1977	1,484	8.9	100	1,323	270	1,668	1,938	748	478	55
1978	1,842	8.9	55	1,314	264	1,660	1,924	776	498	40
1979	1,512	9.0	40	1,360	267	1,710	1,977	770	494	31
1980	1,585	9.0	31	1,425	295	1,740	2,035	753	484	26
1981	1,601	9.0	26	1,444	282	1,762	2,044	734	471	13
1982	1,651	9.1	13	1,495	283	1,817	2,100	757	487	3

Table 10--Production of cottonseeds, soybeans, and sunflowers, Iran, actual 1970-76 and forecasts 1977-82

Year	Cottonseeds			Soybeans			Sunflowers		
	Total	Oil 1/	Meal 1/	Total	Oil 1/	Meal 1/	Total	Oil 1/	Meal 1/
	1,000 metric tons								
1970	341	52.1	146.7	6.4	1.09	4.8	51.4	21.0	27.8
1971	280	42.7	120.4	7.5	1.27	5.6	37.4	15.3	20.3
1972	320	48.8	137.6	9.7	1.66	7.3	44.3	18.1	24.0
1973	420	64.1	180.7	9.5	1.63	7.2	47.2	19.3	25.6
1974	450	68.7	193.6	34.9	5.97	26.2	43.0	17.6	23.3
1975	290	44.3	124.7	70.3	12.0	52.8	29.0	11.9	15.7
1976	348	53.1	149.7	98.0	16.8	73.6	36.0	14.7	19.5
1977	378	57.7	162.5	100.4	17.2	75.4	42.8	17.5	23.2
1978	436	66.5	187.5	115.4	19.7	86.6	43.5	17.8	23.5
1979	478	73.0	205.7	130.3	22.3	97.8	41.8	17.1	22.6
1980	560	85.6	241.1	152.8	26.1	114.7	42.3	17.3	22.9
1981	671	102.5	289.0	182.7	31.2	137.1	42.6	17.4	23.1
1982	722	110.2	310.5	197.6	33.8	148.0	42.8	17.5	23.2

1/ From 1970 to 1982 predicted values.

Table 11--Vegetable oil: Production, consumption, and imports, Iran, actual 1970-76 and forecasts 1977-82

Year	Production	Consumption	Imports: Total	Imports: From United States
	1,000 metric tons			
1970	78.8	160	128.3	43.1
1971	60.0	176	105.0	77.6
1972	84.0	190	126.4	51.5
1973	88.0	205	133.8	42.6
1974	96.0	313	227.0	157.5
1975	70.0	320	249.6	130.9
1976	89.3	336	300.0	80.0
1977	104.3	368	289.7	191.2
1978	117.2	380	281.8	190.6
1979	127.2	400	300.5	210.9
1980	144.9	419	309.5	204.9
1981	168.5	441	327.9	216.3
1982	179.8	464	368.9	237.5

Data Appraisal

Data availability is a major constraint on the specification of the time series equations reported in this study. To update the estimated quantitative models easily and regularly for use by USDA analysts, the data had to be easily accessible from regularly published sources. This factor limited the sources investigated for available economic data, which tended to be incomplete and inaccurate.

The study's objectives to provide short- and intermediate-term quantitative forecasts dictated the use of time series analysis rather than survey data. Data on Iranian farm prices were not available. To analyze and estimate the supply response to changes in producer prices, the available price indexes at the wholesale or consumer market level were used as proxies. Data on prices of major agricultural inputs--i.e., fertilizer prices, agricultural labor wages, seed prices--were not available. Neither were prices available for corn, barley, and oilseeds and products for a sufficient number of years at any market level. Thus, price indexes for close substitutes--when available--were used.

The level of agricultural production in Iran is generally affected by weather and Government policies. To analyze the effect of weather on yield, consistent data on crop yields and average weather indicators for different regions were required. However, only data on wheat yield, wheat production, and average rainfall for consistent regions were obtained for 1970/71-1972/73. Consistent historical data for other crops were hard to obtain, and the analysis of the effect of rainfall on yield was restricted to wheat.

Official area and production data were generally not available for oilseed crops, and existing information was often conflicting (34, May 1976). Analysis of factors affecting area and yield for oilseed crops was not feasible because of inconsistency in available historical data. The production data on different types of vegetable oils are the results of guesswork. Efforts to gather data on oilseed crushing and oil refining capacity were unsuccessful, and present analysis ignores those two factors as affecting vegetable oils imports and oilseeds exports and imports decisions. Because of these data limitations, the analysis of the oilseeds and products sector was carried out using aggregated variables and the simplified quantitative model.

There are several well-established organizations in Iran responsible for gathering and publishing economic and agricultural time series data. Among them are the Ministry of Agriculture and Natural Resources (MANR), 2/ Plan and Budget Organization, Statistical Center of Iran, and Bank Markazi Iran. Unfortunately, data published by those organizations are often conflicting (8, p. 7).

2/ The MANR was merged with the Ministry of Cooperatives and Rural Affairs to form the new Ministry of Agriculture and Rural Development in August 1977. In this study, MANR is used throughout.

According to the International Bank of Reconstruction and Development, (IBRD) average wheat production over 1967-69, as reported by the Ministry of Agriculture, was 4.7 million tons, compared with 4.0 million tons as reported by the Central Bank (10, p. 1). According to the Central Bank, wheat output increased by 11 percent from 1962 to 1963; according to the Ministry of Agriculture's estimates, it declined by 10 percent.

The problem of incompleteness of available data also resulted from the uncertainty of the values associated with import data for some years. Often the published data indicate a zero value whenever the import level is less than 500 tons (33), whenever there are no data available, and when there were actually no imports. To overcome this problem, the zero value was used as a legitimate value in the analysis whenever there were no imports or when the actual values classified as less than 500 metric tons were not available. In the case of the missed observations the time series data were regressed on a time trend variable and an appropriate value for the missing observation was replaced by one derived from using the estimated regression line.

Personal observation indicated that large amounts of the corn produced in Iran are used for feeding animals. Published data, however, indicate that both imported and domestically produced corn is consumed directly by humans. To overcome this unrealistic data problem, 80 percent of domestic corn production and all corn imports were treated as used for feeding animals and poultry. Only 20 percent of domestic corn production was assumed to be for human consumption.

FORECASTING RESULTS

Wheat

The wheat sector simulation projects imports at about 10 to 13 percent of consumption--a surprisingly high degree of self-sufficiency for Iran in 1977-82 (table 5). Increases are projected in both harvested area and yield relative to the 1970-74 actual experience. As a result, Iran's wheat production is projected at 5.7 million tons in 1977 and to increase steadily to 6.5 million tons by 1982. These levels would be records for Iran, even exceeding the record wheat production levels of 1974-75, when Iran's weather was generally recognized as favorable.

The higher production projections can be traced to the assumption of much higher inputs of fertilizer and tractors and the strong association between higher levels of fertilizer and tractors, and higher yields and larger harvested area during 1960-74. Projected levels will be too high only if the assumed levels of tractor and fertilizer use do not materialize or if the past association between tractors and fertilizer inputs and area and yield does not hold. Of course, projections are expected values and actual values may exceed or fall short of the projected numbers because of weather fluctuations or the influence of other unconsidered variables. The historical yield and area-harvested equations do not explicitly account for weather or attempt to explain that part of the variation in yield or area harvested due to weather variation. In Iran, favorable weather generally means increased total rainfall and a larger harvested wheat area, with a greater yield per harvested hectare. The favorable weather of 1975 and 1976 probably will not continue throughout 1977-82, but those 2 years are also not considered in the sample period.

Wheat consumption increased by 11 percent a year during 1973-76. During 1977-82, the rate of increase in total wheat consumption in Iran is forecast at 3 percent a year. The principal explanation for the slower rate of increase is the assumption of a less rapid increase in disposable income per capita in 1977-82 than the unprecedented jump of 38 percent in 1973 and 1974 after the oil price increase.

Wheat imports during 1977-82 are expected to average about 0.9 million tons per year, with about 70 percent coming from the United States.

Rice

The rice sector analysis projects imports at 20 to 30 percent of consumption, which reflects a higher degree of self-sufficiency than in 1974-76, but lower than in 1970-74, when Iran produced over 90 percent of its own rice (table 6). The analysis for 1975 and 1976 overestimated the yield and underestimated the harvested area relative to the official Iranian statistics.

The model's estimate of less rice area and more yield than officially expected for the future may prove correct if the conversion of rice land along the Caspian seashore for urban use continues at its current rate. Rough rice production may approach 1.5 million tons by 1982, a 50-percent increase over historical levels, even with a yield of 4.5 tons per hectare rather than the historical 3.4. This should be true because the harvested area by 1982 may not exceed 326,000 hectares, although 265,000 harvested hectares of rice were reported in 1976.

Iranian rice consumption increased during 1974-76 to 1.1 million tons, an astonishing 50 percent increase over the stable 700,000 tons consumed historically. The analysis predicts rice consumption to trend up smoothly during 1977-82 at about 2 percent a year. Official expectations in Iran are that rice consumption will increase by 10 percent a year. If those projections prove more nearly correct than this analysis, 1982 import requirements would greatly exceed the 350,000-ton level projected here. Imports may even exceed the approximately 500,000 tons imported in 1974 and 1976. The U.S. share of Iran's rice imports in 1974-76 was over two-thirds and is projected to average about 80 percent in 1982, with volume totaling 190,000 to 300,000 tons of milled rice equivalent.

Coarse Grains

The coarse grain analysis indicates that nearly 40 percent of the barley and corn consumed in Iran, or an average of about 750,000 tons a year, may be imported (tables 7-9). This indicates a future expansion of coarse grain imports and an increase in the importance of feed relative to food grain imports. The large city-related poultry and dairy industries are especially dependent on imported feed grain. Iran's grain-producing capacity will probably continue to be used predominantly for wheat and rice production which will meet a larger share of the country's food grain needs, while the urban demand for feed grain is likely to be met largely from imports.

Barley, which constitutes 90 to 95 percent of Iran's domestic feed grain production, follows a year-to-year variation in area and yield similar to that for wheat, with larger area and yield associated with favorable weather and larger inputs of fertilizer and tractors. Both area and yield are projected to rise during 1977-82 relative to the historical period. By 1982, total barley production is expected to be about 25 percent larger than in 1975-76. However, Iran's total feed grain consumption by 1982 is projected to exceed by 35 to 40 percent the record consumption levels of 1975-76. Thus, feed grain imports are expected to be at least 50 percent larger in the future. Total U.S. feed grain exports to Iran are expected to expand only slightly over the record 1976 level, when the United States captured an unprecedented 85 percent of the Iranian feed grain market. Such U.S. dominance is not expected in the future.

Oilseeds and Products

Analysis of the oilseed-vegetable oil sector indicates that, as in the past, imports will continue to provide the major portion consumed (tables 10-11). Iran has exported vegetable oil from time to time, though some oil is regularly imported. Vegetable oil stocks have also apparently built up and been drawn down in the past. Such activities should continue and will serve to loosen the relationship between import levels and growth in domestic demand relative to domestic supply from crushing locally produced oilseeds.

Consumption of vegetable oil more than doubled during 1970-76. This is probably due to substitution of vegetable oil for animal fats, especially in urban areas. Future growth in consumption is forecast at less than half the rate of the past--4.75 versus 13.2 percent per year. The growth of consumption and imports will be clearly upward, but the amount or rate is uncertain.

Cottonseed is the principal source of Iranian oilseeds. Since Iran produces a surplus of cotton lint, the primary value, the amount of domestic cottonseed is exogenously or world market determined. Iranian cottonseed production dropped from 450,000 tons in 1974 to 290,000 tons in 1975 after the world cotton price dropped and Iranian wheat price increased in late 1974 versus 1973. Future cottonseed production cannot be projected accurately, but will probably be substantially less than the 722,000 tons reported for 1982 in table 10.

COMMODITY MODELS AND HISTORICAL ANALYSIS

Although the models for each commodity are presented separately, they are interrelated through their specification. For example, the current level of coarse grains production affects wheat consumption, net wheat imports, and net rice imports in the same period. Coarse grains area harvested is affected by wheat area harvested. The price of the U.S. wheat exports affects net wheat and rice imports. Current availability of wheat affects human barley consumption, and current wheat production affects sunflower production. The correct ordering of equations within each model in the total system has facilitated the integration of all separate models into one computer simulation model.

For each commodity--except oilseed and its products--the production level is estimated through both direct and indirect methods. The indirect method estimates are obtained through separately estimating yield and area harvested. Direct production estimates include all or some of the variables responsible for explaining variations in the yield and/or area harvested to explain variations in production directly. Net import levels are also estimated directly and indirectly. The indirect estimation is obtained by using an identity equation involving the estimated production, consumption, and ending stocks (if available) variables. In the final projections model, a choice between the two methods is made depending upon the ability of each equation to predict accurately. The chain of relationships in each model begins with estimating production, consumption, imports, and imports from the United States and ending stocks.

Wheat Model

Wheat, the largest grain crop and most important cereal crop in Iran, provides about half the caloric intake and about a third of total farm income. During 1960-74, wheat area harvested averaged 3.9 million hectares annually, accounting for almost 49 percent of the total harvest cropland.

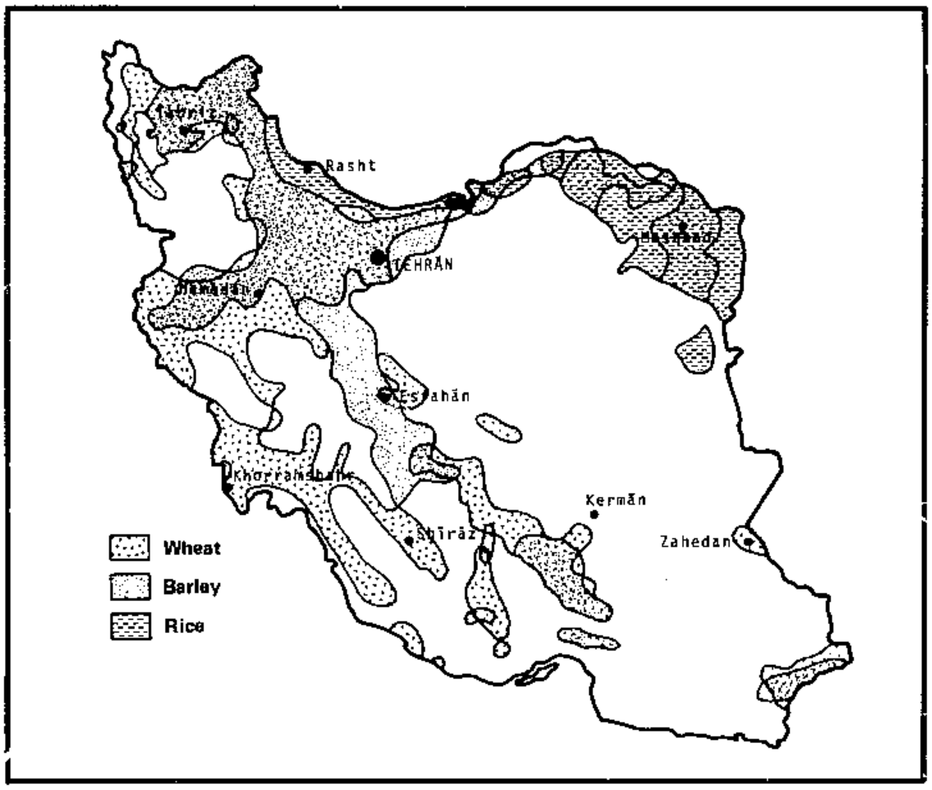
Per capita consumption of wheat rose from 118 kilograms in 1965 to 173 kilograms in 1975. Rice consumption stood at only 28 and 30 kilograms per capita for those same years. Estimates are that rural wheat consumption runs even higher, exceeding 200 kilograms per capita in 1975.

In general, the Iranian Government's wheat policy is aimed at keeping bread prices at a low level and reducing their seasonal fluctuations. Before fall wheat planting, the Government announces the official purchase price--at Rls 6,000/ton for the past decade--which indicates both a price support program and a willingness to purchase any quantity at this price. However, the Government actually buys very little, mainly because of the Government's low price and the government demand for a particular quality of wheat which is not generally grown (8). Until now, the Government has been successful in providing price incentives for producers to increase their production.

Every year, almost 10 percent of domestic production is kept for seed, nearly 50 percent for rural consumption, and nearly 40 percent for urban consumption. About 5 percent is waste. Domestic wheat production covers rural consumption, while imported wheat mainly covers the requirements of urban areas.

Import requirements are suggested by the Cereal Organization, Wheat Section of the Ministry of Commerce. This is decided by estimating stock levels, production, and population growth. For distributing the import wheat, the Cereal Organization announces an official wheat quota for different cities and provinces (table 12). The Government is then ready to supply a specified amount of imported wheat to the bakers at a set price. The Government price is uniform throughout the year, and was Rls 7,510/ton during 1965-74 (8), or about the same as the open market price of wheat in Tehran.

Since most wheat production takes place on nonirrigated farms, it fluctuates significantly from one year to another, with the pattern depending largely on weather conditions (fig. 1). Accordingly, there are large year-to-year fluctuations in wheat imports. In 1974, when production was 3.3 percent less than in 1972, imports were about 2.5 times the 1973 level. Between 1970 and 1971, imports increased by almost 1,002 percent--11 times higher. These extreme fluctuations in production and imports, along with the inaccuracy and inconsistency of the data, make quantifications of cause and effect difficult. The wheat model is illustrated in figure 2.



Map. 3. Iran: wheat, barley, and rice areas

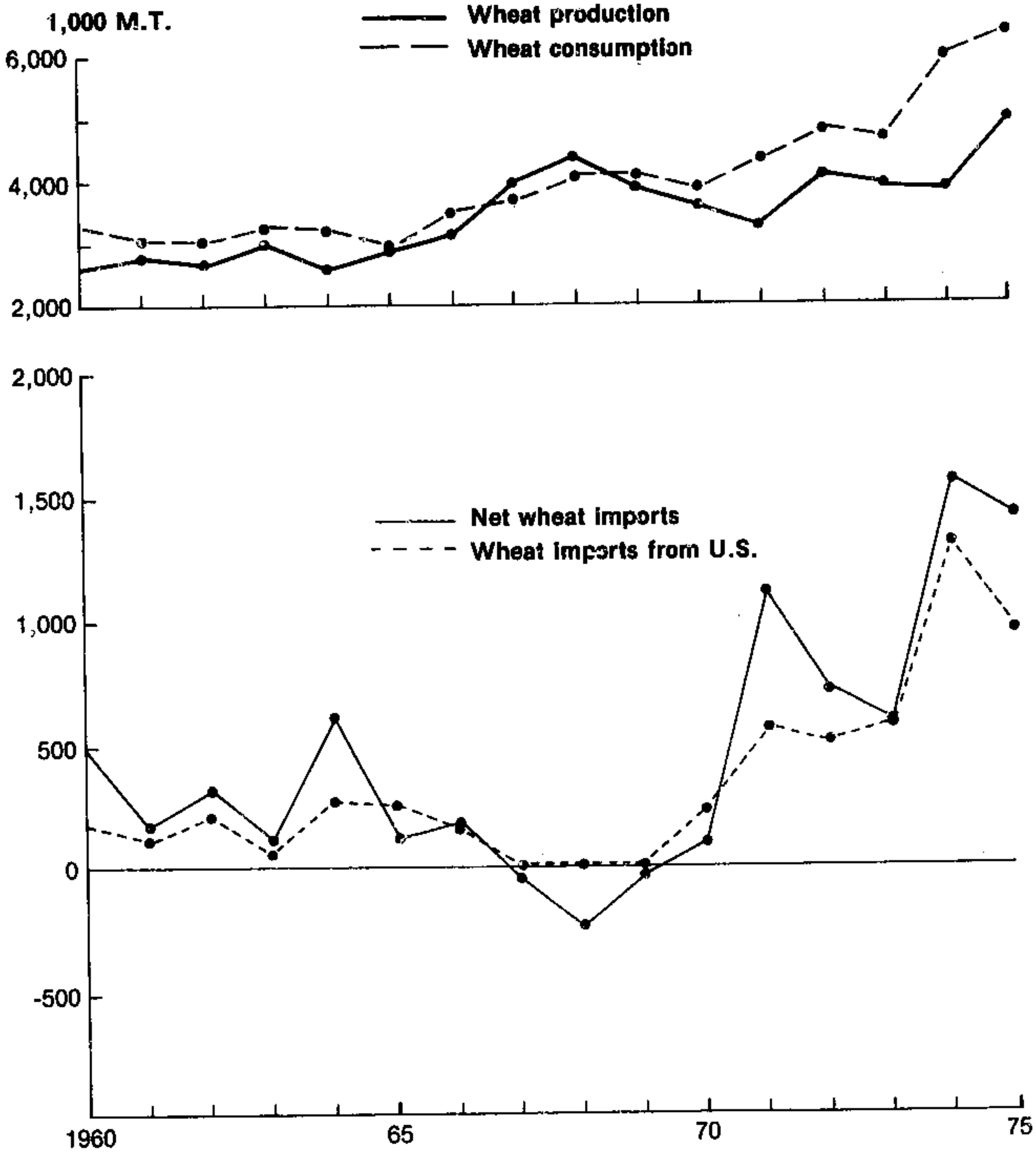


Figure 1. Wheat production, consumption, and net imports, Iran

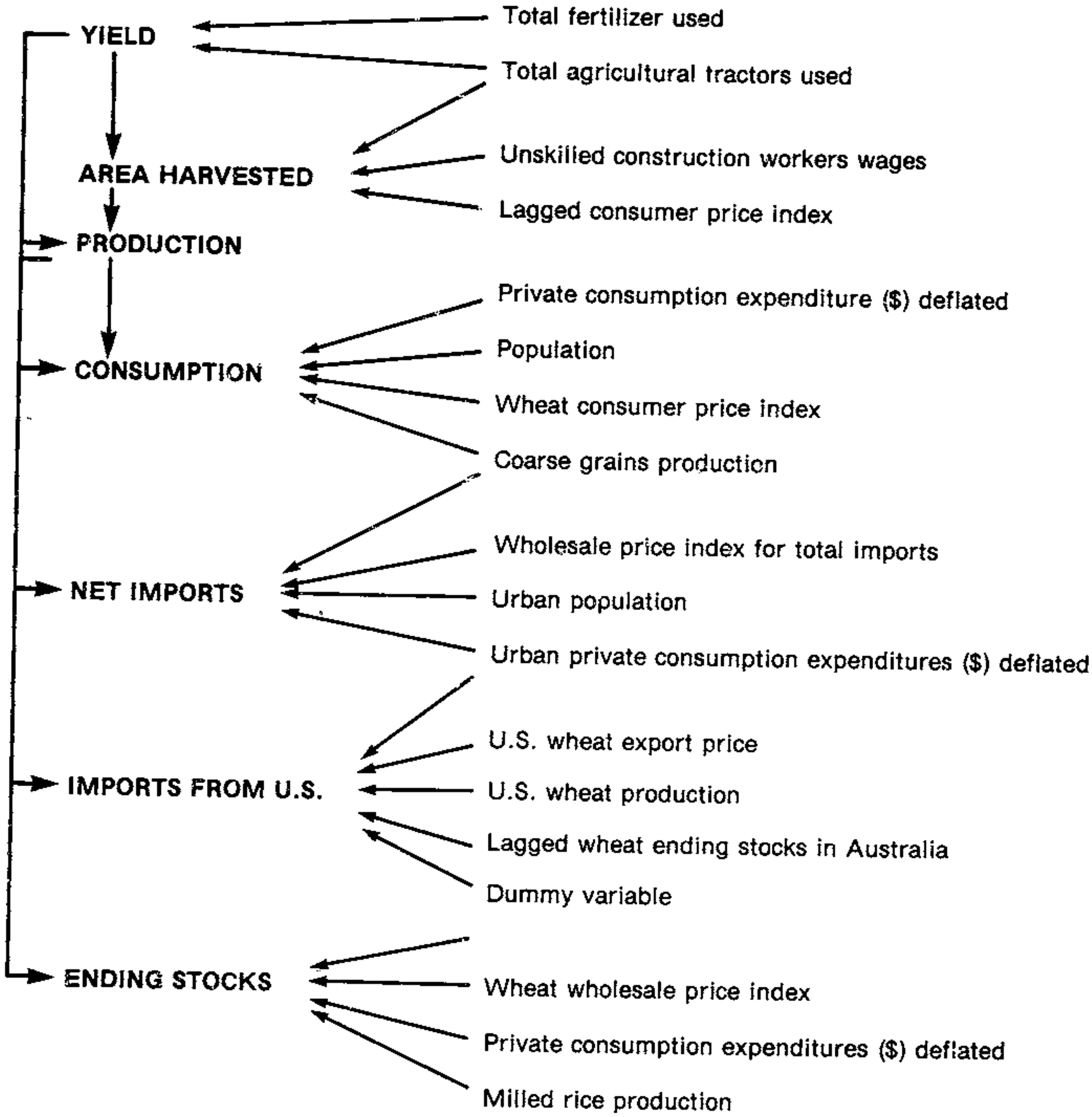


Figure 2. Visual representation of the wheat model

Table 12--Share of imported wheat by major provinces, Iran, 1973/74

Provinces	Quota	Quota	Population
	Tons	Percent	Percent
Tehran and suburbs	225,000	57	19
Khorasan	17,000	4	9
East Azarbaijan	16,000	4	10
Isfahan	20,000	5	5
West Azarbaijan	10,000	3	4
Kermanshahan	8,000	2	2
Fars	6,000	1	6
Sisten & Baluchestan ...	8,000	2	2
Mazandaran	5,000	1	7
Gilan	5,000	1	5
Other	70,000	20	31
Total	390,000	100	100

Source: Ministry of Rural Cooperatives, Tehran.

Wheat Production

Because production is determined by area and yield, it is important to determine which is the most instrumental in causing output variations from year to year (20). In the analysis, the effect of a percentage change in area and yield on output, representing the relative influence of the total output determinants, was obtained. The natural logarithms of wheat output were regressed jointly on the natural logarithms of yield and area harvested. Results of the model indicated that changes in yield are more instrumental in causing variations in total output. A 1-percent change in yield changes output by 1.37 percent, while each 1-percent change in area harvested changes output by only 0.63 percent. Since wheat planting takes place mainly on non-irrigated lands, and since crop yields are primarily a function of technology and weather, and secondarily a function of economic factors such as prices, Iranian farmers have few possibilities of controlling year-to-year variation in yield. The relatively small effect of a change in acreage upon a change in wheat output for the 15 years considered reflects Iran's traditional farming sector, with its lack of response to market conditions, especially prices.

To estimate wheat yield, or yields of other crops, proxies for weather and technology should be used as explanatory variables. Generally, historical time series data related to production and weather or average rainfall by regions were not available. Data on wheat yield (total, irrigated, and nonirrigated) and rainfall for 12 regions were obtained for the years 1349, 1350 and 1351 (1970-71, 1971-72 and 1972-73). From regressing wheat yield on the previous year's rainfall--mainly to account for September-May precipitation--the significance of rainfall in explaining wheat yield (total and in irrigated and nonirrigated areas) was examined (pp. 3). The 1.0-millimeter increase in the previous year's rainfall would tend to increase wheat yield by 1.3 kilos per hectare and 0.51 kilos per hectare for nonirrigated and total area, respectively. However, in irrigated areas, the estimated equation seems to indicate that a 1.0-millimeter increase in the previous year's rainfall would tend to decrease wheat yield by 0.22 kilos per hectare.

The total number of agricultural tractors used indicates the technological progress and mechanization in tillage. The impact of tractors on Iran's farms is reflected mainly in increased output per hectare (20).

The use of fertilizer is also important in intensive farming, especially on irrigated farms. Current fertilizer use averages about 60 kilos per hectare on total cultivated area, and 137 kilos per hectare on irrigated land. About 60 percent of fertilizer is applied between September and November with the remainder applied between March and May. Thirty-two percent of total fertilizer use is for wheat production. Given that the farming land/population ratio is low, the average yield--and output--may depend on current inputs such as fertilizer in the short run.

In the absence of time series weather variables, the estimated yield equation is:

$$WY(L) = 7.3677 + \underset{(.145)}{0.0041\ FRTU(L)} + \underset{(2.072)}{0.0713\ TRAG(L)}$$

$R^2 = 0.997$ S.E. = 0.517 D.W. = 1.557 F = 1275.0 $\overline{Y} = 8.53$

Total fertilizer consumed, (FRTU(L), is not significant at the 0.1-level of significance, but both variables have the correct a priori expected signs. The year-to-year variations in both FRTU(L) and total tractors in use, TRAG(L), explain 99 percent of the variations in wheat yield, WY(L). The equation fits well, and has a standard error representing about 6 percent of the average yield per hectare for the 1960-73 sample period.

The price response of production was investigated through trying several variables: a 3-year moving average of the wheat wholesale price index, WWPI(L); the previous years' wheat wholesale and consumer price indices, WWPI(L-1) and WCPI(L-1); and the first difference of wholesale price index [WWPI(L) - WWPI(L-1)]. All these variables were used separately or in combination in estimating wheat yield, but were consistently insignificant and provided a negative sign. This left the possibility of investigating the price effect on area harvested.

WWPI(L-1) and wheat consumer price index, WCPI(L-1), as proxies for wheat farm prices, provided a positive and a priori expected sign when used to explain variation in the yearly wheat area harvested, WAH(L). Both variables were insignificant at the 0.1 level and their omission improved the standard error of the equation slightly. For compatibility between this model and models for other countries, WCPI(L-1) was used as an explanatory variable to estimate WAH(L). The TRAG(L) was very significant in explaining variation in area harvested. The use of WY(L) in explaining WAH(L) illustrates the advantage of harvesting marginal land with low yield. The rationality in crop harvesting was tested in this equation. If yield is high in any given year, it will be profitable for farmers to employ labor and machines to harvest the area. However, as land productivity differs, area with low yield may be left unharvested.

Availability of hired labor is a major problem. The agricultural sector finds it difficult to compete with increasing construction and industrial wages. The unskilled construction workers wages index, UCLWI(L) illustrates the approximate number of opportunities open to agricultural workers outside the farming sector. The higher the UCLWI(L), the less likely it is that agricultural workers will be available to work. Thus, the final estimated equation for wheat area harvested, WAH includes WY(L), TRAG(L), UCLWI(L), AND WCPI(L-1) as explanatory variables. The estimated equation for harvested wheat area is:

$$WAH(L) = -119.3244 + \underset{(3.965)}{379.3978\ WY(L)} + \underset{(2.793)}{41.6497\ TRAG(L)} - \underset{(1.955)}{6.5340\ UCLWI(L)}$$

$$+ \underset{(0.8258)}{6.83449\ WCPI(L-1)}$$

$R^2 = 0.999$ S.E. = 159.94 D.W. = 2.887 F = 1615.8 $\overline{Y} = 3969.2$

The equation fits well with S.E. of 160,000 hectares, which is about 4 percent of the average wheat area harvested for the 1961-73 sample period.

The indirect wheat production estimate is obtained by multiplying WY(L) by WAH(L). Because WY(L) is in quintals per hectares, it is divided by 10.0 to convert it to metric tons per hectares. The direct equation for estimating wheat production is:

$$WQ(L) = 1411.3299 + \underset{(1.22)}{66.3379}\, TRAG(L) - \underset{(0.115)}{1.3978}\, UCLWI(L) + \underset{(0.412)}{10.1345}\, WCPI(L-1)$$

$R^2 = 0.953$ S.E. = 405.4 D.W. = 1.86 $\hat{\rho} = 0.603$ F = 46.04

This equation does not totally conform with theoretical considerations. The effect of TRAG(L) and UCLWI(L) is insignificant at the 0.1-level of significance, but the coefficients are still associated with correct a priori expected signs. FRTU(L), associated with a negative sign, is omitted from the equation. The appearance of $\hat{\rho}$ indicates that the generalized least squares method was used.

Wheat Consumption

Estimated total wheat consumption is:

$$WCT(L) = 3102.84 + \underset{(1.073)}{0.203}\, WQ(L) - \underset{(3.221)}{1.5504}\, CGQ(L) + \underset{(2.293)}{0.1725}\, PCE\$D(L)$$

$$+ \underset{(2.858)}{147.485}\, P(L) - \underset{(2.239)}{31.6349}\, WCPI(L)$$

$R^2 = 0.999$ S.E. = 154.04 D.W. = 3.29 F = 1567.6 $\bar{Y} = 3798.5$

All included variables have a priori expected signs and are significant at the 0.05 level of significance except wheat production WQ(L). The weak association between total wheat consumption, WCT and WQ is explained by the large fluctuations in production and the stable consumption of wheat. Consumption increases by only 0.7 percent for each 10-percent increase in production. The small effect of private consumption expenditure in dollars deflated PCE$D(L) on WCT(L) is also reasonable, since people increase wheat consumption very little, if any, as income increases. The 1-percent increase in PCE$D(L) would increase WCT by only 0.2 percent. Also, the price elasticity of -0.19 seems reasonable. The estimated coefficient associated with the population variable indicates that yearly consumption would increase by 147 kilograms for each one-person increase in population. This figure closely reflects the average per capita wheat consumption. The inclusion of CGQ(L) reflects the substitutability of wheat, barley, and corn.

Generally, the equation fits very well, with a standard error of 154,040 tons. This is about 4 percent of the average annual wheat consumption for the 1961-74 sample period.

Net Wheat Imports

The directly estimated equation for net wheat imports is:

$$WNM(L) = 4044.7133 - \underset{(3.403)}{0.3268}\, WQ(L) - \underset{(6.347)}{1.7823}\, CGQ(L) + \underset{(6.126)}{0.5036}\, UPCE\$D(L)$$

$$- \underset{(2.164)}{109.1654}\, UP(L) - \underset{(4.233)}{13.099}\, IWPI(L)$$

$R^2 = 0.986$ S.E. = 93.77 D.W. = 2.6226 F = 103.36 $\bar{Y} = 400.2$

As previously indicated, wheat imports are a reflection of the urban population's needs over and above the remaining 40 percent of domestic production. For purposes of the model, this means including private consumption expenditure and population for urban areas only, rather than for the whole country. Iran's import wholesale price index is included to reflect the general level of import prices.

All variables were significant at the 0.05 level and the coefficients are associated with expected a priori signs. The negative sign associated with UP(L) reflects the different pattern in wheat consumption between urban and rural areas. The coefficient indicates that for each one-person increase in UP(L), net imports would decrease by 109 kilograms. This figure supports the previous hypothesis of the existing difference between rural and urban per capita consumption of wheat. Although the equation fits well, the S.E. of almost 94,000 tons is high, representing almost 23 percent of the average WNM during 1960-74.

Net wheat imports were also obtained through the following identity, which will utilize the estimated equations of WQ, WCT, and wheat ending stocks WES. This equation would be estimated at the end of the chain of equations, where WES would be estimated:

$$WNM(L) = WCT(L) - WQ(L) - WES(L-1) + WES(L)$$

The equation would be used only for checking against the estimates of the direct equation.

Wheat Imports from the United States

Directly estimating the U.S. market share through a stochastic equation--that is, by estimating WMFUS as a function of WNM and other important variables or using WMFUS/WNM as the dependent variable--was not successful. Hence the equation presented estimates WMFUS directly without explicitly estimating the U.S. market share. This equation is:

$$WMFUS(L) = 277.0484 - \underset{(4.274)}{0.3855}\, WQ(L) + \underset{(8.960)}{5.0954}\, UPCEN\$D(L) - \underset{(3.966)}{8.3597}\, (WPEXUS(L)$$

$$+ \underset{(1.269)}{0.0076}\, WQUS(L) - \underset{(4.336)}{0.039}\, WESAUST(L) + \underset{(4.292)}{711.119}\, D1$$

$R^2 = 0.993$ S.E. 53.695 D.W. = 2.619 F = 150.49 $\overline{Y} = 304.2$

W^h the inclusion of WNM in the equation instead of WQ, the signs associated with other included variables were not as *a priori* expected. The equation fits very well and the variables included explain 99 percent of the variations in WMFUS. The U.S. wheat export price and current U.S. wheat production are included to represent the availability and feasibility of buying wheat from the United States rather than from other countries such as Australia. The previous year's ending wheat stocks in Australia are included in the equation to represent availability of wheat from other markets. All variables are significant at the 0.05 level except WQUS(L). Although the equation provides a good fit, its standard error is still about 18 percent of the average wheat imports from the U.S. WMFUS for the 1960-74 sample period.

The estimates of WMFUS obtained from this equation along with net wheat imports WNM estimated previously can be used to estimate and forecast the U.S. market share, K(L). This share, as a percent of total net imports, can be calculated as:

$$\frac{WMFUS(L)}{WNM(L)} = K(L)*100.0$$

To estimate the U.S. market share directly, however, the following equation was estimated, using 1960-74 data:

$$WMFUS(L) = \underset{(12.48)}{0.7124}\, WNM(L)$$

$R^2 = 0.92$ S.E. = 134.25 D.W. = 1.801 F = 155.8

The equation indicates that on the average, the United States captures around 70 percent of Iran's wheat import market. This percentage could be used for forecasting.

Wheat Ending Stocks

The final equation in the wheat sector is the ending stocks equation, estimated as:

$$WES(1) = -329.6699 + \underset{(3.484)}{0.3153}\, WQ(L) - \underset{(1.351)}{0.4698}\, RMQ(L) - \underset{(3.368)}{0.0954}\, PCE\$D(L)$$

$$+ \underset{(3.778)}{3.9946}\, WWPI(L)$$

$R^2 = 0.967$ S.E. = 88.153 D.W. = 2.566 F = 58.373 $\overline{Y} = 377.8$

Year-to-year variations in the wheat stocks depend on domestic production and world prices. In addition factors affecting consumption logically influence the amount left in the silos by the end of the year. Availability of storage facilities is also a factor. The milled rice production used in this equation represents the competition for limited storage in Iran. The significant negative association of WES and PCE$D conforms with the logic of the positive sign associated with PCE$D in the WCT equation. The equation fits very well and explains 97 percent of the variation in WES, with S.E. less than 23 percent of the average ending stocks for the 1960-74 sample period. The estimates of WES are then used to obtain WNM indirectly.

Rice Model

In terms of area, rice is the third most important cereal crop in Iran, after wheat and barley. Rice is the main dish for people living in northern Iran and in the Caspian coastal regions, and is being consumed in greater quantities all over the country. The regions of most intensive production are the Rasht district (the lower valley of the Safid Rud) and the Caspian provinces of Mazandaran and Gilan. Rice is also increasingly grown in other parts of the country where irrigation water is available and as new irrigation schemes develop (17).

The yearly rice area harvested has not changed noticeably in the past 15 years. The area harvested declined in the early sixties, but this trend was reversed in the early seventies, increasing from 250,000 hectares in 1969 to 310,000 hectares in 1973. Many farmers, noting the difficulty of keeping a successful farming operation in Iran, the lack of farm labor, and the attractive housing investment returns, are selling their farms to construction companies or converting them to hotels or apartment buildings. As this increasingly occurs in the Caspian coastal region, rice areas will be most affected.

Published data indicated a negative association between yield and area harvested of rice, a relationship which was repeated seven times during 1965-73 (table 13).

It is probable that rice production in Iran is demand-limited--that is, there is a substitution between yield and area harvested to produce the amount of rice required to meet the demand in that particular year. This phenomenon is different from that in wheat production, where yield and area are positively associated over time.

Iran was formerly a net exporter of rice, and the USSR was its main customer. For the last 15 years, however, the country has imported much of its rice, with the United States its main supplier since the early seventies. American exporters first sold rice in quantity to Iran in 1968. Although U.S. rice differs in quality and cooking characteristics, consumers accepted it fairly well. In 1974 and 1975, rice imports from the United States amounted to 92 and 80 percent of total rice imports, respectively.

In 1974, Iran's net imports of rice were 614 percent greater than the 1973 level (fig. 3). In 1975, rice imports were half those of 1974, but still 257 percent higher than in 1973. During 1973-74, production increased by 8 percent, while consumption increased by about 61.5 percent.

Table 13--Rice: Yield and area harvested percentage change from previous year's level, Iran, 1965-73

Year	Yield	Area harvested
	Percent	
1965	+18.5	- 6.0
1966	+ 2.7	0.0
1967	+10.7	- 6.8
1968	-11.1	+21.8
1969	+10.6	-21.4
1970	+ 0.7	+ 8.0
1971	-11.2	+ 3.7
1972	- 6.3	+ 3.6
1973	- 5.8	+ 6.9

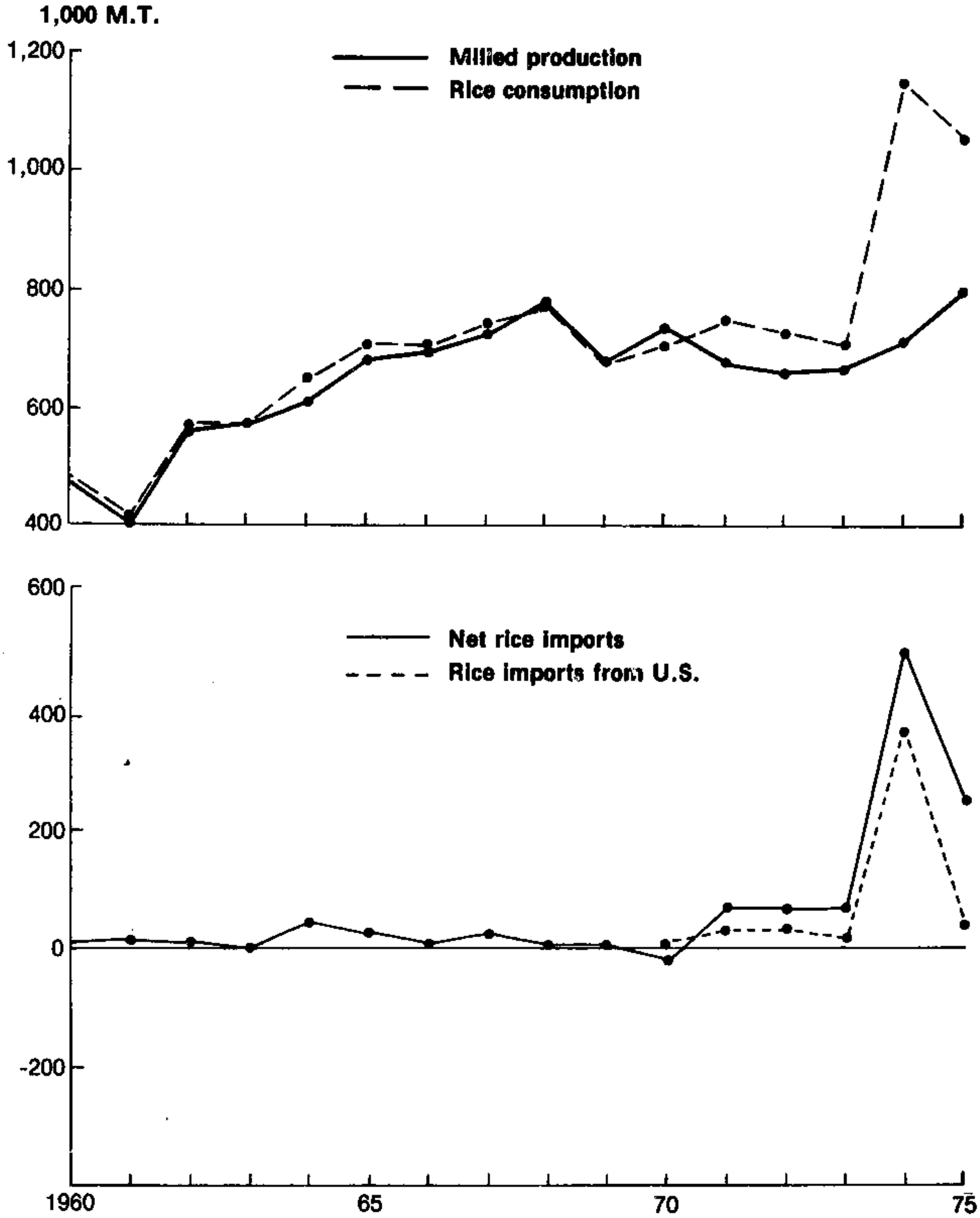


Figure 3. Rice production, consumption, and net imports, Iran

Given the data limitations, the rice model specified in this study is simple; however, it covers all aspects of major economic functions in that sector (fig. 4). Several statistical fits for different specifications were tried, but the reported equations are considered the best obtained fits.

Rough Rice Production

The rough rice production equations are similar to those estimated for wheat. This similarity stems from limitation in data availability. Rough rice production is estimated through a direct and indirect method. The indirect method, which is obtained by specifying and estimating separate equations for yield and area harvested, is applied where variables affecting yield and area harvested are combined to explain variations in production directly.

To separately identify the importance of changes in yield and area harvested on changes in production, the elasticities of each with respect to rough rice production were calculated. With area harvested held constant, it is estimated that a 1-percent change in yield will effect a 0.92-percent change in production. A 1-percent change in area harvested, holding yield constant, generates a 0.64-percent change in production. This analysis suggests, among other things, that changes in yield are more instrumental in causing variations in total output. The small effect of a change in area reflects the nature of Iran's agricultural sector--one characterized by a lack of response to market conditions (especially prices), and protection from the Government. Following the logical derivation used in specifying the wheat yield equation, the rough rice yield equation is estimated as:

$$RY(L) = \underset{}{22.35401} + \underset{(0.957)}{3.9438}\ LNT(L) + \underset{(.0371)}{0.1985}\ TRAG(L)$$

$R^2 = 0.97$ S.W. = 3.473 D.W. = 2.031 $\hat{\rho} = 0.6663$ F = 58.96 $\overline{Y} = 33.49$

Variations in time trend in natural logarithm, LNT(L) and total tractors in use, TRAG(L) explain 97 percent of the variations in rice yield. However, both variables are insignificant at the 0.05 level of significance. Although rice production accounts for 11 percent of total fertilizer utilized, total fertilizer consumed, FRTU(L) was associated with a negative a priori unexpected sign in all attempted fits. By using 1960-73 data, this equation was estimated by the G.L.S. method, as indicated by the appearance of $\hat{\rho}$.

The estimated rice area harvested equation is:

$$RAH(L) = 404.0308 - \underset{(1.955)}{4.4993}\ RY(L) + \underset{(1.250)}{4.2546}\ TRAG(L) - \underset{(0.944)}{0.5829}\ UCLWI(L)$$

$$+ \underset{(0.314)}{0.1509}\ RWPI(L)$$

$R^2 = 0.998$ S.E. = 17.78 D.W. = 2.828 F = 7[illegible]7.2 $\overline{Y} = 288.14$

The negative relationship between rice yield and area harvested is not surprising. The other variables included are insignificant at the 0.1 level of significance, but all have correct a priori signs. The unskilled construction workers wage index, UCLWI(L) is included because of the availability of agricultural labor for rice cultivation and harvesting. RWPI(L) is used to approximate farm prices. According to data means, area harvested will increase by only 0.6 percent for each 10-percent increase in the rice wholesale price index. The equation fits very well, with a standard error of 17,780 hectares--almost 6 percent of the average harvested area for the 1960-73 sample period.

Rough rice production could be calculated indirectly through the estimates of RY(L) and RAH(L) obtained from the previous two equations. To estimate RRQ(L) directly, all explanatory variables included in the rice yield, RY and rice area harvested, RAH equations, except FRTU(L), were used. FRTU(L) gave a negative a priori unexpected sign and was excluded from the equation:

$$RRQ(L) = 757.0946 + \underset{(7.233)}{34.9722}\ TRAG(L) - \underset{(3.827)}{5.0768}\ UCLWI(L) + \underset{(0.405)}{0.6888}\ RWPI(L)$$

$R^2 = 0.997$ S.E. = 63.504 D.W. = 2.673 F = 813.79 $\overline{Y} = 957.93$

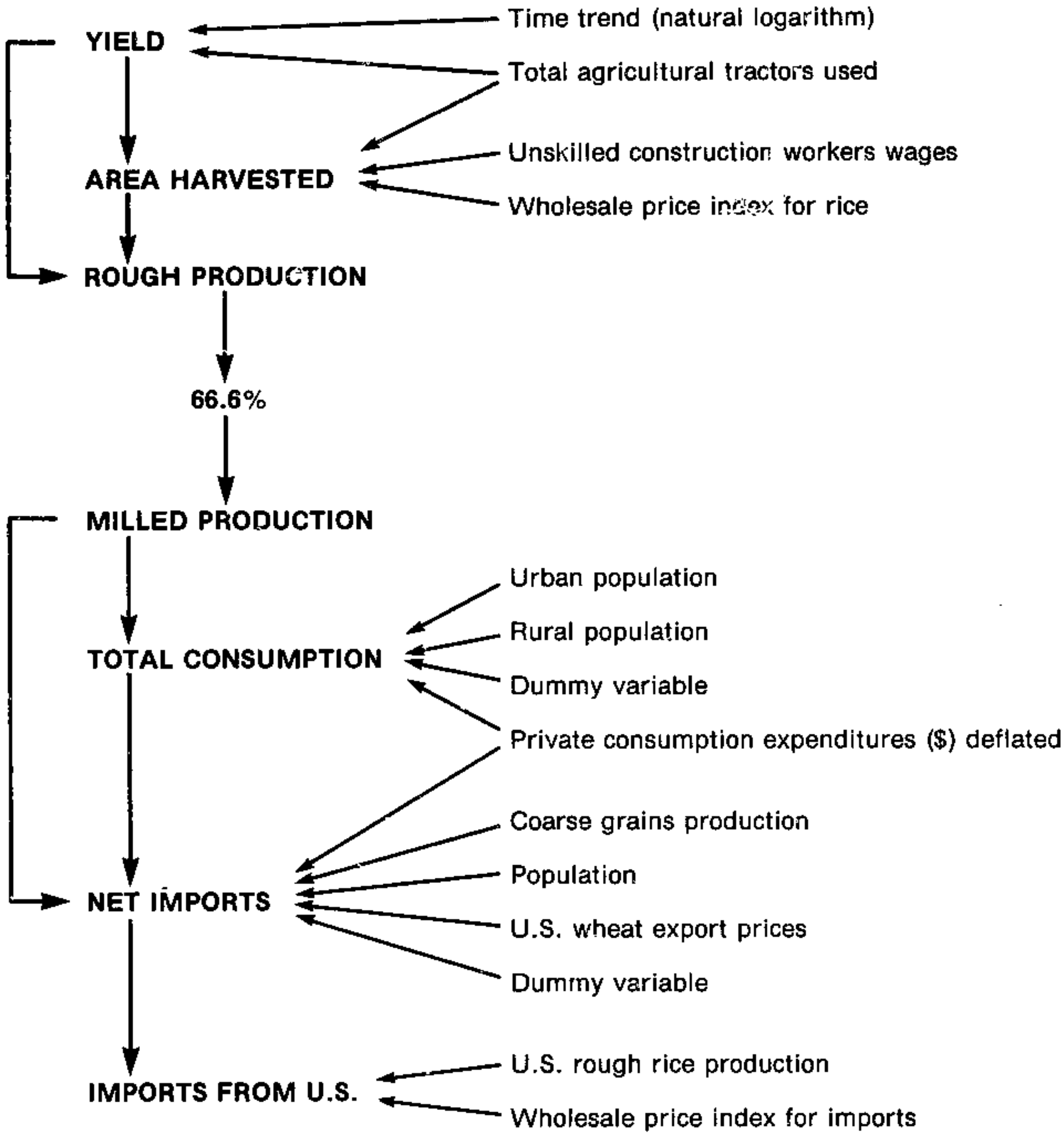


Figure 4. Visual representation of the rice model

Although TRAG(L) and UCLWI(L) were insignificant in the area harvested equation, they are significant at the 0.05 level of significance in the RRQ direct equation. The price variable, RWPI(L), still has a correct sign and insignificant effect. The elasticity-using data means of RRQ(L) with respect to RWPI(L), is around 0.08. The equation fits very well and the standard error of 63,504 metric tons is less than 7 percent of the average rough rice production during the 1960-73 sample period. Milled rice production is calculated at 66.6 percent of the rough production.

Total Rice Consumption

The reported consumption equation does not include a price variable which always maintained a positive *a priori* expected sign and insignificant coefficient. Although deviating from traditional economic theory, the equation proved useful in explaining some points. The total rice consumption equation is:

$$RCT(L) = 908.699 + \underset{(8.340)}{0.8396\ RMQ(L)} - \underset{(2.262)}{0.0586\ PCE\$D(L)} + \underset{(2.289)}{119.3312\ UP(L)}$$

$$- \underset{(1.693)}{103.9214\ RP(L)} + \underset{(8.939)}{454.1768\ D1}$$

$R^2 = 0.999$ S.E. = 23.612 D.W. = 2.21 F = 2256.5 $\overline{Y} = 691.9$

In general, the equation fits very well, with a standard error equaling 23,600 tons, which is only 3.4 percent of average total rice consumption for the 1960-74 sample period. All variables are significant at the 0.05 or 0.1 level of significance. Consumption would increase by 839 tons for each 1,000-ton increase in milled rice production. Although the expenditure variable is significant in explaining variations in total rice consumption, it is associated with *a priori* unexpected negative sign. It was left in the equation, however, for its effect on reducing the standard error. The division of population into urban and rural components provided information conforming to the known pattern of rice consumption in Iran. As migration from rural to urban areas increases, so does total rice consumption. The inclusion of D1--a dummy variable with the value of one for 1974 and zero otherwise--reduced the standard error of regression. The equation with D1 was superior to all other equations without it. This conclusion is reached by using the F-test for homogeneity (12).

Net Rice Imports

The net rice imports equation was estimated directly as:

$$RNM(L) = -237.3055 - \underset{(0.687)}{0.0442\ RMQ(L)} - \underset{(3.999)}{0.1243\ CGQ(L)} - \underset{(1.564)}{0.0285\ PCE\$D(L)}$$

$$+ \underset{(1.954)}{18.3587\ P(L)} + \underset{(1.834)}{1.3165\ WPEXUS(L)} + \underset{(0.684)}{365.7567\ D1}$$

$R^2 = 0.996$ S.E. = 11.982 D.W. = 2.353 F = 266.16 $\overline{Y} = 55.93$

Although the equation fits very well, the standard error of 11,982 tons is almost 21 percent of average net rice imports for the 1960-74 sample period. All variables are significant at the 0.05 or 0.1 level except RMQ, which was retained in the equation because of its logical and economic significance. The U.S. export price of wheat was added to the equation to reflect wheat prices in the world market in a given year. It is hypothesized that whenever world wheat prices are favorable, Iran would tend to increase its imports of wheat (either for direct consumption or stocks).

Net rice imports also were calculated through an identify equation indirect method:

$$RNM(L) = RCT(L) - RMQ(L) - RES(L-1) + RES(L) \quad 3/$$

3/ Rice ending stocks variable is treated as an exogenous variable. The data available start at 1969 and their statistical estimation may be more unreliable and costly to the model than just obtaining its values outside the quantitative model.

Rice Imports from the United States

The equation used to estimate Iran's imports of U.S. rice is:

$$RMFUS(L) = -186.5872 + \underset{(11.534)}{0.97596\ RNM(L)} + \underset{(1.607)}{47.1188\ RRQUS(L)} - \underset{(0.556)}{0.2258\ IWPI(L)}$$

$R^2 = 0.99$ S.E. =22.856 D.W. = 3.463 F = 102.13 $\bar{Y} = 66.8$

The U.S. market share is analyzed directly in this specification. When data means are used, a 1-percent increase in total net imports would increase U.S. exports to Iran by 1.3 percent. As expected, imports of U.S. rice are highly related to current levels of U.S. rough rice production. A 1-percent increase in RRQUS(L) would increase U.S. exports to Iran by 2.9 percent. Given the difference between mean values of RMFUS(L) and RRQUS(L), this result is reasonable. RMFUS(L) has a reported value of zero for 1967, 1968, and 1969. These values were included in the analysis, and the sample period used was 1967-74. This indicates that the reported standard error of 22,856 tons, 33 percent of average RMFUS for the sample period, is higher than it should be if the data for 1967, 1968, and 1969 were not included. The import wholesale price index, IWPI(L), is insignificant at the 0.1 level of significance. Its coefficient, however, is associated with a correct sign, and its inclusion reduced the standard error of regression. The equation indicates that for each 1-percent increase in IWPI(L), the current RMFUS(L) would increase by only 0.4 percent.

For 1975 and 1976, the United States captured an average of 81.5 percent of the rice import market in Iran. This ratio was assumed and RMFUS also was determined as:

$$RMFUS(L) = 0.815*RNM(L)$$

In the final model, a choice between those two equations for RMFUS(L) will be made depending upon their forecasting ability outside the sample period.

Coarse Grains Model

Livestock operations account for about 32.8 percent of total value-added in Iran's agriculture sector. A crucial issue in the overall development of Iran's livestock industry is the availability of feeds in sufficient quantity and quality and in proper mix to fulfill the requirements of the cattle, sheep, and poultry industries. As the numbers of sheep and goats have increased and range area has declined, rangeland has been overgrazed, perhaps by as much as three to six times the range capacity (18). In addition to sheep, goats, and cattle, there are horses, camels, and donkeys (used mainly for transportation in villages) also utilizing some of the feed resources (table 14).

Mutton and goat meat account for about 70 percent of red meat consumption in Iran; beef and veal constitute almost 30 percent, but their share is expected to increase. Camel meat and pork constitute only about 1.2 percent of total red meat consumed. Poultry consumption has increased dramatically in recent years (table 3), with per capita consumption rising from 1.8 kilograms in 1968 to 3.3 in 1975. Demand for meat is expected to increase substantially. The average per capita red meat consumption of 13.9 kilograms annually is very low by world standards (U.S. per capita consumption of red meat is 100 kilograms). With the rapid increase in income and low level of current meat consumption, demand for meat in Iran could increase by more than 10 percent per year (18).

Because of the overgrazing problem, the higher demand for meat, and the substantial development in Iran's poultry and dairy industries, demand for feed grains has increased rapidly in recent years (figs. 5-7). Expansion in feed grain production, however, competes with human food production. The allocation of land resources between food and feed depends upon relative prices, water availability, farmers' preferences, access to markets, and especially the potential policy of the Iranian Government (18). Iranian farmers tend to prefer food production crops, especially wheat, because of the insecurity of food supplies and a conservative attitude toward adopting new techniques (8). Development of feed production is consequently at a disadvantage. Feed development plans therefore require more incentives, extension services, and market guarantees, in addition to the removal of water and land constraints.

Table 14--Livestock population and coarse grain production, Iran, average 1961-65 and 1970-74

Year	Cattle	Buffalo	Camel	Sheep	Goat	Chicken	Duck	Coarse grains
				1,000 head				1,000 m. tons
1961-65 ...	4,901	203	234	24,400	13,860	24,900	128	986
1970	5,800	280	120	32,000	14,000	29,700	142	1,235
1971	5,700	280	115	32,000	14,000	20,500	143	835
1972	6,250	280	110	32,000	14,000	31,000	143	840
1973	6,350	265	111	34,000	15,000	32,000	143	940
1974	7,000	265	111	35,000	15,000	35,000	143	850
				Percent				
Percentage change, 1970-74 ..	20.7	-5.4	-7.5	9.4	7.1	17.8	.7	-31.2

Source: Ministry of Agriculture and National Resources and agricultural attache estimates (34).

Several Governmental agencies in Iran are involved in the development of the livestock industry and, in particular, the livestock-feed sector. Some officials believe that the real development of this sector lies in feed subsidy policies rather than in direct meat subsidies. Because feeds constitute up to 85 percent of meat production costs, lower feed costs could consequently change the meat supply function at the same price (18). The feed subsidies in Iran are implemented through the following general policies:

1. Input subsidies to feed producers for items such as fertilizer, credit, improved seeds, and irrigation equipment.

2. Subsidies in the form of deficiency payments to farmers, such as higher fixed prices for feed producers and lower feed prices for livestock producers.

3. Importing feed at higher prices and selling at lower prices to livestock producers, and at the same time ensuring incentives to domestic feed producers to expand their production.

Such policies, however, have not been very successful. The Government-fixed prices for feed producers are lower than producers are hoping for. Although the Government sells feed (domestic and imported) at lower prices to livestock producers, there is a quota for each producer, which is determined according to the size of the livestock operation. This quota is very small and does not provide the necessary incentive for livestock or poultry producers to expand. In general, the producers must buy the major portion of their feed at free-or black-market prices.

In Iran, there have been no other major sources of feed grains other than barley, small amounts of corn, and a negligible amount of sorghum. Barley is second in importance to wheat and is grown in the same areas. Since barley needs less water than wheat, it is grown on marginal land. More than 75 percent of the land under barley cultivation in 1971 was nonirrigated. Although barley is the second largest cereal crop in terms of area, total coarse grains (barley and corn) area harvested was only a third of the wheat area harvested in 1975. Corn production in 1975 represented only 6.4 percent of the coarse grains, and its area harvested was only 2.1 percent of the barley area harvested. Barley is used mainly for animal feeding, although small portions are used for human consumption. Barley used for food was only 29 and 20 percent of total barley consumed in 1960 and 1975, respectively. In this study, 80 percent of corn production and all corn imports are assumed to be allocated for animal feeding.

During 1960-75, coarse grain imports ranged from zero to 450,000 tons. For many years, Iran was self-sufficient in barley and corn, mainly because livestock was not grain fed and the poultry industry not yet commercially developed. In the last few years, however, barley and corn production have not met domestic requirements. Given the Iranian people's traditional preference for domestic fat-tailed mutton and rejection of imported frozen or chilled meat, it may be advantageous for the Government to import feeds rather than meat. This strategy, which is in conflict with the recommendation provided in the National Cropping Plan Study (3), must take such factors as employment, foreign exchange, and meat costs into consideration. The argument, as adopted by Government agencies, concludes that imports of feed for chicken, beef, and mutton production under the present price system are preferable to meat imports per se (18). This fact underlies the recent sharp increase in coarse grain imports. In 1975 red meat imports were about 3.5 times above the 1970 level, but coarse grain imports were up more than 26 times.

During 1973-75, the United States supplied most of Iran's coarse grain imports. In 1973, imports from the United States were 349,000 tons; total imports amounted to 380,000 tons. In 1974 and 1975, imports from the United States accounted for 60 and 75 percent of Iran's total imports of coarse grains, respectively.

Of the three models presented, the first is developed to quantify factors affecting production, consumption, and trade for coarse grains as an aggregate commodity composed of barley and corn. The second model is specified for corn, and third for barley. The coarse grains model can be substituted for the corn and barley models, and vice-versa, depending on the ability of each to forecast outside the sample period. In the barley model, the barley imports equation is derived from the total coarse grains and corn imports equations. Although no quantitative analysis was attempted to incorporate the livestock sector, the interrelationships between the feed and livestock sectors were recognized in the models. Variables representing changes or development in the livestock sector are considered in the specification, and their impact is analyzed.

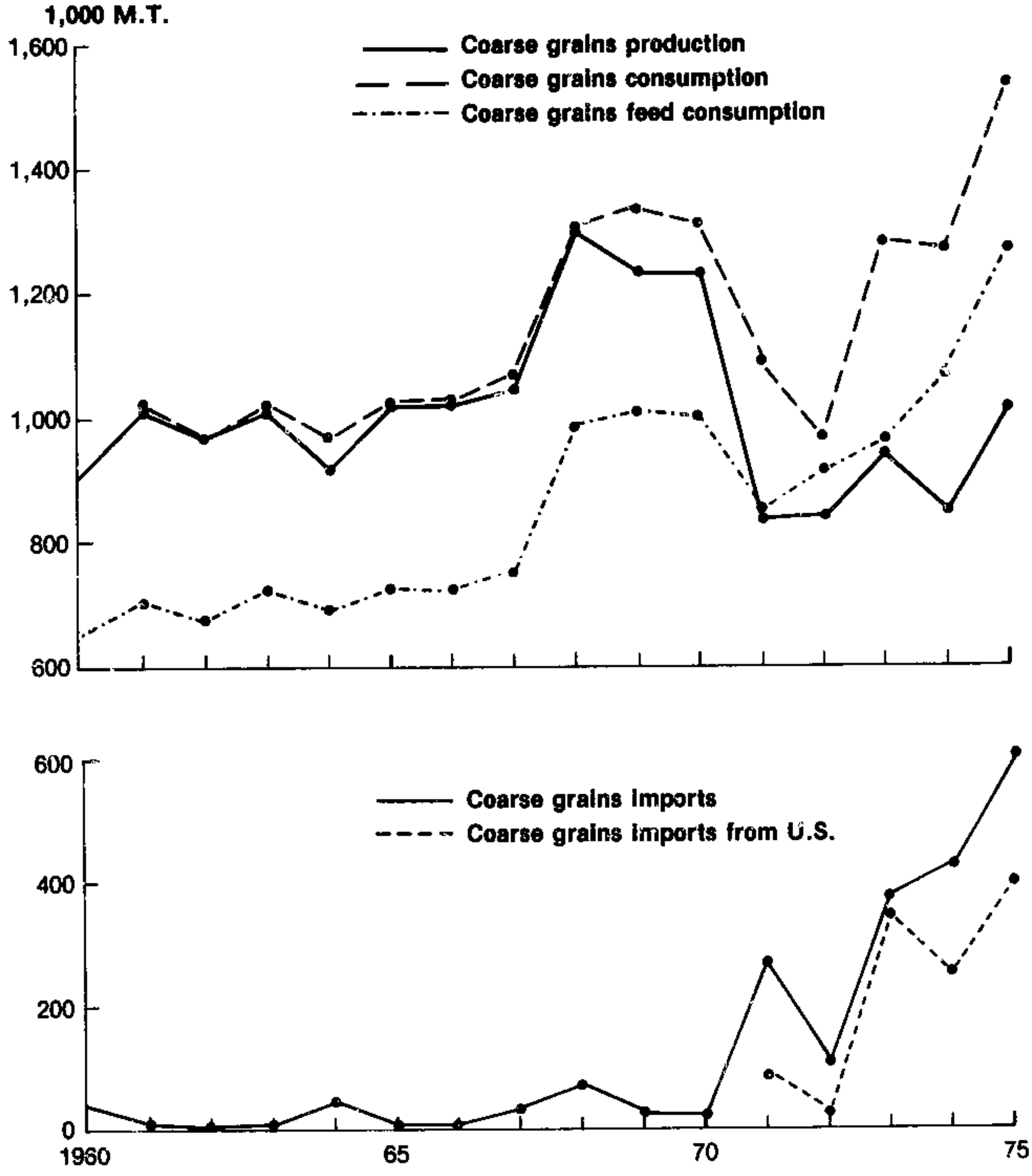


Figure 5. Coarse grains production, consumption, and imports, Iran

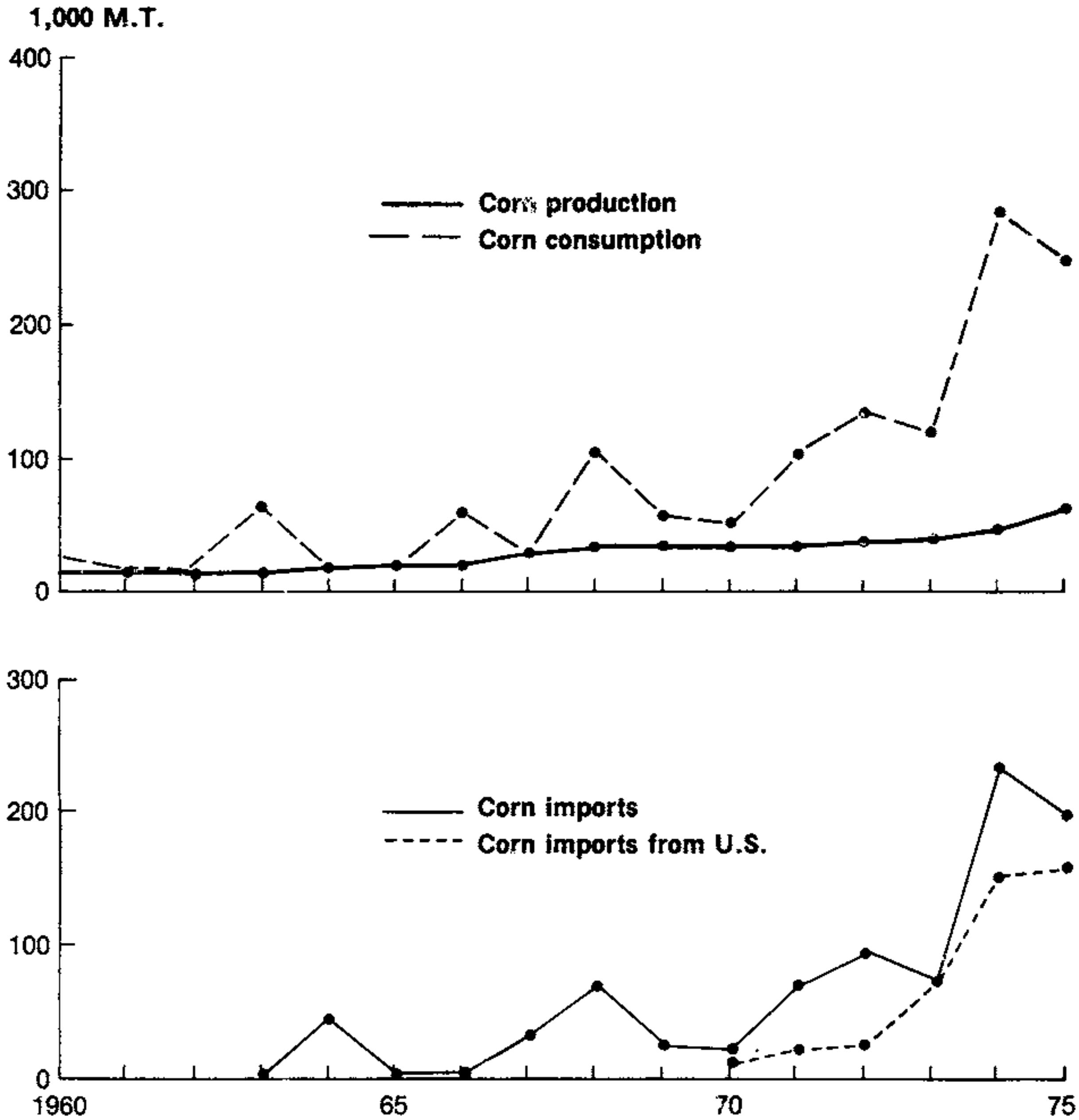


Figure 6. Corn production, consumption, and imports, Iran

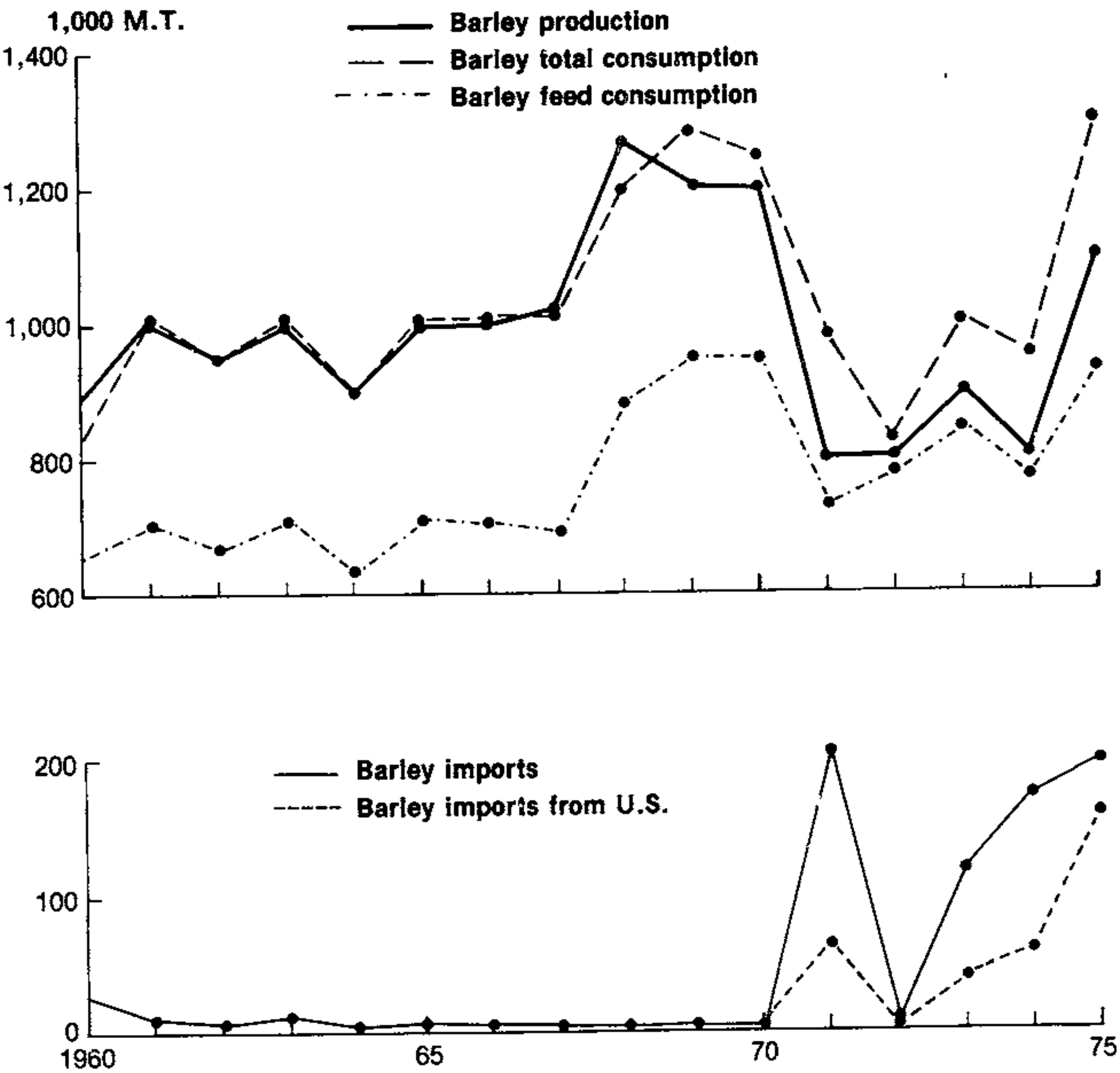


Figure 7. Barley production, consumption, and imports, Iran

Aggregate Coarse Grains Model

To isolate the effects of changes in yield and area on changes in production, (fig. 8) a natural logarithm regression of production on yield and area harvested for the aggregated commodity and its components was fitted (table 15). Results indicate that yield is a more important instrument than area in causing changes in total output.

Table 15--Relative impact on production of a change in yield and area harvested, Iran

Crop	Yield	Area harvested
	Percent	
Coarse grains	1.11	0.65
Corn	0.89	0.34
Barley	1.08	0.66

Coarse Grain Production--Coarse grain production is estimated directly and indirectly. In the indirect method, no equation is presented for yield estimation coarse grains yield, CGY(L). All trials failed to produce an acceptable equation. Thus CGY(L) was used as an exogenous variable. The indirect method of estimating coarse grain production is therefore a product of the exogenous yield variable and the estimates of area harvested obtained from the equation:

$$CGAH(L) = 707.1769 + \underset{(1.447)}{35.1615\ CGY(L)} + \underset{(3.662)}{0.1787\ WAH(L)} - \underset{(2.735)}{1.9799\ UCLWI(L)}$$

$R^2 = 0.999$ S.E. = 50.944 D.W. = 2.826 F = 2972.7 $\bar{Y} = 1483.0$

There is a positive association between yield and area harvested. The wheat area harvested variable has a positive sign, which is logically acceptable. Wheat and coarse grain area planted may in fact be in competition, and, with appropriate relative price signals, be negatively associated because both areas are planted in the same parts of Iran. For area harvested, however, this is not necessarily the case. Labor available for barley harvesting could be utilized 3 to 4 weeks later for wheat harvesting, and most other farm resources can be allocated to barley harvesting before wheat harvesting starts. The wage index of unskilled construction labor has a negative *a priori* expected sign. The equation fits well, with a standard error that is over 3.4 percent of the average area harvested during the 1960-73 sample period. The direct equation to estimate coarse grains production is:

$$CGQ(L) = -156.535 + \underset{(1.763)}{9.5116\ SGWPI(L-1)} - \underset{(1.984)}{6.7926\ UCLWI(L)} + \underset{(1.161)}{0.1296\ MLSL(L-1)}$$

$R^2 = 0.965$ S.E. = 115.39 D.W. = 1.879 p = 0.536 F = 68.56 $\bar{Y} = 1017.2$

The effect of sheep and goat meat wholesale price index SGWPI(L-1) indicates the expected profitability of feeding, especially for lamb and sheep, and hence affects the level of coarse grain production. The equation indicates that a 10-percent increase in the sheep and goat wholesale price index in the previous year would increase the current level of CGQ(L) by 8 percent. Inclusion of the previous year's mutton and lamb slaughter numbers provides an approximation for expected feeding requirements in the current year. A 10-percent increase in MLSL(L-1) would tend to increase CGQ(L) by 9.4 percent. The equation fits very well, with a standard error that is over 115,000 tons, or about 11 percent of the average CGQ(L) for the 1960-73 sample period.

Coarse Grain Consumption--Food consumption accounts for 20 percent of corn production and for a small portion of barley production. Feed consumption for about 80 percent of corn production and for all corn imports. Separate equations to explain variations in human and animal consumption were developed.

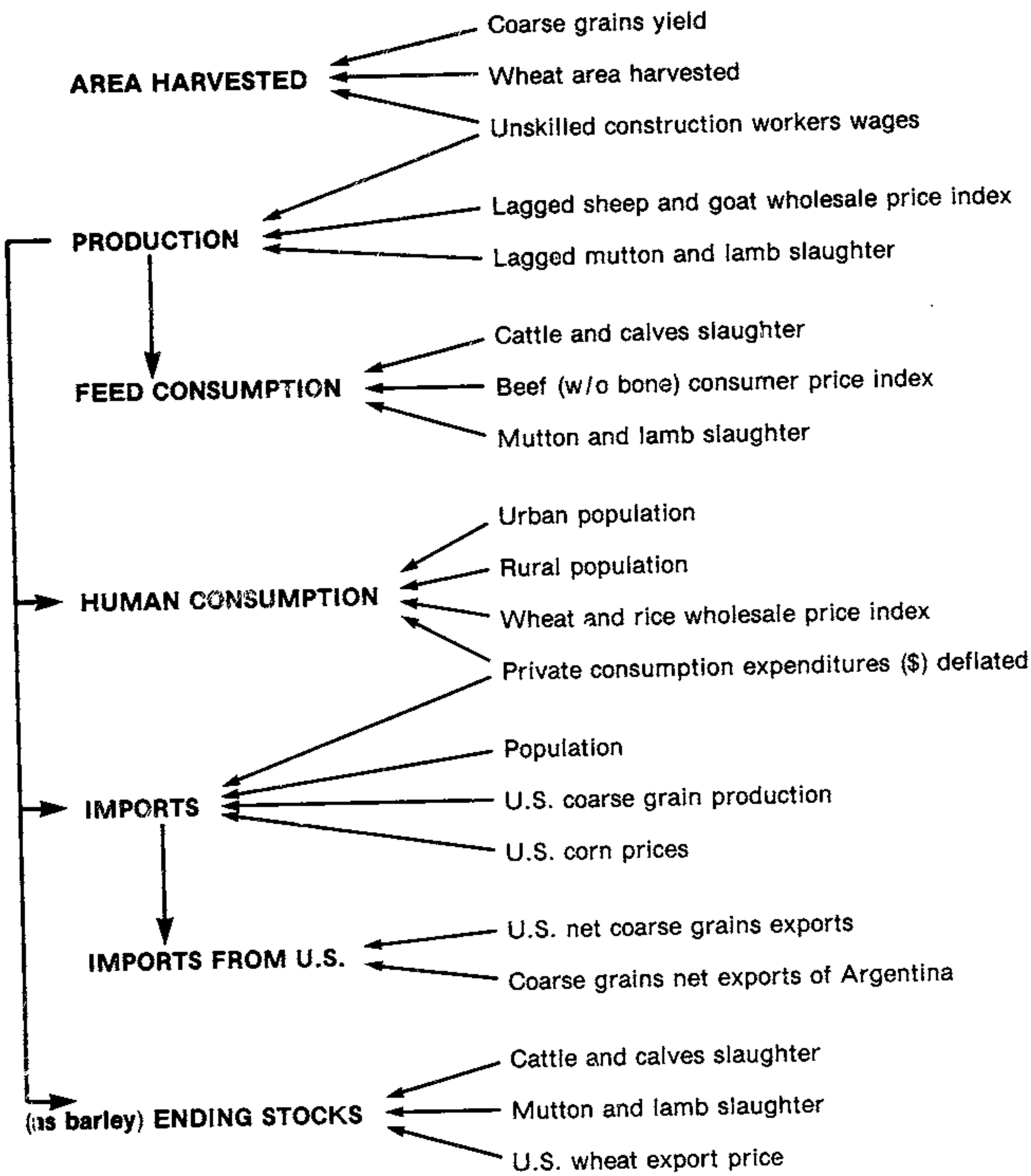


Figure 8. Visual representation of the coarse grains model

Most consumption of barley for food takes place in the rural areas. Different consumption patterns between the urban and rural population are taken into consideration through the inclusion of urban (UP) and rural populations (RP) into the estimated equation. The wheat and rice consumer price index was also included as prices of substitute cereals in Iran. The estimated equation is:

$$CGCH(L) = -941.9811 + \underset{(1.656)}{0.2574}\ CGQ(L) + \underset{(1.513)}{0.07972}\ PCE\$D(L) - \underset{(1.051)}{130.7098}\ UP(L)$$

$$+ \underset{(0.682)}{106.6642}\ PR(L) + \underset{(0.539)}{1.7858}\ WRCPI(L)$$

$R^2 = .986$ S.E. = 53.351   D.W. = 3.008   F = 107.81 $\overline{Y} = 345.4$

All included variables have the <u>a priori</u> expected signs. The last three, however, are not significant. The standard error is almost 15 percent of the average coarse grain human consumption during 1960-74. The different signs of the coefficients associated with UP and RP are of interest when compared with the RCT(L) equation, where rice consumption is estimated. Again, the signs explain the difference in the pattern of consumption between rice and coarse grains in Iran.

The following equation is used to explain variations in the coarse grains feed consumption:

$$CGCF(L) = -379.9201 + \underset{(5.815)}{0.3772}\ CGQ(L) + \underset{(1.149)}{0.2846}\ BVSL(L) + \underset{(4.49)}{0.0754}\ MLSL(L)$$

$$+ \underset{(1.802)}{1.172}\ BCPI(L)$$

$R^2 = 0.999$ S.E. = 33.768   D.W. = 1.789   F = 1873.3 $\overline{Y} = 833.13$

Development in the livestock sectors affects coarse grains for feed CGCF consumption. BVSL and MLSL are included to represent the effect of meat production, and hence, its demand. As cattle and calf slaughter, BVSL(L) and sheep and lamb slaughter, MLSL(L), increase by 1,000 head, coarse grains for feed consumption will increase by 285 and 75 tons, respectively. This indicates the larger requirement of feeding cattle than sheep. Since not all slaughtered animals are fed barley, however, the reasonableness of these figures cannot be judged from available data. As beef prices increase, the feeding profitability will increase. The equation fits well, and the standard error represents only 4.1 percent of the average CGCF for the 1960-74 sample period.

<u>Coarse Grain Imports</u>--The equation specified and estimated for the coarse grains imports is:

$$CGM(L) = 1803.598 - \underset{(1.737)}{0.2593}\ CGQ(L) + \underset{(1.899)}{0.2326}\ PCE\$D(L) - \underset{(1.728)}{110.1186}\ P(L)$$

$$+ \underset{(1.667)}{0.00314}\ CGQUS(L) - \underset{(1.057)}{5.0537}\ CPUS(L)$$

$R^2 = 0.944$ S.E. = 62.882   D.W. = 3.143   F = 16.898 $\overline{Y} = 117.17$

The United States, Argentina, and Australia are the major exporters of coarse grains to Iran. CGQUS(L) was included to represent the leading role of the United States in the coarse grains world market and to approximate the availability of coarse grains in the world market. CPUS(L) was used to approximate coarse grain prices in the United States. The population variable had an unexpected negative sign but was significant at the 0.1 level and was kept for its effect on reducing the standard error. Because CGM ranged from 1,000 to 428,000 tons during 1963-74, and the expected level of imports is likely to stem mainly from factors existing late in the sample period, the high standard error of this equation is acceptable.

Imports are calculated indirectly through an identity equation including the estimates of coarse grains production, CGQ(L), CGCF(L), coarse grains consumption for food, CGCH(L), CGES(L), and CGES(L-1). Results obtained from the direct and indirect methods are compared in the computer simulation model.

Coarse Grains Imports from the United States--As indicated earlier, the United States has accounted for most of Iran's coarse grain imports during the last 3 years, but there is some competition from Argentina. This factor is taken into consideration in the estimated equation:

$$CGMFUS(L) = -178.272 + \underset{(2.576)}{0.409\ CGM(L)} + \underset{(1.544)}{0.0034\ CGNEXUS(L)} + \underset{(1.871)}{0.0171\ CGNEXAR(L)}$$

$R^2 = 0.93$ S.E. = 42.43 D.W. = 2.145 F = 25.222 $\overline{Y} = 62.17$

The equation is acceptable despite the large standard error. Coarse grains net exports from Argentina, CGNEXAR(L) has an unexpected positive sign, but total net imports from Argentina could be positively associated with CGMFUS over time, while keeping the percentage of the market share captured by the United States unaffected--that is, the effect of coarse grains imports CGM on coarse grains imports from the U.S. (CGMFUS). By using 1971-75 data, a simple equation was attempted to explain CGMFUS as a function of CGM.

$$CGMFUS(L) = \underset{(7.84)}{0,65581\ CGM(L)}$$

$R^2 = 0.94$ S.E. = 73.626 D.W. = 1.815 F = 61.515

It is clear that this equation indicates a larger U.S. market share but has a very high standard error.

Coarse Grain Ending Stocks (Barley Ending Stocks)--According to available data, there are no corn stocks in Iran; thus, coarse grain ending stocks consist only of barley. The following equation is also used for barley ending stocks:

$$CGES(L) = 194.7569 + \underset{(2.307)}{0.1227\ CGQ(L)} - \underset{(1.809)}{0.2549\ BVSL(L)} - \underset{(1.853)}{0.0197\ MLSL(L)}$$

$$+ \underset{(1.962)}{0.6224\ WPEXUS(L)}$$

$R^2 = 0.94$ S.E. = 25.841 D.W. = 2.0172 F = 31.327 $\overline{Y} = 77.87$

Note the logical difference of signs of the coefficients associated with BVSL(L) and MLSL(L) in this equation and the feed consumption equation. The U.S. wheat export price was included to approximate the price level of wheat in the world market and to represent the notion that wheat and barley are competing for limited available storage facilities. As the wheat export price from the U.S. WEXPUS(L) increases, Iran will import only as much as consumption requires, so that enough space will be available for barley storage. The opposite may occur when WEXPUS is low.

Corn Model

Until recently corn was a minor crop in Iran. Production has started to expand in the last few years, and its cultivation is gaining popularity among Iranian farmers. Imports of U.S. corn have increased during the last 3 years and are expected to maintain high levels. The model specified and estimated for corn is presented in figure 9.

Corn Production--Yield has a more significant effect on year-to-year variations in corn production than does area harvested. As in the other models in this study, corn production is estimated through both direct and indirect methods. The indirect method consists of estimating yield and area harvested separately. The estimated equation for corn yield is:

$$CY(L) = 8.3702 + \underset{(6.508)}{0.3273\ TRAG(L)} - \underset{(1.309)}{0.0163\ WWPI(L-1)}$$

$R^2 = 0.986$ S.E. = 0.5684 D.W. 1.4375 $\hat{\rho} = 0.6907$ F = 263.86

There are no corn price series data available for Iran. Since corn production is expanding in districts where wheat can be produced, farmers' expectations of wheat prices, given their traditional experience in wheat farming, affect the resources allocated to corn production. As the lagged wheat wholesale price increases, farmers tend to allocate most of their time and effort to producing more wheat; thus corn yield would be expected to decrease, given similar

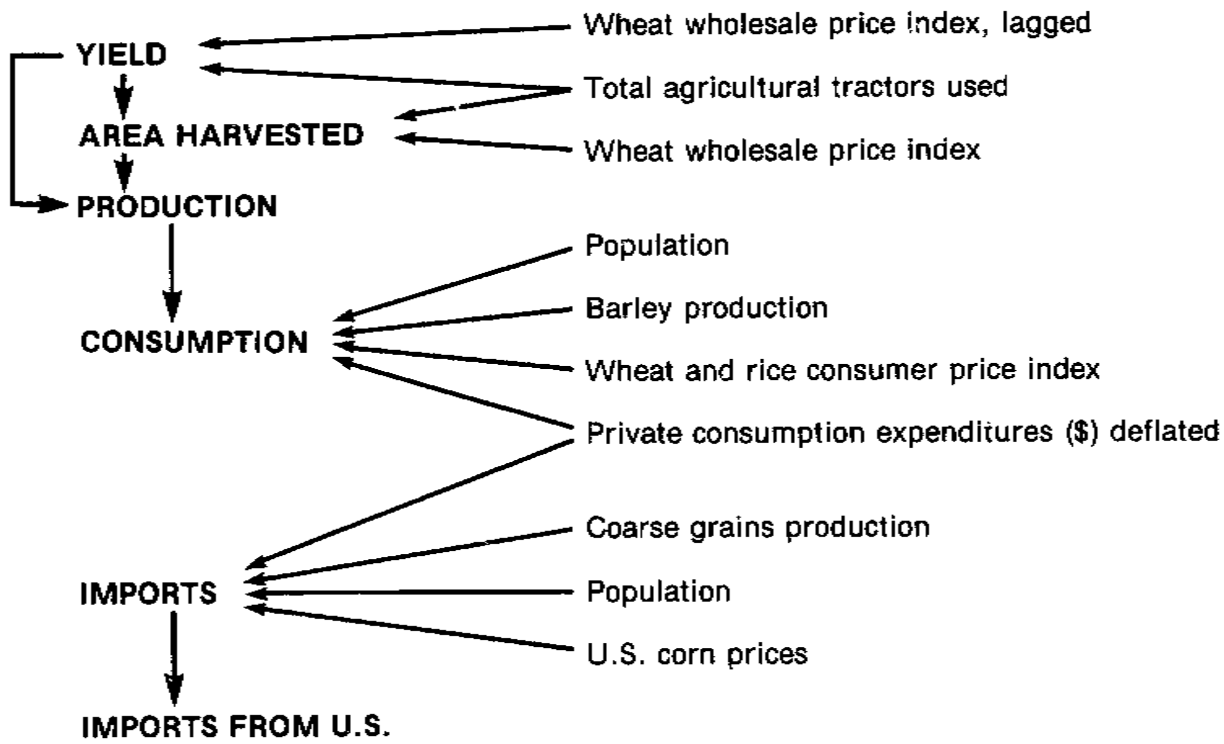


Figure 9. Visual representation of the corn model

weather conditions over time. TRAG(L) is included to approximate this kind of resource allocation process. The equation was estimated through the generalized least squares, G.L.S., method and provided a high R^2 and <u>a priori</u> expected signs.

Current wheat prices together with corn yields and technology were also used to indicate the resource allocation process. The estimated corn area harvested equation is:

$$CAH(L) = 8.8667 + \underset{(2.355)}{0.8966\ CY(L)} + \underset{(2.321)}{0.3329\ TRAG(L)} - \underset{(1.398)}{0.0275\ WWPI(L)}$$

$R^2 = 0.9988$ S.E. = 0.92752 D.W. = 2.44 F = 1953.5 $\overline{Y} = 21.5$

The equation fits very well, with signs as <u>a priori</u> expected. The standard error represents only 4.3 percent of the average corn area harvested during 1960-73. Several combinations of the explanatory variables were tried to estimate corn production directly. The best fit was obtained through the equation:

$$CQ(L) = 15.082 + \underset{(6.494)}{1.4049\ TRAG(L)} - \underset{(1.851)}{0.0946\ WWPI(L)}$$

$R^2 = 0.96$ S.E. = 2.349 D.W. = 1.941 $\rho = 0.7104$ F = 80.63 $\overline{Y} = 10.709$

The equation fits well, and variables have a correct sign. G.L.S. method was used to estimate the parameters of this equation.

<u>Corn Consumption</u>--All livestock variables included in the specification of this equation were insignificant and had incorrect signs. Also, efforts to obtain reasonable estimates for corn for food consumption were unsuccessful. Thus, no variables associated with the livestock sector were included in this aggregate equation:

$$CCT(L) = 382.5643 + \underset{(4.133)}{9.4504\ CQ(L)} - \underset{(1.615)}{0.094\ BQ(L)} + \underset{(0.592)}{0.00765\ PCE\$D(L)}$$

$$- \underset{(3.852)}{28.6722\ P(L)} + \underset{(1.867)}{2.3093\ WRCPI(L)}$$

$R^2 = .978$ S.E. = 19.938 D.W. = 2.097 F = 66.702 $\overline{Y} = 74.8$

In general, the equation fits well. Barley production--BQ(L)--was included to represent the substitutability between corn and barley for human and animal consumption. The wheat and rice consumer price index--WRCPI(L)--has a correct sign because when wheat and rice prices increase, consumers tend to consume less of these grains, and hence may increase corn consumption.

<u>Corn Imports</u>--The current production level of corn is not the sole factor affecting corn import decisions in Iran. It seems more logical that total coarse grain production represents corn and barley consumption. Since a portion of corn is consumed as food, private consumption expenditure--PCE$D--was included. The U.S. corn price--CPUS(L)--represents the importance of the United States in the world corn market. By using the 1963-74 sample period, the estimated equation is:

$$CM(L) = 1763.3862 - \underset{(4.353)}{0.1702\ CGQ(L)} + \underset{(6.597)}{0.2026\ PCE\$D(L)} - \underset{(5.976)}{85.5631\ P(L)}$$

$$- \underset{(5.361)}{6.8284\ CPUS(L)}$$

$R^2 = 0.978$ S.E. = 16.969 D.W. = 2.647 F = 63.053 $\overline{Y} = 80.8$

The equation fits well, with the standard error representing 16,969 tons. All variables are highly significant and have correct <u>a priori</u> expected signs. Corn imports can also be obtained through the simple identity:

$$CM(L) = CCT(L) - CQ(L)$$

<u>Corn Imports from the United States</u>--All efforts to produce a meaningful equation for this item failed. By using 1971-75 data, however, the following equation was attempted to obtain the U.S. market share:

$$CMFUS(L) = 0.6297\ CM(L)$$
$$(8.8596)$$

$R^2 = 0.94$ S.E. = 29.622 D.W. = 2. 5947 F = 78.493

This equation representing corn imports from the United States as an average percentage of total imports is used to predict the U.S. corn market share in the computer simulation model.

Barley Model

Some of the barley equations were very difficult to estimate, such as the yield and imports equations. The imports equations are derived from the estimated equations for coarse grains and corn imports. Other equations are similar to those presented in the coarse grains model, such as the ending stocks equations (which is not presented in this section). The barley model is presented in figure 10.

Barley Production--Table 15 indicates that yield is the most important variable affecting year-to-year changes in barley production. Yet variations in barley yield were very difficult to quantify. The following equation is reported, however, because its explanatory variables are associated with *a priori* expected sign and provided a reasonable standard error.

$$BY(L) = 6.288 + 0.0626\ TRAG(L) - 0.3125\ LNT(L)$$
$$(0.631) \qquad (0.401)$$

$R^2 = 0.964$ S.E. = 0.657 D.W. = 1.555 $p = 0.593$ F = 98.20

The presented coefficients for total tractors used in agriculture--TRAG(L)--and for the time trend--LNT(L)--are insignificant but are associated with correct *a priori* expected signs. The standard error of the equation represents less than 10 percent of the average barley yield during 1960-73. Barley yield has been decreasing, and the negative sign associated with the natural logarithm of the time trend variable is logical.

Area harvested is treated as a function of yield, the wages index for unskilled construction workers, and the current beef consumer price index. The estimated equation is:

$$BAH(L) = 988.4584 + 64.4549\ BY(L) - 2.4333\ UCLWI(L) + 2.7498\ BCPI(L)$$
$$(2.064) \qquad (1.036) \qquad (1.068)$$

$R^2 = 0.998$ S.E. = 73.564 D.W = 2.505 F = 1383.3 $\overline{Y} = 1461.5$

Beef pricing is included to indicate the feeding importance of barley. The higher the current price of beef, the more marginal area will be harvested during that particular year. SGWPI(L) was tried, but its inclusion resulted in a higher standard error than that in the equation reported. The equation fits well, with the standard error representing 73,564 hectares--almost 5 percent of the average barley area harvested during the 1960-73 sample period.

In estimating barley production directly, variables used in explaining variations in barley yield and barley area harvested were tried. The best functional fits included variables associated closely with those included in the previous two equations. By following the same concepts and logic used in specifying the previous two equations, the estimated barley production equation is:

$$BQ(L) = -144.2874 + 9.2289\ SGWPI(L-1) - 7.0282\ UCLWI(L) + 0.1304\ MLSL(L-1)$$
$$(1.735) \qquad (2.072) \qquad (1.625)$$

$R^2 = 0.965$ S.E. = 114.78 D.W. - 1.8886 $\hat{p} = 0.5231$ F = 68.944

Although SGWPI(L-1) and MLSL(L-1) were not included in either the barley yield, BY or the barley area harvested, BAH equation, they provided a satisfactory result in the direct estimation of barley production, BQ. All variables included have correct *a priori* expected signs and are significant at the 0.1 level of significance. The explanatory variables included in this equation are almost the same as those included in the CGQ equation. Given the position of BQ from CGQ, this specification proved useful to explain both.

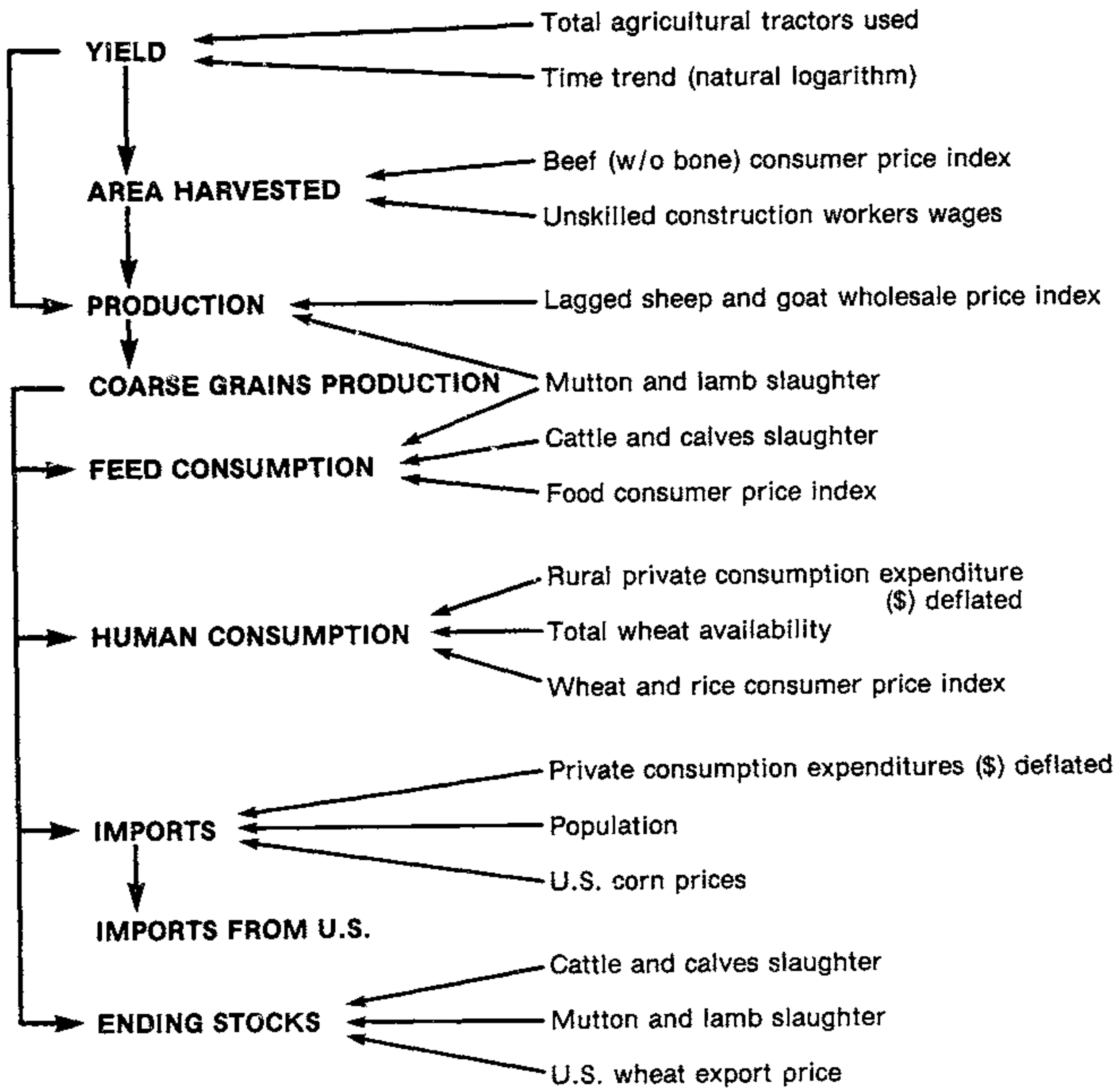


Figure 10. Visual representation of the barley model

Barley Consumption--As previously indicated, there is a degree of substitution between barley and wheat consumption--thus, total wheat availability was included as an explanatory variable in the equation for barley consumed as food. Available prices of other cereal grains used for food were also considered. Because barley is consumed mainly by rural populations, the rural private consumption expenditures also was included:

$$BCH(L) = 134.5271 + \underset{(1.131)}{0.2353}\ CGQ(L) - \underset{(2.072)}{0.0917}\ WTAV(L) + \underset{(0.656)}{0.1271}\ RPCE\$D(L) + \underset{(0.048)}{0.16097}\ WRCPI(L)$$

$R^2 = 0.975$ S.E. = 53.755 D.W. = 3.06 F = 79.013 $\bar{Y} = 270.6$

Unfortunately, while all variables have correct a priori expected signs, most are insignificant at the 0.1 level. The equation can reproduce BHC, with the standard error representing around 19 percent of average consumption of barley for food during 1960-74. The negative sign of the significant coefficient associated with WTAV indicates the weak substitutability between wheat and barley in human consumption.

The following equation is used to estimate barley feed consumption:

$$BCF(L) = -294.6682 + \underset{(6.762)}{0.4617}\ CGQ(L) + \underset{(2.055)}{0.4802}\ BVSL(L) + \underset{(4.199)}{0.0692}\ MLSL(L) - \underset{(1.483)}{1.853}\ FCPI(L)$$

$R^2 = 0.996$ S.E. = 26.836 D.W. = 1.522 $\hat{\rho} = 0.6097$ F = 461.7 $\bar{Y} = 763.87$

Developments in the livestock sectors affect BCF. Hence BVSL and MLSL were included to represent the effect of meat production, and hence its demand. The equation indicates that as the number of beef cattle and calves slaughtered increases by 1,000 head, barley consumption will have risen by 480.2 tons, and as the number of sheep and lambs slaughtered increases by 1,000 head, barley consumption will have risen by 69.2 tons. However, since not all slaughtered animals are barley fed, the reasonableness of these figures cannot be judged from available data. As the consumer price index for food increases, less barley will be allocated to feeding animals and, accordingly, more will be allocated to human consumption. The equation fits very well, with the standard error representing only 3.5 percent of the average consumption of coarse grains in feed.

Barley Imports--This equation is the difference between the coarse grains imports and the corn equations estimated earlier. The derived equation is:

$$BM(L) = 40.212 - 0.0891\ CGQ(L) + 0.03\ PCE\$D(L) - 24.5555\ P(L) + 0.00314\ CGQUS(L) + 1.7747\ CPUS(L)$$

In forecasting, barley imports can also be obtained through the identity:

$$BM(L) = BCH(L) + BCF(L) - BQ(L) - CGES(L-1) + CGES(L)$$

Barley Imports from the United States--Imports from the United States were regressed directly on total barley imports during 1970-75. The resulting coefficient represents the U.S. market share:

$$BMFUS(L) = \underset{(7.332)}{0.6571}\ BM(L)$$

$R^2 = 0.931$ S.E. = 45.185 D.W. = 1.469 F = 53.755

The standard error is high, but the equation indicates that 93 percent of variation in BMFUS is explained by variations in BM. Although the equation does not provide economic information, it is used to estimate BMFUS in the computer model.

Oilseeds and Oilseed Products Model

Iran is an expanding market for U.S. vegetable oils and an important potential market for high protein oilseed meal. The oilseeds and oilseed products sector has experienced a drastic change since the mid-sixties, when vegetable oils began to seriously compete as a substitute for the traditionally consumed animal fats and ghees. This shift has placed oilseeds in a leading position among cash crops.

Cottonseed production accounts for about 80 percent of total oilseed supply in Iran. Soybeans and sunflowers are next in importance. In 1975, production of these three oilseeds accounted for 97 percent of total oilseed production, and their oil production accounted for about 95 percent of total vegetable oil production. Thus, any fluctuation in the production level of these three crops would have a significant impact on vegetable oil imports. Linseed, sesame, and castor oils account for less than 3 percent of total oilseed production, and peanuts and olives account for about the same.

Cotton area is expanding in newly irrigated areas. In 1975, total cotton area was about 290,000 hectares. But it is unlikely that cotton area will again exceed 300,000 hectares. There are efforts, however, to improve productivity through better yields.

Soybean area is expanding rapidly at the expense of total cotton area. In 1975, area planted to soybeans was an estimated 53,200 hectares, about 144 percent higher than in 1974. In 1976, area planted increased to 70,000 hectares, and soybean production reached 100,000 tons. Soybeans have achieved a significant place among crops since 1974, and their production is expected to increase rapidly. Sunflower area expanded from 16,200 hectares to 98,200 hectares during 1968-70. However, sunflower area and production has declined since, with the emphasis shifting to soybeans (table 16).

Since its establishment in 1967, the Oilseeds Research and Development Company (ORDC), a semi-Government agency has coordinated expanded soybean production in Iran. ORDC, which is the only buyer of soybeans and sunflowers in Iran, initiates contracts with farmers to encourage production of the crops. To promote soybean production, ORDC offers farmers, on a per-hectare basis, 60 kilos of soybean seeds at a 50-percent discount, 125 kilos of fertilizer at a 20-percent discount, and a production loan of 4,000 Rls (about $59) at 4 percent interest. Seed produced is distributed through ORDC to crushing factories which sell brand vegetable oils to consumers at a subsidized price. The oilmeal, however, must be distributed through the Ministry of Agriculture and Natural Resources, which sells it chiefly to the poultry industry at a subsidized price of 9 Rials per kilo.

Vegetable oil production in Iran is governed by the crushing capacity and domestic oilseed production. During 1960-70, crushing capacity was a limiting factor in Iran's vegetable oil production, and any domestic oilseed production in excess of crushing capacity was exported to the USSR and other neighboring countries, while greater amounts of vegetable oils were imported. In 1961, for example, about 3,000 tons of oilseeds were exported, and 15,000 tons of vegetable oils were imported. Most of the crushing factories in Iran have their own refinery and hydrogenating processes for soybean, sunflower, and cottonseed oils, and they manufacture brand shortening. Data on crushing capacity in Iran could not be obtained; however, table 17 shows the refining capacity for 1976 as published by the Ministry of Industry and Mines. There is an excess capacity in the vegetable oil refining plants, but this excess capacity is expected to be fully utilized given the expected expansion in oilseeds production.

Cottonseed oil is the most important vegetable oil produced in Iran, and accounts for about 75 percent of total vegetable oils production. In 1974, vegetable oil production totaled 96,000 metric tons (figure 11) and cottonseed, soybean and sunflower oils accounted for 95 percent of this amount, or around 91,200 metric tons. Since the Oilseeds Research and Development Company does not promote cottonseeds production, crushing factories get cottonseeds directly from farmers.

Since 1974, the Ministry of Commerce--through the Foreign Transaction Company--has been the main buyer and importer of vegetable oils for distribution to local refineries. Total imports of vegetable oils increased dramatically from 15,000 tons in 1961-62 to about 250,000 tons in 1975-76. The U.S. market share also greatly increased. In 1968-69, the United States accounted for 8,980 tons, or only 7 percent, of Iran's imports. However, in 1974-75, imports from the United States were 157,500 tons, or 52 percent of vegetable oils imports. Exact figures on the imported quantities separated into crude and refined categories were not available, although

Table 16--Area and production of cottonseed, soybean, and sunflower seed crops, Iran, 1970-76

Year	Area			Production		
	Cotton	Soybeans	Sunflowers	Cotton	Soybeans	Sunflowers
	1,000 hectares			1,000 metric tons		
1970	320	6.3	98.2	341	6.4	51.4
1971	320	7.6	71.3	280	7.5	37.4
1972	340	7.0	67.2	320	9.7	44.3
1973	340	6.4	80.0	420	9.5	47.2
1974	340	21.8	72.0	450	34.9	43.0
1975	290	53.2	76.9	290	70.3	29.0
1976	310	70.0	65.0	348	98.0	36.0
	Percent					
Percentage change, 1970-76	-3.1		-33.8	2.1	1431.2	-29.9

Source: Ministry of Agriculture and Natural Resources and agricultural attache estimates (34).

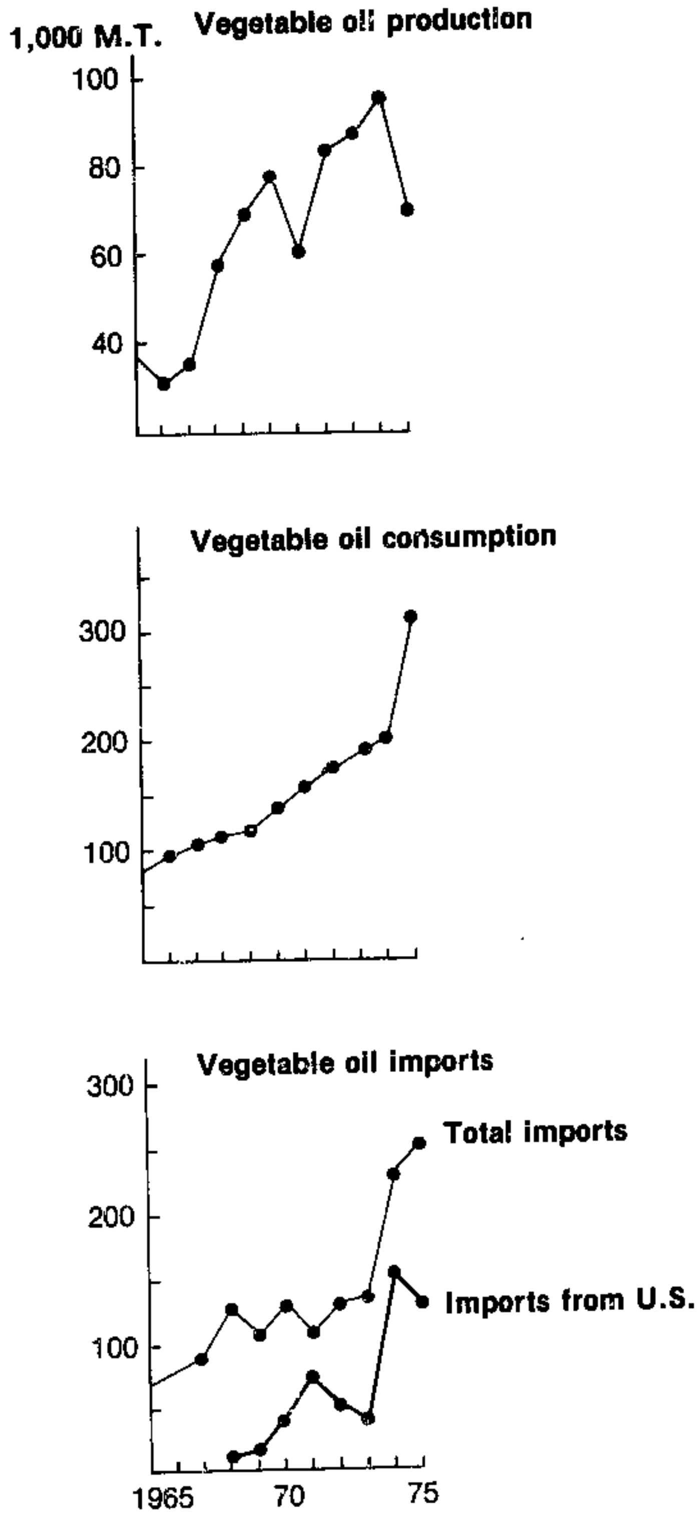


Figure 11. Vegetable oils production, consumption, and imports, Iran

Table 17--Major vegetable oil refining plants and their capacity, Iran, 1976

Name and location of establishment	Crude oil refining capacity
	Metric tons
Behshahr Industrial Group, Tehran	108,000
Pars Cotton Ginning and Oil Mills, Co., Tehran	96,000
Jahan Vegetable Oil Co., Tehran	45,000
Naze Company, Esfahan	30,000
Nargese Vegetable Ghee Company, Shiraz	120,000
Margarine Company, Tehran	24,000
Nab Margarine Manufacturing Company, Tehran	18,000
Etka Distribution Cooperatives Organization, Tehran	18,000
Em Em Company, Sari	7,000
Se-gole Company, Neyshabour	12,000
Others	249,640
Total capacity	727,640

Source: Ministry of Industry and Mines, Tehran.

most are in the crude form. Imported crude vegetable oils are mixed with domestic oils to produce refined vegetable oils or shortening. Most vegetable oils, however, are hydrogenated and sold as solid cooking fats.

So far, Iran has not imported soybeans. However, the Government has for some time discussed the possibility of expanding the country's crushing industry, so it could import soybeans rather than soybean oil and meal separately. A joint Iranian-Brazilian project and long-term contract for supplying soybeans to Iran has been proposed. If materialized, the project will surely affect the soybean and vegetable oil situation in Iran. This could also adversely affect the level of Iran's imports of soybean oil in the future.

Thus, vegetable oils in Iran are actually filling the supply-demand gap in the fats and oils sector generated by the scarcity and high price of animal fats. Consumption of vegetable oils is increasing by about 8 percent annually, largely because of a high population growth rate, rising per capita income, and scarcity of the traditionally consumed animal fats. Data on vegetable oils consumption separated according to end use are not available. Total vegetable oils consumption, however, increased from 49,000 tons in 1961/62 to about 320,000 tons in 1975/76, when only 22 percent of the consumption was met by domestic production.

An econometric model representing the oilseeds and oilseed products sector in Iran should capture the essence of the above-described situation and developments. However, accurate analysis of Iranian fats and oils production and consumption was impossible because of the lack of reliable data (34). To identify and quantify major factors affecting production, consumption and imports, a simple model was specified and statistically estimated. The model emphasizes vegetable oils, and its simplicity is governed by availability of time series data. Complete analysis of oilmeal products was not possible, and only oil and meal production of cottonseeds, soybeans, and sunflowers are projected to 1982. Uniform assumptions were made concerning the amounts disposed of as seeds, waste, and feed.

Available information necessitates the use of aggregated variables for Iranian production, consumption, imports and imports from the United States. When complete data are available for components of oilseeds and vegetable oils, separate models should be specified and estimated. The aggregate model for the oilseeds and vegetable oils specified and statistically estimated in this study is presented in figure 12.

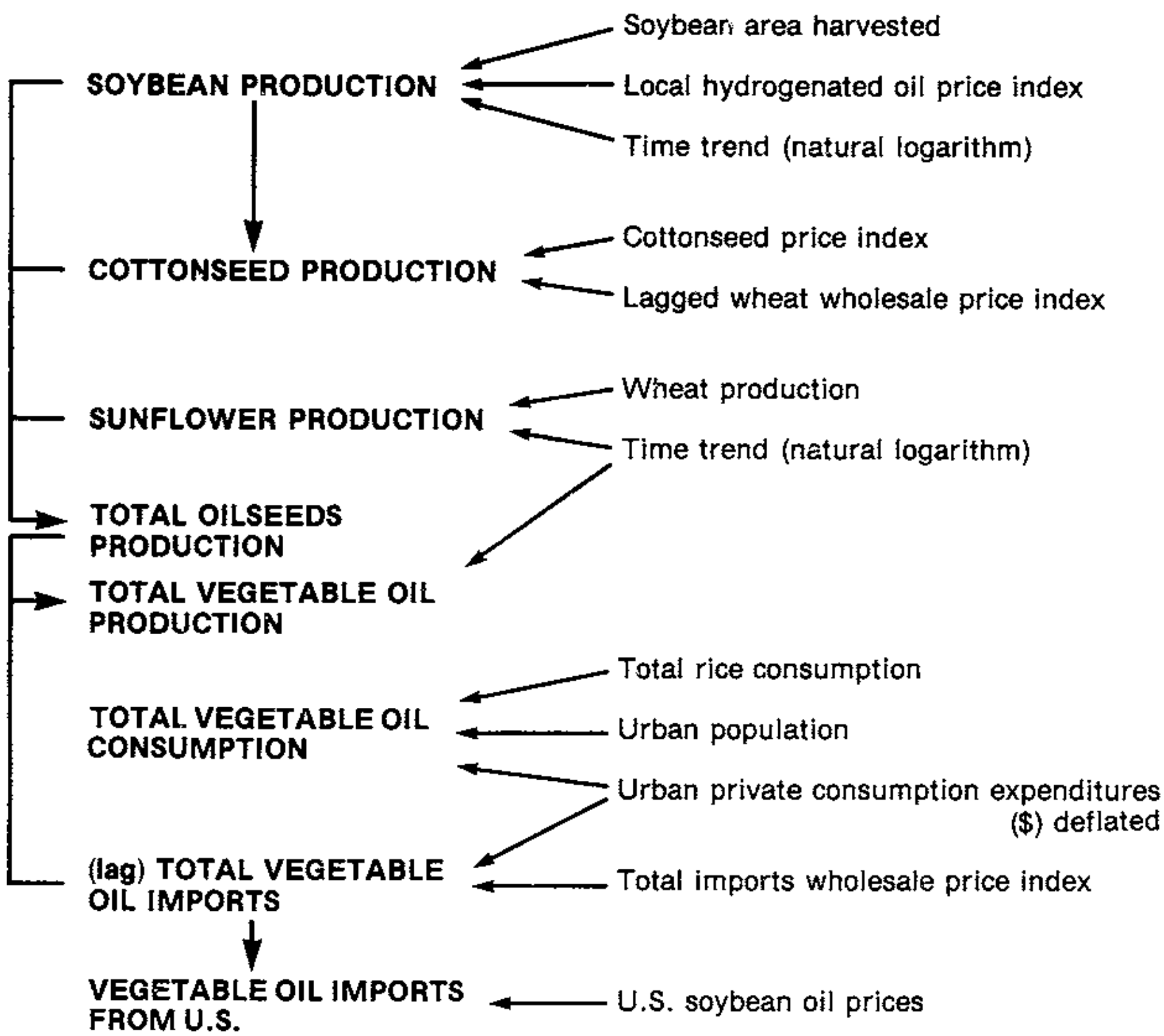


Figure 12. Visual representation of the oilseeds and oilseed products model

Oilseeds Production

In the aggregate model, total oilseeds production, TOSQ(L), is estimated indirectly by the yearly production of cottonseeds, OSCTQ(L); soybeans, OSSBQ(L); and sunflowers, OSSUNQ(L). The equation provides a good estimate of the part of production that directly affects edible oils consumption and total imports. Oilseeds for industrial use do not have a great effect on vegetable oil imports.

Soybean Production--Current soybean area planted, OSBAP(L), and lagged price index of local hydrogenated vegetable oils, OLHPI(L-1), are used as explanatory variables in estimating soybean production. Soybean area planted is usually determined by the ORDC, whose success is indicated by the number of farmers with whom contracts have been made, to achieve the soybean development goals. The variable OLHPI(L-1) indicates profitability for farmers who produce soybeans through contracting with the ORDC. It is also related to the degree of resources or discounts the organization will be will be willing to offer the contracted farmers to increase soybean production in any given year.

$$OSSBQ(L) = -21.2547 + \underset{(12.18)}{1.4914}\ OSBAP(L) + \underset{(2.502)}{0.1727}\ OLHPI(L-1)$$

$R^2 = 0.984$ S.E. = 1.864 D.W. = 1.44 F = 143.49 $\overline{Y} = 7.609$

The equation fits well and explains 98 percent of the variations in OSSBQ(L). The standard error of 1,864 metric tons is higher than desirable, representing about 24 percent of the average soybean production for the 1965-74 sample period. The two explanatory variables are significant at the 0.05 level of significance and have the correct a priori expected signs. From the estimated equation, a 10-percent increase in soybean area planted would increase soybean production by 12.4 percent, while a 10-percent increase in the lagged local hydrogenated oil prices, would increase soybean production by about 26 percent. The equation indicates that during 1965-74, the average soybean yield was around 1.5 tons per hectare.

The following equations are used to forecast soybean oil and meal production. The forecasted values of soybean oil and meal are not tested against actual values because of the lack of consistent time series data. It is assumed that about 95 percent of annual soybean production is crushed. The other 5 percent consists of waste and feeds. Using an oil extraction rate of 18 percent and a 79-percent meal rate, the equations used to obtain and forecast soybean oil and meal production, are:

$$OSBQ(L) = OSSBQ(L)*0.95 * 0.18$$

$$OSBMQ(L) = OSSBQ(L)*0.95 * 0.79$$

Cottonseeds Production--One factor affecting cottonseed production is the degree of competition from soybean expansion. Thus, soybean production is used as a predetermined variable in the cottonseed production equation. The lagged wheat wholesale price index, WWPI(L-1), is included in the equation to represent the competition between cotton and wheat for land. The lagged cottonseed price index, OSCTPI(L-1), is included to represent the direct expected profitability of farming cotton instead of soybeans or wheat.

$$OSCTQ(L) = 294.1733 + \underset{(1.914)}{2.2002}\ OSCTPI(L-1) + \underset{(2.977)}{4.1477}\ OSSBQ(L) - \underset{(2.462)}{2.0755}\ WWPI(L-1)$$

$R^2 = 0.993$ S.E. = 35.583 D.W. = 1.6434 F = 221.46 $\overline{Y} = 330.4$

The equation fits well, and the standard error represents about 10.8 percent of average cottonseed production during 1965-74. A 10-percent change in the lagged cottonseed price index would change cottonseed production by 7.3 percent, while the same rate of change in the lagged wheat wholesale price index would bring a 7.2 percent change in cottonseed production. However, the own-price effect is low. Cottonseed production would increase by only 0.96 percent for each 10-percent increase in lagged cottonseed prices. The positive sign associated with soybean production, OSSBQ(L), indicates that both soybean and cotton production are increasing. Although soybeans are expanding at the expense of cotton area, some newly irrigated areas are devoted to cotton production.

It is assumed that 92.5 percent of cottonseed production is crushed every year, while the other 7.5 percent consists of waste and feed. Using an oil extraction rate of 16.5 percent and a meal extraction rate of 46.2 percent, the following equations are used to forecast cottonseed oil production, OCTQ(L), and meal production, OCTMQ(L):

OCTQ(L) = OSCTQ(L)*0.925 * 0.165

OCTMQ(L) = OSCTQ(L)*0.925 * 0.465

Sunflower Production--Although a number of equations were specified and statistically estimated for sunflower production, none was completely satisfactory. The following equation was associated with the lowest standard error:

$$OSSUNQ(L) = 40.189 - \underset{(0.793)}{0.0096}\ WQ(L) + \underset{(4.30)}{22.5242}\ LNT(L)$$

$R^2 = 0.962$ S.E. = 9.115 D.W. = 2.541 F = 42.171 $\overline{Y} = 32.53$

The standard error represents about 28 percent of the average sunflower production for the 1967-74 sample period.

Sunflower oil production, OSUNQ(L), and sunflower meal production, OSUNMQ(L) were projected through the following equations. Almost 5 percent of the annual production is assumed to be wasted or used for feeding. A 43-percent oil extraction rate and a 57-percent meal rate are assumed:

OSUNQ(L) = OSSUNQ(L)*0.95 * 0.43

OSUNMQ(L) = OSSUNQ(L)*0.95 * 0.57

Total Oilseeds Production--This variable TOSQ(L), is obtained through the identity:

TOSQ(L) = OSSBQ(L) + OSCTQ(L) + OSSUNQ(L)

Total Vegetable Oils Production--Published data on total vegetable oils production, TVOQ(L), were used in the analysis rather than the summation of soybean bean oil, cottonseed oil, and sunflower oil production because observations for sufficient numbers of historical years were readily available, and believee to be reasonably accurate.

$$TVOQ(L) = 16.9973 + \underset{(4.706)}{0.1602}\ TOSQ(L) + \underset{(3.611)}{14.753}\ LNT(L)$$

$R^2 = 0.994$ S.E. = 6.147 D.W. = 2.273 F = 399.7 $\overline{Y} = 63.61$

The equation fits well, with the standard error representing only 9.7 percent of average vegetable oil production during 1965-74. The estimated equation indicates that for each 1-ton increase in oilseed production, vegetable oil production would increase by 0.16 ton. That is, the average oil extraction rate is around 16 percent. Using data means, a 10-percent increase in domestic oilseed production would tend to increase vegetable oil production by 9.2 percent.

Vegetable Oils Consumption

Data available on vegetable oil consumption are generally not disaggregated by end use or parent product. Accordingly, aggregate vegetable oil consumption--mostly edible--is estimated through a single equation. Animal fats consumption should be included in the equation, but unfortunately no historical data are available.

Although cooking vegetable oils are distributed throughout Iran, the rural population still follows traditional consumption patterns. The substitution of vegetable oils for animal fats occurs mainly in urban areas. Thus, current urban population, UP(L), and the urban private consumption expenditure deflated in dollars, UPCE$D(L), are used as explanatory variables in this equation. Total rice consumption, RCT(L), also is included to represent the relationship which exists between consumption of rice in main meals and the use of vegetable oils in the preparation of those meals.

$$TVOC(L) = -179.1745 + 0.1407\ RCT(L) + 0.0119\ UPCE\$D(L) + 15.3543\ UP(L)$$
$$\qquad\qquad (2.259) \qquad\qquad (0.899) \qquad\qquad (1.341)$$

$R^2 = 0.998$ S.E. = 9.567   D.W. = 1.827   F = 821.75 $\overline{Y} = 162.61$

The equation fits very well, with the standard error representing about 5.9 percent of the average consumption level during 1965-74. Using data means, a 10-percent increase in total rice consumption will increase vegetable oil consumption by 6.6 percent. A 10-percent increase in the urban population and urban private consumption expenditure would change total vegetable oil consumption by 11.1 and 2.7 percent, respectively.

Total Vegetable Oil Imports

Based on data for 1965-74, Iran's imports of vegetable oils are estimated through the equation:

$$TVOM(L) = 77.6377 + 0.0498\ UPCE\$D(L) - 1.0609\ TVOQ(L-1) - 1.0428\ IWPI(L)$$
$$\qquad\qquad (6.263) \qquad\qquad (3.101) \qquad\qquad (2.957)$$

$R^2 = 0.995$ S.E. = 11.273   D.W. = 2.073   F = 310.53 $\overline{Y} = 118.65$

Data available indicate that there is always a 1-year lag between changes in production and the decision to import. Using data means, a 10-percent change in the previous year's vegetable oil production would adversely change total vegetable oil imports by only 5.7 percent. The 10-percent change in urban/private consumption expenditure and the wholesale price for imported goods would change total vegetable oil imports by about 1.6 percent and adversely by 10.5 percent, respectively. Other variables such as current and lagged U.S. prices for soybean oil, natural logarithm of time, and population were tried separately or in combination in other equations to estimate the variations in imports. However, the reported equation was chosen as the best because of the lower standard error and the correct a priori expected signs associated with the variables included.

Vegetable Oil Imports from the United States

Consistent data were readily available only for 1968-74. Consequently, only seven observations were used in this equation. The following produced the lowest standard error:

$$VOMFUS(L) = -61.5477 + 0.5183\ TVOM(L) + 0.1768\ SBOUSP(L)$$
$$\qquad\qquad (1.019) \qquad\qquad (3.919)$$

$R^2 = 0.9475$ S.E. = 22.193   D.W. = 2.523   F = 24.076 $\overline{Y} = 56.99$

For each 1,000-ton increase in vegetable oils imports, U.S. supplies would account for an estimated 518.3 tons--that is, for each 10-percent increase in Iran's vegetable oil imports, U.S. exports to Iran would increase by 9.86 percent. The coefficient for wholesale soybean prices in the United States is highly significant but is associated with a priori unexpected sign. It was retained in the equation only for its effect on reducing the standard error.

SIMULATION MODEL

Methods

The estimated models for wheat, rice, coarse grains, corn, barley, and oilseeds and oilseed products are integrated through a computer simulation model. The model, which contains 42 endogenous variables and 36 exogenous variables, is complete because each endogenous variable is assigned an equation for its determination. The model will provide simulated time paths for the endogenous variables for 1961-82. Forecasts for the 42 endogenous variables are obtained by using the statistically estimated parameters relating variables in the structural relations and forecasted values for the 36 exogenous variables.

No attempt was made to construct an aggregate model for the Iranian agricultural economy. However, through appropriate specification and ordering of equations within each commodity model and among models, intercommodity analysis and the integration of the commodity models into one aggregate recursive model was possible. Prices are generally controlled by the Government and were considered to be exogenous. For each commodity, production was specified as being affected by input availability, price indexes, and Government policies. Consumption was affected by production levels and other demand shifters. Imports were affected by production, demand shifters and world prices or availability in the world market. That the model linkage is forward, with no feedbacks in the present structure, does not affect the validity of the model or the expected projection accuracy.

In the computer simulation program, the model is divided into two main blocks--one for the production equations, the other for the consumption and imports equations. Within each block, the estimation and simulation process begins with wheat and is followed by rice, corn, barley, coarse grains, and oilseeds and oilseed products.

The computer simulation model provides a framework for obtaining simulated time paths for the 42 endogenous variables for 1961-82. Forecasts obtained are conditional. The values of the forecasts for the endogenous variables are obtained given the forecasted values of the exogenous variables. Thus, the accuracy of the endogenous variable forecasts depends, among other things, on the accuracy of the exogenous variable forecasts.

The model provides ex post and ex ante forecasts. The last actual observation is for 1974, and ex post forecasts outside the sample period for 1975 and 1976--where actual values of exogenous and endogenous variables are available--were obtained. Forecasted values of the 36 exogenous variables were also used to obtain ex ante forecasts for the endogenous variables during 1977-82. Values of the ex post forecasts during 1961-76 were examined against the actual values through two accuracy indices.

The validation of the simulation model is affected by the appropriate structure of the model (19), and by its ability to represent the crucial essence of the relationships existing in the real system (12). The economic structure represents the crucial essence of the true structure in Iran as much as data and information allow. The simulation model presented is also valid since the unknown parameters of the structural relations were estimated through correct quantitative system and statistical methods. In general, the model's validity is a measure of how much it satisfied its a priori stated objective.

The validation of the simulation model deals with testing the hypothesis that the forecasting procedure is correct. Accuracy analysis, however, deals with the degree of imperfection between the actual and forecasted values (26). Since the main purpose of developing the simulation presented in this chapter is projecting, accuracy indices that deal with average and exact matching of projected and actual values rather than the turning point concept or average amplitude over the whole series (26). To measure the accuracy of the exact matching of the estimated and observed ordered pairs of observations for each variable, a simple percentage error index is used:

Let:

A(i,j) = The actual observed value of the jth endogenous variable for the ith time period (i=1, ...,17; j=1,...,42).

a(i,j) = The change in the actual value of the jth endogenous variable over the ith time period (i=2,...,17) (j=1,...,42).

S(i,j) = The simulated value of the jth endogenous variable over the ith time period.

s(i,j) = The change in the simulated value of the jth endogenous variable over the ith time period.

n = Number of observations--time periods--endogenous variable estimates are to be generated [n=16(1961-1976)].

For each endogenous variable, a simple percentage error index is calculated for each pair of actual and simulated values. This index is commonly used and computationally simple. The simple percentage error index is defined as:

$$EI(i,j) = [S(i,j) - A(i,j)]*100.0 \quad \text{for all } j.$$

If EI(i,j) would equal 100.0 for time period i for variable j, then exact simulation of the actual value is obtained. The index of 90.0 and 110.0 would indicate that the simulated value is 10 percent under and over the actual value for this particular time period, respectively.

The same concept is used to obtain an index for the average matching of simulated and actual values for each variable over the 16 time periods. The average absolute percentage error for variable j is defined as:

$$E(.,j)=\left\{\sum_{i=1}^{n}[\ S(i,j) - A(i,j)\ ] \ / \sum_{i=1}^{n} A(i,j)\right\} * 100.0 \quad \text{for all j.}$$

The index avoids the problem of positive and negative errors cancelling. For example, E(.,j) would equal 105.0 if the simulated values for the variable j over the 16 observations are 5 percent higher than the actual values in the average. This average absolute percentage error index does not penalize large individual error (table 18. See also appendix D).

Table 18--Calculated average percentage error indexes and Theil's inequality coefficient for endogenous variables estimated through stochastic equations (1961-76)

Endogenous variable	Average percentage error index	Theil's inequality coefficient
WY	6.46	.945
WAH	4.44	1.091
WCT	3.77	.490
WES	18.04	.527
RY	7.71	.904
RAH	6.44	1.034
RCT	2.09	.209
RMFUS	26.36	.286
CY	11.72	.838
CAH	9.17	1.166
CCT	34.43	1.317
CMFUS	28.98	.816
BY	7.45	.813
BAH	3.58	.682
BCH	11.49	.465
BCF	2.29	.2496
BM	71.44	.7912
BMFUS	47.44	.796
OSSBQ	16.64	.374
OSCTQ	7.84	.302
OSSUNQ	49.60	1.352
TVOQ	8.02	.3238
TVOC	3.59	.195
TVOM	13.52	.544
VOMFUS	53.58	1.029

The second accuracy measure used in this study is Theil's inequality coefficient (26, p. 28). This coefficient, U, is defined as the square root of

$$U^2(j) = \sum_{i=1}^{n} [s(i,j) - a(i,j)]^2 / \sum_{i=1}^{n} a^2(i,j) \qquad \text{for all j.}$$

For the purpose of <u>ex post</u> forecasting, the change in simulated values are defined as s(i,j) = [S(i,j) - A(i-1,j)]. Substituting this value for s(i,j) in the numerator, the coefficient could be stated as the square root of:

$$U^2(j) = \sum_{i=1}^{n} [S(i,j) - A(i,j)]^2 / \sum_{i=1}^{n} a^2(i,j) \qquad \text{for all } j.$$

The Theil's inequality coefficient, U, as stated above, would yield a zero for perfect simulation but has no upper bound. The value of one, however, would be associated with a simple extrapolation simulation procedure where this period's simulated value is the previous year's actual value. While the percentage error index presented does not penalize for large individual errors, Theil's inequality does. For example, over the ex post simulation--1961-76 (16 time periods)--if the difference between simulated and actual values is one point for each time period, the absolute percentage error index would be the same, as if only one observation has an error of 16 points, and the rest of the simulated and actual values match exactly the other 15 observations. However, Theil's inequality coefficient would heavily penalize the latter case. Thus, a better understanding of the simulation accuracy of each endogenous variable can be gained by using the two error indices together.

Characteristics

The computer simulation model is user-oriented and should be updated periodically by USDA analysts or other interested researchers. The computer program is written in FORTRAN WATFIV language and contains 651 statements. Besides establishing the parameter's or simulation's control cards, the program is divided into five subroutine subprograms. Table 19 states the names, number of statements, and function of those subroutine subprograms.

Table 19--Names and functions of the subroutine subprograms for Iran model

Subroutine	Statements	Function
SUB 1	84	Reads and prints all endogenous and exogenous variables.
PROD	165	Estimates all production variables.
CONS	189	Estimates all consumption, imports, imports from United States, and ending stocks variables
OUTPUT	116	Prints the estimated, actual and simple percentage error indices.
ACCUR	75	Calculates and prints the average percentage error indices and Theil's inequality coefficients.

There are also 22 control parameters that denote the number of variables used (endogenous and exogenous), the type of output listing desired, the mode of operation, and any temporal constraints for a specific run of the program. The name and description of the main parameters are given in table 20.

With the present program, the maximum value that NUMEXO and NYEARS can take is 25 (see table 20). Simulation can be provided until 1984 if values for exogenous variables are given. If simulation beyond 1984 is desired, the variables' arrays should be changed as well as those two parameter cards.

If the mode of operation equals zero, then the estimated values of the endogenous variables are not replaced with actuals but left to evolve through the estimated system of equations. If the mode equals one, then actual values of predetermined endogenous variables rather than estimates are used in estimating any of the equations. For example, if wheat production is estimated for 1965 and the mode of operation equals one, then actual wheat production of 1965 will be used

Table 20--Name and description of the main parameters for Iran model

Control parameter	Description
NWHEAT	An integer constant specifying the number of the endogenous variables in the wheat sector (NWHEAT=7)
NRICE	An integer constant specifying the number of the endogenous variables in the rice sector (NRICE=7)
NGRAIN	An integer constant specifying the number of endogenous variables in the coarse grains sector (NGRAIN=7)
NCORN	An integer constant specifying the number of endogenous variables in the corn sector (NCORN=6)
NBARLEY	An integer constant specifying the number of endogenous variables in the barley sector (NBARLEY=7)
NOILSD	An integer constant specifying the number of the endogenous variables in the oilseeds and products sector
NEXVAR	An integer constant specifying the number of exogenous variables used in the model (NEXVAR=36)
NUMEND	An integer constant specifying the number of observations of the endogenous variables (NUMEND=17). This value specifies the last year where actual values of endogenous variables are used (i.e. 1960 to 1976)
NUMEXO	An integer constant specifying the number of observations of the exogenous variables actual and forecasted (NUMEXO=23)
NYEARS	An integer constant specifying the last year estimations to be derived (NYEARS=23). Thus, NYEARS must equal NUMEXO
LBEGIN	An integer constant specifying the first year that simulation is desired. LBEGIN must be greater than or equal to two (1961=2, 1965=6, 1969=10, etc.)
MODE	If mode=1, then actual values of endogenous variables (when available until NUMEND) immediately replace estimated values for further simulation. If mode=0, then estimated values are used for further simulation.

to estimate wheat consumption for the same year. If the mode equals zero, then the estimated value of wheat production for 1965 will be used in estimating wheat consumption. In general, when the estimated time paths of the endogenous variables are replaced by actual value immediately within the ex post sample period, the shock that the model receives in ex ante forecasting will be less severe, but the accuracy indices are expected to be biased downward.

In the computer model, the endogenous variables' arrays are specified by the letter Y, while exogenous variables' arrays are specified by the letter X (tables 21 and 22).

The production and imports equations are estimated twice for each commodity--once through a stochastic structural equation and then again through an identity equation. For consistency, however, the identity--indirect method--was left in the final computer simulation program. In this case, yield and area harvested estimates would always provide the production estimates. Also, the import level for each commodity--except barley--is generated through the indirect method. The barley imports level was estimated through the direct method and its simulated values were reported because they were more reasonable.

Table 21--Endogenous variables' arrays for Iran model

Mnemonic name	Actual value	Estimated value
WY	Y1(1,L)	YE1(1,L)
WAH	Y1(2,L)	YE1(2,L)
WQ	Y1(3,L)	YE1(3,L)
WCT	Y1(4,L)	YE1(4,L)
WNM	Y1(5,L)	YE1(5,L)
WMFUS	Y1(6,L)	YE1(6,L)
WES	Y1(7,L)	YE1(7,L)
RY	Y2(1,L)	YE2(1,L)
RAH	Y2(2,L)	YE2(2,L)
RRQ	Y2(3,L)	YE2(3,L)
RMQ	Y2(4,L)	YE2(4,L)
RCT	Y2(5,L)	YE2(5,L)
RNM	Y2(6,L)	YE2(6,L)
RMFUS	Y2(7,L)	YE2(7,L)
CGAH	Y3(1,L)	YE3(1,L)
CGQ	Y3(2,L)	YE3(2,L)
CGCH	Y3(3,L)	YE3(3,L)
CGCF	Y3(4,L)	YE3(4,L)
CGM	Y3(5,L)	YE3(5,L)
CGMFUS	Y3(6,L)	YE3(6,L)
CGES	Y3(7,L)	YE3(7,L)
CY	Y4(1,L)	YE4(1,L)
CAH	Y4(2,L)	YE4(2,L)
CQ	Y4(3,L)	YE4(3,L)
CCT	Y4(4,L)	YE4(4,L)
CM	Y4(5,L)	YE4(5,L)
CMFUS	Y4(6,L)	YE4(6,L)
BY	Y5(1,L)	YE5(1,L)
BAH	Y5(2,L)	YE5(2,L)
BQ	Y5(3,L)	YE5(3,L)
BCH	Y5(4,L)	YE5(4,L)
BCF	Y5(5,L)	YE5(5,L)
BM	Y5(6,L)	YE5(6,L)
BMFUS	Y5(7,L)	YE5(7,L)
OSSBQ	Y6(1,L)	YE6(1,L)
OSCTQ	Y6(2,L)	YE6(2,L)
OSSUNQ	Y6(3,L)	YE6(3,L)
TOSQ	Y6(4,L)	YE6(4,L)
TVOQ	Y6(5,L)	YE6(5,L)
TVOC	Y6(6,L)	YE6(6,L)
TVOM	Y6(7,L)	YE6(7,L)
VOMFUS	Y6(8,L)	YE6(8,L)

Table 22--Exogenous variables' arrays for Iran model

Mnemonic name	Value	Mnemonic name	Value
FRTU	X(1,L)	WPEXUS	X(19,L)
TRAG	X(2,L)	WQUS	X(20,L)
UCLWI	X(3,L)	WESHUS	X(21,L)
WCPI	X(4,L)	D1	X(22,L)
RWPI	X(5,L)	WRCPI	X(23,L)
CGY	X(6,L)	BVSL	X(24,L)
SGWPI	X(7,L)	CPUS	X(25,L)
MLSL	X(8,L)	CGNEXUS	X(26,L)
WWPI	X(9,L)	CGNEXAR	X(27,L)
BCPI	X(10,L)	OLHPI	X(28,L)
PCE	X(11,L)	OSCTPI	X(29,L)
EXRATE	X(12,L)	RPCE	X(30,L)
CPI	X(13,L)	FCPI	X(31,L)
P	X(14,L)	RRQUS	X(32,L)
UP	X(15,L)	CGQUS	X(33,L)
RP	X(16,L)	OSBAP	X(34,L)
IWPI	X(17,L)	OSBUSP	X(35,L)
UPCE	X(18,L)	RES	X(36,L)

For the same reason, the simple direct percentage equations were used to obtain the level of imports from the United States for each commodity. Those alternative specifications presented in the final model were also more accurate in their projecting ability. The coarse grains model was initiated as a possible substitute for corn and barley models and all its endogenous variables' values can be obtained directly from corn and barley. In the final model, projections for corn and barley were summed to obtain values for coarse grains. Thus, no structural behavior equations for coarse grains are present in the final computer model.

Assumptions

Economic Setting

During 1970-75, Iran's economy grew at a record rate. Gross national product at current prices increased on the average of 38.4 percent per year. Export price of Iranian oil rose 6.3 percent in 1975-76 and oil revenue from export increased to $19 billion. The Iranian economy is still benefiting from rebound in world oil demand and from the recent strong investment and domestic expansion. GNP is expected to increase by 11.5 percent. This rate is within the Government's target for the sixth development plan (1978-83).

Little is yet known about the sixth development plan, that is being formulated. However, its known objectives include annual average real GNP growth rate of 10-12 percent, an altered supply profile to avoid a serious foreign exchange gap, and balanced regional and spatial development. Emphasis in this plan may include the removal of bottlenecks and development of social infrastructure, health, labor and education (34).

As of 1977, there is still some congestion at the ports and on the roads, but waiting time at all Persian Gulf ports is less than a year ago. In the principle port of Khorramshahr, the ships' predisembarkation wait averages less than 1 month, compared to 4 months in late 1975. With a less severe port and road congestion, an expected rate of growth in agriculture less than 5 percent, and the huge increase in income and consumption expenditure, Iran's heavy reliance on imports should continue.

The projected values for the 36 exogenous variables for 1977-82 are presented in table 23.

Table 23--Exogenous variables forecasts, Iran model, 1977-82

Variable name	1977	1978	1979	1980	1981	1982
FRTU	650.0	690.0	730.0	750.0	780.0	810.0
TRAG	48.0	49.0	52.0	53.0	54.0	55.0
UCLWI	281.0	285.3	289.6	293.9	298.6	302.8
WCPI	141.0	142.0	143.0	145.0	146.0	147.0
RWPI	318.0	344.0	371.0	400.0	433.0	455.0
CGY	6.5	6.5	6.7	6.6	6.5	6.4
SGWPI	186.0	200.0	216.1	233.4	252.1	272.3
MLSL	11,435.0	12,063.0	12,727.0	13,426.0	14,164.0	14,843.0
WWPI	301.0	311.0	317.0	323.0	329.0	335.0
BCPI	215.0	219.0	230.0	260.0	269.0	290.0
PCE	2,200.0	2,700.0	3,000.0	3,500.0	4,000.0	4.700.0
EXRATE	68.0	69.0	69.1	69.3	70.0	70.2
CPI	210.9	231.9	255.2	280.7	308.8	339.7
P	35.[illegible]	36.4	37.5	38.6	39.7	40.8
UP	16.6	17.1	17.5	18.0	18.5	19.0
RP	18.7	19.3	20.0	20.6	21.2	21.8
IWPI	200.0	204.0	204.0	212.0	216.0	219.0
UPCE	1,530.0	1,739.0	2,020.0	2,370.0	2,840.0	3,402.0
WPEXUS	194.7	214.2	235.6	262.2	288.1	316.6
WQUS	58,600.0	60,000.0	60,600.0	62,400.0	65,100.0	70,000.0
WESAUST	1,400.0	1,300.0	1,250.0	1,200.0	1,100.0	1,000.0
WRCPI	179.0	185.0	188.0	191.0	196.0	205.0
BVSL	778.0	832.0	890.0	952.0	1,018.0	1,089.0
CPUS	91.9	97.0	105.0	110.0	109.0	116.0
CGNEXUS	45,500.0	46,000.0	46,500.0	47,000.0	47,500.0	48,500.0
CGNEXAR	5,549.0	5,643.0	5,749.0	5,840.0	5,926.0	6,011.0
OLHPI	143.5	143.6	144.5	144.5	144.5	144.6
OSCTPI	130.8	131.4	132.0	132.0	132.3	132.5
RPCE	503.8	579.3	666.2	766.2	842.8	927.1
FCPI	195.4	214.9	236.4	260.4	286.0	314.6
RRQUS	5.8	5.9	5.8	5.8	5.9	5.9
CGQUS	186,000.0	196,000.0	201,000.0	205,000.0	210,400.0	213,500.0
OSBAP	65.0	75.0	85.0	100.0	120.0	130.0
OSBUSP	580.0	600.0	660.0	600.0	610.0	610.0
RES	100.0	150.0	100.0	100.0	75.0	125.0

Input Availability and Usages

Total fertilizer used was assumed to increase by 29 percent in 1977 but is expected to increase by an average of 5 percent during 1978-82. Total agricultural tractors are assumed to increase by 16 percent in 1977 and by only 5 percent thereafter. Labor availability is assumed to increase, given a 1.5 percent increase in the unskilled construction workers wages index.

Population

Population in Iran is expected to rise by an average rate of 3 percent a year. Urban population is assumed to constitute about 47 percent of the total population during 1977-82. The urban population ratio is likely to change in the future, and model users are advised to use variable ratio in other scenarios. (It changed from 40.6 percent of the total in 1970 to 46.0 percent in 1975, growing at the rate of 5.5 percent per year, versus 1.5 percent per year for the rural population--table 2).

Private Consumption Expenditures

Private consumption expenditure (PCE) increased by 20 percent in 1974 and 23 percent in 1975. It is assumed that it will increase an average of 16.5 percent a year during 1976-82--by 18 percent for the urban population and 13.3 percent for the rural population.

Price Indices

The Government's price control, based on January 1974 prices, reduced the inflation rate to about 9.9 percent during 1975-76. However, predictable market distortions occurred; shortages and an accompanying black market developed. The inflation rate increased 19.4 percent during 1976-77. Given the Government's determination to control prices, especially at the retail level, the general and food consumer price indices are assumed to increase by an average of 10 percent annually during 1977-82.

Given the importance of bread in the Iranian diet, the Government is expected to keep bread prices low. The consumer price index for wheat will probably increase by only 1 percent a year during 1977-82. The consumer price index for both wheat and rice, however, is expected to increase by 2.7 percent a year. Boneless beef consumption, which rose by 5 percent in 1976, is expected to rise by 6 percent a year over 1977-82.

Government efforts to implement price control policies in the wholesale markets are generally less concerted than those oriented toward implementing consumer price policies. Thus, the wholesale price index for rice is expected to increase by an average of 8 percent a year during 1977-82, as is the wholesale price index for sheep and goats. The wholesale price index for wheat is assumed to increase by only 2 percent.

The wholesale price index for total imports is assumed to increase by 4 percent a year during 1977-82. The exchange rate of Iranian rials to one U.S. dollar is expected to rise from 68.0 Rls/1 U.S.$ in 1976 to 70.2 Rls/1U.S.$ by 1982.

Livestock Slaughter

Because of the emphasis on development of the livestock-feed sector in Iran, mutton and lamb slaughter rose by 6.7 percent a year during 1974-76. It is expected to increase by only 5.5 percent a year during 1977-82. Cattle and calf slaughter, however, is expected to rise by 7 percent a year.

Appraisal

Given the great fluctuations in actual observations and the quality of data used in the construction of the econometric model, the high average percentage error and the high values of Theil's coefficients, discussed earlier in this chapter, are not surprising.

In general, however, the model projects well outside the sample period and provides staple projections. Neither explosions nor oscillations occur. The future will probably prove that several equations provided overestimated or underestimated values due to either poor assumptions, changed relationships, or other factors not considered here. Because of data limitations, some structural relationships are specified in less than conceptually satisfying form. Because of the incomplete time series, some coefficients were difficult to estimate. Some equations with statistically insignificant coefficients and/or *a priori* unexpected signs are left in the model. This mathematical approximation of the real world is clearly not perfect nor complete but still provides a useful analytical tool.

REFERENCES

1. Bank Markazi Iran. Annual Report and Balance Sheet, as of March 20. Several issues. Tehran, Iran.

2. Boloorforoosh, M. Demand Estimation of Meat in Iran. Unpublished Ph.D. Dissertation, Iowa State University. Ames, Iowa. 1977.

3. Bookers Agricultural and Technical Services Limited and Hunting Technical Services Limited. National Cropping Plan. Final Report. Vol. 2, Annexes I to V. Tehran, Iran. 1975.

4. Bowden, D.M., Manoucheri, M., and Van Ores, J. Analysis of Feedstuffs Available in Iran. Animal Husbandry Research Institute. Tehran, Iran.

5. Fisher, W.B. The Middle East, a Physical, Social and Regional Geography, Sixth Edition, Methuen and Co. Ltd. London. 1971.

6. Food and Machinery International. Animal Protein Development Program. Vol. II, Planning Data. Food and Machinery International. Tehran, Iran. 1975.

7. Foote, Richard J. Statistical Analysis Relating to the Feed-Livestock Economy. U.S. Department of Agriculture, Technical Bulletin No. 1070. June 1953.

8. Ghobadi, Farrokh. Estimated Impact of Variation in Wheat Price Policy in Northern Iran. Unpublished Ph.D. Dissertation, Iowa State University. Ames, Iowa. 1975.

9. Hashemi, F. Predicting the Wheat Yield of Iran with Weather Data. Iranian Meteorological Department. DDC No. 630.2515. May 1973.

10. International Bank for Reconstruction and Development. Economic Development of Iran, Vol. III, Statistical Appendix. Oct. 1974.

11. Johnston, J. Econometric Models. Second Edition. McGraw-Hill Book Company, New York. 1972.

12. Kamal-Abdou, D.K. The Effect of Separating Fed from Nonfed Beef in an Econometric Simulation. Unpublished Ph.D. Dissertation, Iowa State University. Ames, Iowa. 1975

13. King, Gordon A. The Demand and Price Structure for Byproduct Feeds. U.S. Department of Agriculture, Technical Bulletin No. 1183, Aug. 1958.

14. Kurtzig, Michael E. Iran, Agricultural Production and Trade. U.S. Department of Agriculture, Economic Research Service, ERS-Foreign 357, Apr. 1974.

15. Kurtzig, Michael E., and Parker, J.B., Jr. "Middle Eastern Countries Will Buy More Wheat as Hopes for Big Harvests Dim," Foreign Agriculture, U.S. Department of Agriculture, Foreign Agricultural Service, Sept. 12, 1974.

16. LeBaron, Allen. Long Term Projections of Supply and Demand for Selected Agricultural Products in Iran. Utah State University Press. Logan, Utah. June 1970.

17. Longrigg, Stephen H. The Middle East, A Social Geography, Second Edition. Aldine Publishing Company. Chicago. 1974.

18. Mojtahed, Ahmad. Economic Development of the Livestock Industry in Iran. Unpublished Ph.D. Dissertation, Iowa State University. Ames, Iowa. 1977.

19. Naylor, T.H., Balintfy, J.L., Burdick, D.C., and Chu, K. Computer Simulation Techniques. John Wiley and Sons, Inc. New York. 1966.

20. Ouray, Bernard. A Production Model for Wheat and Feed Grains in France (1946-1961). Contribution to Economic Analysis (4). North Holland Publishing Company. Amsterdam. 1966.

21. Pindyck, R.S. and Rubinfeld, D.K. Econometric Models and Economic Forecasts. McGraw-Hill Book Company. New York. 1976.

22. Plan and Budget Organization. Iran's Fifth Development Plan, 1973-1978, A Summary. Tehran, Iran. 1973.

23. ________________, Planning Division. Economic Statistics and Trends of Iran. Statistical Research Unit, Planometric and General Economy Bureau. Sept. 1975.

24. Roa, P. and Miller, R. Applied Econometrics. Wadsworth Publishing Company, Inc. Belmont, Calif. 1971.

25. Shaffer, James D. "On the Concept of Subsector Studies," American Journal of Agricultural Economics, 55.333-335. May 1973.

26. Theil, Henry. Economic Forecasts and Policy. Second Revised Edition. North Holland Publishing Company. Amsterdam. 1965.

27. United Nations. Food and Agriculture Organization. Prospective Study of Agricultural Development for Iran, Livestock Production. Animal Husbandry and Health Division. Rome. 1974.

28. ________________. F.A.O. Production Yearbook, Vol. 21 to 27. Rome.

29. ________________. Monthly Bulletin of Statistics. Statistical Office of the United Nations, several issues. New York.

30. U.S. Department of Agriculture. Fats and Oils Statistics, Oilseeds, Oils and Meals, Animal Fats and Oils, Food Fats, Nonfood Fats. Economic Research Service, Statistical Bulletin No. 376. Aug. 1966.

31. U.S. Department of Agriculture. Food Grain Statistics, Wheat, Rye, Rice, Flour, By-products. Statistical Bulletin No. 423, Supp. for 1971. Economic Research Service.

32. ________________. Foreign Agriculture. Foreign Agricultural Service. Dec. 16, 1974, and several other issues.

33. ________________. Foreign Agricultural Circular. Grain FG-9-76, FG-26-1976, and other issues. Foreign Agricultural Service.

34. ________________. Iran: Agricultural Situation. Report by The Agricultural Attache American Embassy, Tehran. Unpublished.

35. ________________. World Agricultural Production and Trade. Foreign Agricultural Service, several issues.

36. ________________. Wheat Situation. Economic Research Service. July 1976.

APPENDIX A--Variable Code Names, Units of Measurement, and Data Sources

Variable Code Name	Unit of Measure	Description	Data Sources*
BAH	1,000 Ha.	Barley area harvested	33,34
BCF	1,000 M.T.	Barley consumption for feed	33,34
BCH	1,000 M.T.	Barley consumption for food	33,34
BCPI	--	Beef (w/o bone) consumer price index (1969=100)	1
BCT	1,000 M.T.	Total barley consumption	33,34
BES	1,000 M.T.	Barley ending stocks	33,34
BM	1,000 M.T.	Barley imports	33,34
BMFUS	1,000 M.T.	Barley imports from the U.S.	33,34
BQ	1,000 M.T.	Barley production	33,34
BVSL	1,000 Head	Cattle and calves slaughter	34
BY	Q./Ha.	Barley yield	33,34
CAH	1,000 Ha.	Corn area harvested	33,34
CGCH	1,000 M.T.	Coarse grains consumption for food	33
CGCF	1,000 M.T.	Coarse grains consumption for feed	33
CGCT	1,000 M.T.	Total coarse grains consumption	33
CGM	1,000 M.T.	Coarse grains imports	33
CGMFUS	1,000 M.T.	Coarse grains imports from the U.S.	33
CGNEXAR	1,000 M.T.	Coarse grains net exports from Argentina	33
CGNEXUS	1,000 M.T.	Coarse grains net exports from the U.S.	33
CGQ	1,000 M.T.	Coarse grains production	33
CGQUS	1,000 M.T.	Coarse grains production in the U.S.	33
CGY	Q./Ha.	Coarse grains yield	33
CM	1,000 M.T.	Corn imports	33,34
CMFUS	1,000 M.T.	Corn imports from the U.S.	33,34
CPI	--	General consumer price index (1969=100)	1
CPUS	$/M.T.	Corn price in U.S.--#2 Yellow at Chicago	
CQ	1,000 M.T.	Corn production	33,34
CY	Q./Ha.	Corn yield	33,34

* Source number as they appear in the references.

Variable Code Name	Unit of Measure	Description	Data Sources*
D1	--	Dummy variable: Equals one for 1974 and zero otherwise	
EXRATE	Rls/1 U.S. $	Exchange rate of Rials to U.S. dollars	29
FCPI	--	Food consumer price index (1969=100)	1
FRTU	1,000 M.T.	Total fertilizer consumed (nitrogen, phosphate, potash)	28
IWPI	--	Wholesale price index for imported goods (1969=100)	1
LNT	--	Time trend in natural logarithm	
MLSL	1,000 Head	Mutton and lamb slaughter	34
OCTMQ	1,000 M.T.	Cottonseed meal production	34
OCTQ	1,000 M.T.	Cottonseed oil production	34
OLHPI	--	Local hydrogenated oil price index (1969=100)	34
OSBAP	1,000 Ha.	Soybean area planted	34
OSBMQ	1,000 M.T.	Soybean meal production	34,30
OSBQ	1,000 M.T.	Soybean oil production	34,30
OSBUSP	U.S. $	U.S. soybean price	30
OSCTPI	--	Cottonseed price index (1969=100)	34
OSCTQ	1,000 M.T.	Cottonseed production	34
OSSBQ	1,000 M.T.	Soybean production	34
OSSUNQ	1,000 M.T.	Sunflower production	34
OSUNMQ	1,000 M.T.	Sunflower meal production	34,30
OSUNQ	1,000 M.T.	Sunflower oil production	34,30
P	Millions	Total population	10
PCE	Billion Rials	Total private consumption expenditure in current prices	1,10
PCE$D	Million $	Private consumption expenditure in dollars deflated by C.P.I.	23,29
PCEN$D	$	Per capita private consumption expenditure in dollars deflated by C.P.I.	10,23,29
RAH	1,000 Ha.	Rice area harvested	34
RCT	1,000 M.T.	Total rice consumption	34
RES	1,000 M.T.	Rice ending stocks	34
RMFUS	1,000 M.T.	Rice imports from the U.S.	34
RMQ	1,000 M.T.	Milled rice production	34

Variable Code Name	Unit of Measure	Description	Data Sources*
RNM	1,000 M.T.	Net rice imports	34
RP	Millions	Rural population	10
RPCE	Billion Rials	Rural private consumption expenditure in current prices	1,10
RPCE$D	Million $	Rural private consumption expenditure in dollars deflated by C.P.I.	23,29
RPCEN$D	$	Per capita rural private consumption expenditure in dollars deflated by C.P.I.	10,23,29
RRQ	1,000 M.T.	Rough rice production	34
RRQUS	1,000 M.T.	Rough rice production in the U.S.	33,35
RTAV	1,000 M.T.	Total rice availability [RTAV(L) = RMQ(L) + RNM(L) + RES(L-1)]	
RY	Q./Ha.	Rice yield	34
SBOUSP	$/M.T.	Soybean oil wholesale prices in the U.S.	33
SGWPI	--	Sheep and goat meat wholesale price index (1969=100)	1
TOSQ	1,000 M.T.	Total oilseeds production	34
TRAG	Thousands	Total tractors in use--Agriculture	28
TVOC	1,000 M.T.	Total vegetable oil consumption	34
TVOM	1,000 M.T.	Total vegetable oil imports	34
TVOQ	1,000 M.T.	Total vegetable oil production	34
UCLWI	--	Unskilled construction workers wage index (1969=100)	1
UP	Millions	Urban population	10
UPCE	Billion Rials	Urban private consumption expenditures in current prices	1,10
UPCE$D	Million $	Urban private consumption expenditure in dollars deflated by C.P.I.	23,29
UPCEN$D	$	Per capita urban private consumption expenditure in dollars deflated by C.P.I.	10,23,29
VOMFUS	1,000 M.T.	Vegetable oil imports from the U.S.	34
WAH	1,000 Ha.	Wheat area harvested	33
WCPI	--	Wheat (bread, all) consumer price index (1969=100)	1
WCT	1,000 M.T.	Total wheat consumption	33
WES	1,000 M.T.	Wheat ending stocks	33

Variable Code Name	Unit of Measure	Description	Data Sources*
WESAUST	1,000 M.T.	Wheat ending stocks in Australia	33
WMFUS	1,000 M.T.	Wheat imports from the U.S.	33
WNM	1,000 M.T.	Net wheat imports	33
WEXPUS	$/M.T.	Wheat export price in the U.S.	36
WQ	1,000 M.T.	Wheat production	33
WQUS	Million M.T.	Wheat production in the US	33
WRCPI	--	Wheat (flour; bread) and rice consumer price index (1969=100)	1
WTAV	1,000 M.T.	Total wheat availability [WTAV(L) = WQ(L) + WNM(L) + WES(L-1)]	
WWPI	--	Wheat wholesale price index (1969=100)	1
WY	Q./Ha.	Wheat yield	33

Appendix B--Data used 1/

Year	CPI	BCPI	WCPI	FCPI	WRCPI	RWPI	WWPI	SGWPI	IWPI	OLHPI
1960	86.3	54.7	91.5	84.2	87.7	90.1	104.6	67.7	93.8	135.8
1961	87.7	56.6	95.0	85.9	93.1	106.2	104.3	70.8	92.7	135.8
1962	88.5	60.3	98.4	87.2	98.4	104.3	111.9	73.8	93.3	118.5
1963	98.4	66.7	97.6	98.0	92.7	86.8	102.8	77.5	94.7	108.6
1964	93.4	75.2	103.4	94.7	97.5	94.0	120.5	88.1	96.6	111.1
1965	93.7	79.0	107.4	95.4	103.4	109.3	129.3	89.8	96.3	111.1
1966	94.4	80.1	109.2	96.1	105.5	109.9	113.3	88.6	97.4	112.3
1967	95.1	88.5	100.1	96.6	102.4	119.0	92.0	94.2	97.6	100.0
1968	96.6	98.3	97.4	97.6	100.2	119.3	95.6	98.2	98.4	100.0
1969	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1970	101.3	99.6	107.4	101.1	104.7	106.4	121.6	96.5	102.9	113.6
1971	107.1	101.2	117.2	110.8	117.4	131.8	136.9	97.5	109.0	125.9
1972	113.8	115.3	119.7	117.2	121.4	132.0	117.2	104.9	126.6	123.5
1973	126.5	145.0	125.7	127.0	127.5	143.4	125.6	123.7	173.6	128.4
1974	146.1	194.2	138.0	151.3	158.3	234.8	281.9	147.0	187.6	143.3
1975	160.5	203.9	139.4	161.5	162.3	244.2	290.4	154.3	187.7	143.2

Year	P	UP	RP	PCE	UPCE	RPCE	BVSL	MLSL	CGNEXAR	CGNEXUS
	---- Million ---						- 1,000 Head -		- 1,000 M.T. -	
1960	21.8	7.3	14.5	230.4	121.4	109.0	440.0	6948.0	--	--
1961	22.4	7.7	14.7	236.0	124.8	111.2	471.0	6940.0	--	--
1962	22.8	8.0	14.8	252.3	136.0	116.3	451.0	6832.0	--	--
1963	23.5	8.4	15.1	262.1	143.9	118.2	444.0	6666.0	3805.0	16366.0
1964	24.2	8.9	15.4	294.7	161.2	133.5	492.0	6264.0	4178.0	19254.0
1965	25.0	9.3	15.7	312.5	169.7	142.8	571.0	6228.0	3793.0	25485.0
1966	25.8	9.8	16.0	348.6	202.2	146.4	542.0	6768.0	6526.0	19493.0
1967	26.6	10.2	16.3	371.6	222.6	149.0	547.0	6996.0	4042.0	20344.0
1968	27.4	10.7	16.7	423.1	262.3	160.8	537.0	7720.0	5617.0	16059.0
1969	28.3	11.3	17.0	463.7	294.9	168.8	521.0	8830.0	6002.0	18741.0
1970	29.1	11.8	17.3	522.6	344.4	178.2	588.0	7878.0	7621.0	18334.0
1971	30.1	12.4	17.7	554.9	380.6	174.3	580.0	7878.0	6149.0	23986.0
1972	30.9	13.1	17.8	663.7	463.7	200.0	632.0	8600.0	4204.0	38428.0
1973	31.8	13.9	17.9	898.1	679.5	218.6	645.0	9050.0	8356.0	40400.0
1974	32.8	14.6	18.2	1242.6	941.9	300.7	655.0	9350.0	8495.0	35055.0
1975	33.5	15.4	18.6	1533.8	1121.2	412.6	671.0	1000.0	5300.0	46730.0

Year	CGQUS	WESAUST	WQUS	RRQUS	WAH	WY	WQ	WCT	WNM	WMFUS
	- - 1,000 M.T. - -			Mill.M.T.	1,000 Ha.	Q/Ha.	---- 1,000 M.T. ----			
1960	141,909	989	36,869	--	3300	7.9	2400	3163	503.0	193.0
1961	127,489	807	33,539	--	3400	8.2	2800	3020	192.0	122.0
1962	129,604	959	29,718	--	3500	7.7	2700	3030	330.0	212.0
1963	140,270	880	31,211	--	3600	8.3	3000	3250	138.0	57.0
1964	122,546	989	34,928	3.3	3400	7.6	2600	3220	622.0	287.0

1/ For definitions of variable code names, refer to Appendix A.

Continued--

Appendix B--Data used 1/--Continued

Year	CGQUS	WESAUST	WQUS	RRQUS	WAH	WY	WQ	WCT	WNM	WMFUS
	- - 1,000 M.T.		- -	Mil. M.T.	1,000 Ha.	Q/Ha.	- - - - 1,000 M.T. - - - -			
1965 ..:	144,200	774	35,805	3.5	3700	7.8	2900	2967	143.0	285.0
1966 ..:	144,926	2,516	35,513	3.9	4000	8.0	3190	3588	200.0	157.0
1967 ..:	162,911	1,737	41,030	4.4	4300	9.3	4000	3704	-33.0	2.0
1968 ..:	155,258	7,586	42,365	4.7	4700	8.4	4400	4018	-212.0	.535
1969 ..:	161,682	7,545	29,265	4.1	4200	9.3	3900	4178	-1.5	.50
1970 ..:	146,135	3,665	36,783	3.8	4200	9.0	3800	3888	101.0	240.0
1971 ..:	189,673	1,584	44,029	3.9	4000	8.3	3300	4389	1114.0	488.0
1972 ..:	182,123	565	42,046	3.9	4300	9.4	4034	4800	736.0	503.0
1973 ..:	186,593	1,982	46,402	4.2	4300	9.2	3950	4700	600.0	584.0
1974 ..:	150,470	1,788	48,870	5.2	4270	9.1	3900	5063	1571.0	1332.0
1975 ..:	184,074	1,737	58,078	5.6	4350	11.4	5000	6000	1400.0	958.0

Year	WES	WTAV	RAH	RY	RRQ	RMQ	RCT	RNM	RMFUS	RES
	- 1,000 M.T. -		1,000 Ha.	Q/Ha.	- - - - - - - - - 1,000 M.T. - - - - - - - - -					
1960 ..:	440	3603	315	22.5	709	472	483	11	--	--
1961 ..:	412	3432	290	21.4	600	400	419	19	--	--
1962 ..:	412	3442	300	38.2	850	566	573	7	--	--
1963 ..:	300	3550	300	28.7	860	573	576	3	--	--
1964 ..:	302	3522	300	30.8	923	615	656	41	--	--
1965 ..:	378	3345	280	36.5	1022	681	710	29	--	--
1966 ..:	180	3768	280	37.5	1050	699	709	10	--	--
1967 ..:	443	4147	261	41.5	1083	721	745	24	--	--
1968 ..:	613	4631	318	36.9	1172	781	783	2	--	--
1969 ..:	334	4511	250	40.8	1021	680	679	1	--	2
1970 ..:	347	4235	270	41.1	1111	740	705	-17	--	20
1971 ..:	372	4761	280	36.5	1021	680	754	74	14	20
1972 ..:	342	5142	290	34.2	991	660	730	65	38	15
1973 ..:	192	4892	310	32.2	998	665	710	70	20	40
1974 ..:	600	5663	310	34.7	1077	717	1147	500	366	110
1975 ..:	1000	7000	340	35.3	1201	800	1060	250	240	100

Year	RTAV	CAH	CY	CQ	CCT	CM	CMFUS	BAH	BY	BQ
	- 1,000 M.T. -		Q/Ha.	- - - - 1,000 M.T. - - - -				1,000 M.T.	Q/Ha.	1,000 M.T.
1960 ..:	483	16	8.8	14	25	--	--	1400	6.4	900
1961 ..:	419	16	8.8	14	14	--	--	1500	6.7	1000
1962 ..:	573	16	8.8	14	14	--	--	1400	6.8	950
1963 ..:	576	16	8.8	14	14	--	--	1477	6.8	1000
1964 ..:	656	18	10.0	18	67	49	--	1350	6.7	900
1965 ..:	710	20	10.0	20	20	--	--	1477	6.8	1000
1966 ..:	709	20	10.5	21	21	--	--	1477	6.8	1000
1967 ..:	745	25	12.0	30	63	33		1480	6.9	1020

1/ For definitions of variable code names, refer to Appendix A.

Continued--

Appendix B--Data used 1/--continued

Year	RTAV	CAH	CY	CQ	CCT	CM	CMFUS	BAH	BY	BQ
	- 1,000 M.T. -		Q/Ha.	- - - - 1,000 M.T. - - - -				1,000 M.T.	Q/Ha.	1,000 M.T.
1968	783	25	14.0	35	106	71	--	1700	7.5	1270
1969	681	25	14.0	35	59	24	--	1500	8.0	1200
1970	725	25	14.0	35	57	22	12	1500	8.0	1200
1971	774	25	14.0	35	105	70	22	1400	5.7	800
1972	745	27	14.8	40	137	97	23	1400	5.7	800
1973	750	27	14.8	40	120	80	80	1400	6.4	900
1974	1257	28	17.9	50	289	237	151	1400	5.7	800
1975	1160	30	21.7	65	265	200	160	1400	7.9	1100

Year	BES	BCF	BCH	BCT	BM	BMFUS	CGAH	CGY	CGQ
	- - - - - - - - - - - 1,000 M.T. - - - - - - - - - -						1,000 Ha.	Q/Ha.	1,000 M.T.
1960	100	657	270	927	28	38	1416	6.5	914
1961	100	709	300	1009	10	--	1516	6.7	1014
1962	100	655	285	950	--	10	1416	6.8	964
1963	100	714	296	1010	10		1493	6.8	1014
1964	100	632	267	899	1	--	1368	6.7	918
1965	98	713	293	1006	5	--	1497	6.8	1020
1966	91	711	297	1008	1	--	1497	6.8	1021
1967	85	697	313	1010	--	--	1606	7.0	1060
1968	155	884	316	1200	--	--	1725	7.6	1305
1969	74	954	327	1281	--	--	1525	8.1	1235
1970	19	951	305	1256	1	21	1525	8.1	1235
1971	34	753	238	991	206	63	1425	5.9	835
1972	12	790	40	830	8	--	1427	5.9	840
1973	30	850	152	1002	120	40	1427	6.6	940
1974	50	778	180	958	178	60	1428	6.0	850
1975	50	935	365	1300	200	160	1430	7.1	1165

1/ For definitions of variable code names, refer to Appendix A.

Continued--

Appendix B--Data used 1/--continued

	CGCH	CGCF	CGCT	CGM	CGMFUS	CGES	OSSBAP	OSSBQ	OSCTQ	OSSUNQ
	1,000 M.T.						1,000 Ha.	1,000 M.T.		
1960	272.8	679.0	951.8	39	48	100	--	--	--	--
1961	302.8	720.2	1023.0	10	--	100	--	--	--	--
1962	287.8	676.2	964.0	1	10	100	--	--	--	--
1963	298.8	725.0	1024.0	10	--	100	--	--	--	--
1964	270.6	695.0	966.0	50	--	100	--	--	--	--
1965	297.0	729.0	1026.0	5	--	98	0.12	0.12	312	0.12
1966	301.2	727.8	1029.0	1	--	91	0.45	0.5	252	0.50
1967	319.0	754.0	1073.0	33	--	85	3.83	2.06	257	1.45
1968	323.0	983.0	1306.0	71	--	155	5.44	2.29	320	7.30
1969	334.0	1006.0	1340.0	24	--	74	4.28	3.17	352	28.24
1970	312.0	1001.0	1313.0	23	33	19	6.30	6.36	341	51.36
1971	245.0	851.0	1096.0	276	85	34	7.58	7.46	280	37.39
1972	48.0	919.0	967.0	105	23	30	7.02	9.70	320	44.33
1973	176.0	962.0	1138.0	200	120	50	6.36	9.53	420	47.18
1974	237.0	1068.0	1305.0	415	211	50	21.81	34.92	450	42.96
1975	418.0	1287.0	1705.0	400	320	50	53.18	70.33	290	29.02

Year	OSCTPI	SBOUSP	CPUS	WPEZUS	LNT	EXRATE	FRTU	TRAG	UCLWI
		$/M.T.				Res./$	1,000 M.T.		
1960	123.8	--	--	62.13	0.0	75.75	13.4	5.8	61.8
1961	107.7	--	--	62.28	0.693	75.75	13.8	6.0	61.0
1962	101.5	--	46.06	62.21	1.099	75.75	18.1	6.0	59.9
1963	107.7	--	49.99	65.61	1.386	75.75	24.3	9.0	61.9
1964	98.5	299.8	50.78	65.90	1.609	75.75	31.3	13.0	64.6
1965	101.5	269.8	50.78	60.31	1.792	75.75	41.0	15.0	65.3
1966	109.2	261.5	55.51	62.45	1.946	75.75	49.0	16.0	67.5
1967	100.0	216.4	46.45	64.18	2.079	75.75	75.2	17.0	71.6
1968	100.0	178.1	46.45	61.43	2.197	75.09	77.8	20.0	8.36
1969	100.0	198.4	49.60	60.42	2.303	76.38	87.0	21.0	100.0
1970	101.5	288.4	59.05	58.28	2.398	76.38	95.5	23.0	104.8
1971	132.31	306.0	48.42	62.13	2.485	76.38	166.0	21.0	106.7
1972	132.31	230.6	65.59	64.37	2.565	76.38	200.0	23.0	125.2
1973	123.08	436.0	106.69	107.98	2.639	67.63	292.0	24.2	146.1
1974	100.0	832.2	128.73	176.18	2.708	67.63	350.0	27.8	192.5
1975	130.8	563.3	109.44	176.70	2.773	69.23	420.0	31.9	231.0

	TVOQ	TVOC	TVOM	VOMFUS
	1,000 M.T.			
1960	--	--	--	--
1961	--	--	--	--

Continued--

1/ For definitions of variable code names, refer to Appendix A.

Appendix B--Data used 1/--continued

Year	TVOQ	TVOC	TVOM	VOMFUS
	----- 1,000 M.T. -----			
1962 ..	--	--	--	--
1963 ..	--	--	--	--
1964 ..	--	--	--	--
1965 ..	36.0	99.3	66.8	--
1966 ..	30.0	107.8	78.3	--
1967 ..	35.0	115.0	88.4	--
1968 ..	57.4	120.0	128.5	8.9
1969 ..	70.9	140.0	103.9	17.8
1970 ..	78.8	160.0	128.3	43.1
1971 ..	60.0	176.0	105.0	77.6
1972 ..	84.0	190.0	126.4	51.5
1973 ..	88.0	205.0	133.8	42.6
1974 ..	96.0	313.0	227.0	157.5
1975 ..	70.0	320.0	249.6	130.9

1/ For definitions of variable code names, refer to Appendix A.

APPENDIX C--Effect of Rainfall on Wheat Yield in Iran

This appendix presents the results of a simple analysis of the effect of rainfall on wheat yield. Generally, rainfall affects all crop yields in Iran. Only cross section data for rainfall and wheat yields were available.

Weather in Iran is characterized as hot and dry in summer and cold in winter. The extreme north and west regions of the country receive considerable rainfall, and the remainder of the country receives little or none. Only 9 percent of the country receives more than 500 millimeters of rain annually, while about 61 percent receives less than 240 millimeters annually. About 13 percent receives less than 100 millimeters annually. As a result, Iran has severe water problems. Some of these problems are due to the physical environment, characterized by steep gradients, encased drainage, and the loss of stream water, either outwards into other countries, or into closed saline drainage basins (9).

Wheat is usually grown as a winter crop, except in some areas in the high valleys of the Zagros and Elburz. Sowing is in the spring, with the harvest in July and August. Wheat production in Iran is largely nonirrigated, and is dependent upon the weather. The average nonirrigated wheat area cultivated is about 73 percent of total wheat area cultivated. Even irrigated wheat receives water through systems of Qanats and diversions from rivers, where the flows of both sources depend upon the precipitation (9).

To estimate the effect of rainfall on wheat yield (total, irrigated, and nonirrigated), 2 years' data--using Iranian years 1350 and 1351,--or 1971/72 and 1972/73--on average rainfall for 12 years (rather than rainfall data measured at specific stations in the province) were collected. Considering the size of some provinces and the distribution of wheat planting areas, these stations are not representative of the whole province (Ostan). Because Iranian years are used in the present analysis, the use of current rainfall as an explanatory variable means that wheat harvested in late May and early June--winter wheat--is affected by September-May precipitation. That is, if current wheat harvested in May was related to current rainfall, then only rainfall from March to May is considered. The rainfall during September to March, however, is very important in ensuring adequate seedbed preparation and germination. Thus, current wheat yield for each Iranian year is specified as related to the previous year's rainfall.

Utilizing the data presented in appendix table c-1, three simple regression equations were estimated using the ordinary least squares method:

1. $WYN(L) = 128.021 + \underset{(5.35)}{1.3157}\ RF(L-1)$

$R^2 = 0.882 \quad S.E. = 229.55 \quad \overline{Y} = 547.9$

2. $WYI(L) = 1548.66 - \underset{(0.33)}{0.229}\ RF\ (L-1)$

$R^2 = 0.852 \quad S.E.\ 641.49 \quad \overline{Y} = 1475.3$

3. $WYT(L) = 695.1346 + 0.5084\ RF\ (L-1)$

$R^2 = 0.843 \quad S.E. = 401.31 \quad \overline{Y} = 857.31$

WYN(L), WYI(L), and WYT(L) are wheat yield in nonirrigated, irrigated, and total area measured in kg/hectare, respectively. RF(L-1) is the previous year's rainfall measured in millimeters.

As expected, this analysis proves that rainfall affects the wheat yield, especially in nonirrigated areas. Since nonirrigated wheat area accounts for about three-fourths of total wheat area in Iran, wheat yield is also affected by the previous year's rainfall. The 1-millimeter increase in RF(L-1) would tend to increase wheat production by 1.3 kg per hectare and 0.51 kg per hectare in nonirrigated and total wheat area, respectively. The 1-millimeter increase in the previous year's rainfall decreases wheat yield in irrigated areas by 0.22 kg per hectare. However, no serious conclusion can be drawn from equation 2, since the coefficient associated with RF(L-1) is insignificant at the .05 level of significance.

This analysis indicates the importance of rainfall as proxy of weather conditions on wheat yield and production in Iran. Given time-series data on average rainfall, such factors should be included in estimating wheat yield.

Appendix table C-1--Wheat yields and average rainfall by Ostan provinces, Iran, 1971/72 and 1972/73

Ostan provinces	Wheat yields: Nonirrigated 1971/72	Wheat yields: Nonirrigated 1972/73	Wheat yields: Irrigated 1971/72	Wheat yields: Irrigated 1972/73	Wheat yields: Total 1971/72	Wheat yields: Total 1972/73	Average rainfall 1971/72	Average rainfall 1972/73
	Kilograms per hectare						Millimeters	
Markazi	382.4	393.2	1,672.7	1,952.4	878.9	1,042.2	199.0	363.0
Khorasan	105.5	315.9	1,112.0	1,500.0	343.2	623.4	90.0	232.0
Esfahan	347.7	392.9	3,008.5	3,[illegible]7.2	1,721.9	1,728.1	98.0	152.0
East Azarbaijan	420.4	556.9	1,371.2	1,163.3	633.6	696.4	228.0	327.0
Khuzestan	247.4	518.6	641.0	578.3	423.5	543.5	164.0	228.0
Mazandaran	1,129.9	1,340.9	1,245.0	1,409.1	1,141.1	1,341.7	880.0	722.0
Fars	200.5	660.0	1,200.0	1,555.6	631.2	1,125.0	107.0	405.0
West Azarbaijan	658.6	630.1	1,268.6	1,057.9	893.3	823.2	182.0	303.0
Kermanshah	836.9	883.0	1,466.7	1,562.2	918.2	983.0	218.0	373.0
Hamadan	384.5	354.8	2,017.0	1,981.5	728.6	595.2	256.0	510.0
Lurestan	773.5	1,260.5	1,795.9	1,514.3	974.7	1,322.8	482.0	531.0
Zanjan	191.5	218.3	620.8	692.3	222.5	258.1	263.0	346.0

Source: Statistical Yearbook of Iran, 1973-74, Plan and Budget Organization, Statistical Center.

Appendix D--Simulated, actual, and percentage error indexes for selected endogenous variables 1/

Year	WY Simulated	WY Actual	WY Error index	WAH Simulated	WAH Actual	WAH Error index	WCT Simulated	WCT Actual	WCT Error index
1961	7.80	8.2	95.1	3468.4	3400.0	102.0	3017.1	3020.0	99.9
1962	7.80	7.7	101.3	3309.8	3500.0	94.6	3044.7	3030.0	100.5
1963	8.02	8.3	96.6	3677.8	3600.0	102.2	3211.8	3250.0	98.8
1964	8.31	7.6	109.3	3550.5	3400.0	104.4	3112.7	3220.0	96.7
1965	8.45	7.8	108.4	3744.7	3700.0	101.2	3267.5	2967.0	110.1
1966	8.53	8.0	106.6	3875.2	4000.0	96.9	3531.0	3588.0	98.4
1967	8.65	9.3	93.0	4416.4	4300.0	102.7	4038.2	3740.0	109.0
1968	8.83	9.4	93.9	4417.9	4700.0	94.0	4140.5	4018.0	103.0
1969	8.90	9.3	95.7	4296.0	4200.0	102.3	3935.1	4178.0	94.2
1970	9.05	9.0	100.5	4251.9	4200.0	101.2	3995.4	3888.0	102.8
1971	8.96	.3	107.9	3953.7	4000.0	98.8	4105.5	4389.0	93.5
1972	9.09	9.4	96.7	4387.9	4300.0	102.0	4702.5	4800.0	98.0
1973	9.21	9.2	100.1	4242.5	4300.0	98.7	4942.7	4700.0	105.2
1974	9.49	9.1	104.3	4092.4	4270.0	95.8	5314.2	5063.0	105.0
1975	9.81	11.4	86.1	4968.2	4350.0	114.2	5895.2	6000.0	98.3
1976	10.19	12.2	83.5	5180.7	4500.0	115.1	6210.7	6400.0	97.0

Year	WES Simulated	WES Actual	WES Error index	RY Simulated	RY Actual	RY Error index	RAH Simulated	RAH Actual	RAH Error index
1961	442.9	412.0	107.5	25.61	21.4	119.7	313.7	280.0	112.1
1962	343.7	412.0	83.4	24.63	28.3	87.0	283.1	300.0	94.4
1963	388.5	300.0	129.5	29.89	28.7	104.1	290.7	300.0	96.9
1964	285.2	302.0	94.4	30.68	30.8	99.6	297.3	300.0	99.1
1965	361.2	378.0	95.6	32.08	36.5	87.9	282.1	280.0	100.7
1966	335.3	180.0	186.3	35.94	37.5	95.8	280.6	280.0	100.2
1967	468.2	443.0	105.7	36.89	41.5	88.0	268.0	261.0	102.7
1968	476.2	613.0	77.7	39.97	36.9	108.3	292.4	318.0	91.9
1969	400.8	334.0	120.0	36.88	40.8	90.4	268.1	250.0	107.2
1970	362.2	347.0	104.4	39.84	41.1	96.9	271.9	270.0	100.7
1971	291.1	372.0	78.2	39.53	36.5	108.3	288.1	280.0	102.9
1972	371.9	342.0	108.7	37.11	34.2	108.5	294.9	290.0	101.7
1973	103.6	192.0	54.0	35.68	32.2	110.8	298.6	310.0	96.3
1974	489.5	600.0	81.6	34.98	34.7	100.8	289.4	310.0	93.4
1975	715.1	1000.0	71.5	37.05	35.3	105.0	283.1	340.0	83.3
1976	852.5	800.0	106.6	37.93	34.9	108.7	280.0	365.0	76.7

1/ For definitions of variable code names, refer to Appendix A.

Continued--

Appendix D--Simulated, actual, and percentage error indexes for selected endogenous variables 1/--continued

Year	RCT			CY			CAH		
	Simulated	Actual	Error index	Simulated	Actual	Error index	Simulated	Actual	Error index
1961 ..	407.4	419.0	97.2	8.72	8.8	99.1	15.89	16.0	99.3
1962 ..	581.4	573.0	101.5	8.75	8.8	99.5	15.68	16.0	98.0
1963 ..	585.7	576.0	101.7	9.61	8.8	109.2	16.93	16.0	105.8
1964 ..	646.5	656.0	98.6	10.47	10.0	104.7	18.85	18.0	104.7
1965 ..	700.1	710.0	98.6	10.66	10.0	106.6	19.27	20.0	96.4
1966 .	720.1	709.0	101.6	10.59	10.5	100.9	20.49	20.0	102.5
1967 ..	741.6	745.0	99.5	11.56	12.0	96.3	22.92	25.0	91.7
1968 ..	759.0	783.0	96.9	13.24	14.0	94.6	25.72	25.0	102.9
1969 ..	676.6	679.0	99.6	14.25	14.0	101.8	25.66	25.0	102.6
1970 ..	735.0	705.0	104.4	14.37	14.0	102.7	25.73	25.0	102.9
1971 ..	751.8	754.0	99.7	13.17	14.0	94.1	24.75	25.0	99.0
1972 ..	729.2	730.0	99.9	14.11	14.8	95.3	26.57	27.0	98.4
1973 ..	693.8	710.0	97.7	15.16	14.8	102.5	26.74	27.0	99.0
1974 ..	1133.4	1147.0	98.8	15.71	17.89	87.8	38.43	28.0	137.2
1975 ..	1156.5	1060.0	109.1	25.18	21.7	116.1	30.96	30.0	103.2
1976 ..	1196.4	1200.0	99.7	20.82	22.8	90.9	33.39	35.0	95.4

Year	CCT			BY			BAH		
	Simulated	Actual	Error index	Simulated	Actual	Error index	Simulated	Actual	Error index
1961 ..	20.79	14.0	148.5	6.30	6.7	94.0	1427.2	1500.0	95.1
1962 ..	27.88	14.0	199.1	6.47	6.8	95.2	1446.8	1400.0	103.3
1963 ..	-9.24	14.0	-66.0	6.70	6.8	98.6	1461.5	1477.0	98.9
1964 ..	31.23	67.0	46.6	6.83	6.7	101.9	1469.9	1350.0	108.9
1965 ..	33.24	20.0	166.2	6.73	6.8	98.9	1485.1	1477.0	100.5
1966 ..	28.21	21.0	134.3	6.76	6.8	99.4	1482.8	1477.0	100.4
1967 ..	83.46	63.0	132.5	6.80	6.9	98.6	1502.3	1480.0	101.5
1968 ..	84.35	106.0	79.6	6.95	7.5	92.7	1538.8	1700.0	90.5
1969 ..	66.49	59.0	112.7	7.27	8.0	90.8	1535.8	1500.0	102.4
1970 ..	59.63	57.0	104.6	7.64	8.0	95.5	1523.0	1500.0	101.5
1971 ..	98.11	105.0	93.4	7.45	5.7	130.7	1374.5	1400.0	98.2
1972 ..	138.18	137.0	100.9	6.25	5.7	109.6	1386.3	1400.0	97.7
1973 ..	138.96	120.0	115.8	6.25	6.4	97.7	1444.2	1400.0	103.2
1974 ..	301.22	287.0	105.0	6.84	5.7	120.0	1421.5	1400.0	101.5
1975 ..	413.26	265.0	155.9	6.54	7.9	82.8	1496.2	1400.0	106.9
1976 ..	566.65	330.0	171.7	7.99	8.5	93.9	1451.0	1350.0	107.5

1/ For definitions of variable code names, refer to Appendix A.

Continued--

Appendix D--Simulated, actual, and percentage error indexes for selected endogenous variables 1/--continued

Year	BCH Simulated	BCH Actual	BCH Error index	BCF Simulated	BCF Actual	BCF Error index	OSSBQ Simulated	OSSBQ Actual	OSSBQ Error index
1961 ..:	286.1	300.0	95.4	716.9	709.0	101.1	--	--	--
1962 ..:	282.1	285.0	99.0	671.0	665.0	100.9	--	--	--
1963 ..:	284.4	296.0	96.1	675.0	714.0	94.5	--	--	--
1964 ..:	283.1	267.0	106.0	642.3	632.0	101.6	--	--	--
1965 ..:	340.0	293.0	116.1	709.9	713.0	99.6	--	--	--
1966 ..:	306.4	297.0	103.2	732.4	711.0	103.0	--	--	--
1967 ..:	280.7	313.0	89.7	747.9	697.0	107.3	3.85	2.06	187.5
1968 ..:	314.8	316.0	99.6	881.9	884.0	99.8	4.12	2.29	180.2
1969 ..:	308.4	327.0	94.3	930.1	954.0	97.5	2.40	3.17	75.7
1970 ..:	346.4	305.0	113.6	917.3	951.0	96.5	5.42	6.36	85.2
1971 ..:	184.1	238.0	77.4	730.7	753.0	97.0	9.66	7.46	129.6
1972 ..:	162.3	40.0	405.7	801.3	790.0	101.4	10.96	9.70	113.0
1973 ..:	246.5	152.0	162.2	849.4	850.0	99.9	9.56	9.53	100.4
1974 ..:	221.1	180.0	122.8	785.1	778.0	100.9	33.45	34.92	95.8
1975 ..:	206.4	365.0	56.5	957.6	935.0	102.4	82.79	70.33	117.7
1976 ..:	228.1	370.0	61.6	1008.5	980.0	102.9	84.01	98.00	85.7

Year	OSCTQ Simulated	OSCTQ Actual	OSCTQ Error index	OSSUNQ Simulated	OSSUNQ Actual	OSSUNQ Error index	TVOQ Simulated	TVOQ Actual	TVOQ Error index
1965 ..:	261.2	312.0	83.7	--	--	--	33.02	36.0	91.7
1966 ..:	251.3	252.0	99.7	--	--	--	33.76	30.0	112.5
1967 ..:	307.9	257.0	119.8	26.53	1.45	1833.7	40.94	35.0	117.0
1968 ..:	332.7	320.0	104.0	29.17	7.30	399.6	56.25	57.4	98.0
1969 ..:	349.7	352.0	99.3	39.00	28.24	138.1	68.17	70.9	96.2
1970 ..:	333.0	341.0	97.7	44.07	51.36	85.8	73.31	78.8	93.0
1971 ..:	296.1	280.0	105.8	52.34	37.39	140.0	63.75	60.0	106.3
1972 ..:	341.4	320.0	106.7	48.3	44.33	109.0	73.60	84.0	87.6
1973 ..:	381.5	420.0	90.8	51.76	47.18	109.7	91.79	88.0	104.3
1974 ..:	449.1	450.0	99.8	54.61	42.96	127.1	101.54	96.0	105.8
1975 ..:	220.8	290.0	76.1	46.20	29.02	159.2	80.70	70.0	115.3
1976 ..:	385.6	348.0	110.8	43.36	36.0	120.4	96.88	89.3	108.5

Year	TVOC Simulated	TVOC Actual	TVOC Error index	TVOM Simulated	TVOM Actual	TVOM Error index	VOMFUS Simulated	VOMFUS Actual	VOMFUS Error index
1965 ..:	91.97	99.26	92.7	58.09	66.84	86.9	--	--	--
1966 ..:	104.70	107.79	97.1	85.06	78.30	108.6	--	--	--
1967 ..:	119.03	115.0	103.5	92.61	88.42	104.7	--	--	--
1968 ..:	138.32	120.0	115.3	94.21	128.50	73.3	36.54	8.98	406.8
1969 ..:	135.81	140.0	97.0	90.46	103.90	87.1	27.38	17.77	154.1
1970 ..:	154.17	160.0	96.4	108.38	128.31	84.5	55.94	43.05	129.9
1971 ..:	172.67	176.0	98.1	132.02	105.04	125.7	47.00	77.57	60.6
1972 ..:	187.07	190.0	98.5	117.59	126.35	93.1	44.71	51.52	86.8
1973 ..:	219.90	205.0	107.3	162.01	133.81	121.1	84.89	42.59	199.3
1974 ..:	309.04	313.0	98.7	209.78	227.00	92.4	203.24	157.50	129.0
1975 ..:	319.03	320.0	99.7	278.88	249.60	111.7	167.41	130.87	127.9
1976 ..:	349.07	336.0	103.9	262.99	300.00	87.7	194.72	80.0	243.4

1/ For definitions of variable code names, refer to Appendix A.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1978 261 496/46

END
DATE
FILMED
7-24-79
NTIS