

DEVELOPMENT OF WHEAT PRODUCTION IN SAUDI ARABIA: PROBLEMS AND POLICY RE- COMMENDATIONS

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INTRODUCTION

In Saudi Arabia, several climatic and geologic factors have combined to impose severe constraints on agricultural development to a degree not encountered by other countries. Climatic adversities include: harsh summer climate and drying winds; fluctuations in rainfall from extensive dry spells to short thunder storms resulting in floods; and, blowing dust or sandstorms which could go on for many weeks depending on the season. Some of the geologic misfortunes include: difficult terrain; very poor and saline soil; encroachment by sand dunes; and, limited supplies of irrigation water.

This bleak picture is corroborated by the fact that, of the 220 million hectares of land in Saudi Arabia, only 4.5 million hectares are arable (SAMA, 1981: 66); furthermore, only 2.3 million hectares are under cultivation at present (Roberts, 1987). When the climatic and geologic adversities are combined with: the traditional land tenure arrangements and customary water rights; comparatively small size of the average land holdings; and, the shortage of skilled and unskilled manpower; the challenge to develop agriculture in Saudi Arabia appears as a formidable task.

However, the Saudi government was determined to meet this challenge through the implementation of an all-embracing program that would help in overcoming these obstacles and in achieving increases in the agricultural output (Tuncalp and Yavas: 1983), and perhaps, a prudent level of self-sufficiency in food production. Today, what sounded like an impossible dream some years ago, is becoming a reality. Defying all the nature's shortcomings, the Saudi government was able to make its desert bloom and become self-sufficient in wheat production.

It is against this background that the purpose of this article is to examine the current status of wheat production in Saudi Arabia. The first part of the paper traces the major developments in agricultural production

during the national Five-Year Development Plans. The second part describes the dramatic rise in wheat production and examines Saudi Arabia as a wheat exporter. The third part places in proper perspective the programs of the Saudi government that helped wheat production achieve self-sufficiency and created surplus wheat for exportation. The final part discusses some problems associated with the steep rise in wheat output, and proposes a set of policy changes that may be useful for efficient wheat production.

TRENDS DURING THE FIVE-YEAR DEVELOPMENT PLANS

First Development Plan

The objective of the First Five Year Development Plan (1970-1975) for the agriculture sector included more efficiency, greater output, and sound distribution and use of resources (MOP, 1970: 250). Output of the sector was targeted to increase 4.9 percent annually corresponding approximately to an average growth in added value of 4.6 percent per year (MOP, 1970: 256). The programs and projects of the sector for the Plan period required 1.47 billion riyals (3.76 riyals = 1 dollar) in total: 1.32 billion riyals to be spent by the Ministry of Agriculture and Water, and the remaining 150 million riyals budgeted for the Saudi Arabian Agricultural Bank (see Table 1-B, Appendix B).

The highlight of the developments during the First Plan was the introduction of subsidies both for agricultural inputs and output. During 1973, the Saudi government began to subsidize the costs of farm machinery and fertilizer in order to encourage the adoption of modern technology. In addition, the government began to pay 250 riyals per metric ton subsidy to locally produced wheat in order to attract more resources into the cultivation of this agricultural product (MOP, 1975: 122).

The value-added by the agricultural sector to the Kingdom's Gross Domestic Product (GDP) increased at the compounded rate of 3.6 percent in real terms during the First Plan period (MOP, 1975: 114). This performance was achieved largely due to a 13 percent increase in area under cultivation which reached 592,000 hectares by the end of the First Plan (MOP, 1980: 139). Owing to an estimated 5.2 percent per annum growth in consumption, food imports rose faster than domestic production and the Kingdom's level of self-sufficiency in food production plummeted during this period (MOP, 1975: 114-115). However, spurred by the subsidies introduced toward the middle of the First Plan, wheat production increased by 25 percent to 92,000 metric tons in this period (MOP, 1980: 139).

Second Development Plan

The Second Five Year Development Plan (1975-1980) contained three

main objectives for the agriculture sector: to raise per capita income and improve the welfare of the rural people; to minimize the Kingdom's dependence on imported food; and, to release surplus labor for employment in other sectors (MOP, 1975: 123). These objectives would be achieved by increasing productivity and expanding the amount of land used in agriculture within the parameters of scarce water resources:

The search for higher yielding wheat varieties would continue during the plan period. Production and distribution of breeder and certified wheat seeds would reach 13,000 tons. The agricultural credit would be expanded to include other production inputs such as seed and labor; transportation, marketing, and processing; agricultural machinery and irrigation equipment; and, purchasing and developing of agricultural land. Also, all costs associated with borrowing from the Saudi Arabian Agricultural Bank would be removed to make the lending program free of interest and other handling charges.

The agricultural sector was targeted to grow 4.0 percent per annum during the Second Development Plan (MOP, 1975: 75). The financial requirements for agricultural development were set at 4.69 billion riyals (see Table I-B). The projects of the Ministry of Agriculture and Water would require 3.86 billion riyals while the remaining 826 million riyals were targeted for agricultural credit by the Saudi Arabian Agricultural Bank.

The agricultural sector continued to show substantial growth during the Second Plan. The real value-added by this sector to the GDP was estimated at a compounded annual rate of 5.4 percent for this period (SAMA, 1981: 65). The wheat production increased by 53 percent to reach 142,000 metric tons by the end of the Plan period (SAMA, 1983: 83). The average yield was estimated as 1.25 metric tons of wheat per hectare (MOP, 1980: 140). The most important government action during the Second Plan was the institution of a support price and guaranteed market for wheat.

Third Development Plan

The primary objective of the Third Five Year Development Plan (1980-1985) for the agriculture sector was the establishment and maintenance of a prudent level of self-sufficiency in food production (MOP, 1980: 149). Other objectives of the Plan included raising welfare of the rural people, optimizing use of Kingdom's agricultural water and land resources, and improving skill levels in this sector (MOP, 1980: 150). Agricultural subsidies and the price support system for wheat production would be reviewed to improve their overall effectiveness. The availability of agricultural credit would be increased while the complexity of the loan procedures would be reduced.

While targeting an annual growth rate of 5.4 percent for the agriculture sector (MOP, 1985: 180), the Third Plan provided substantially higher expenditures for this sector. Anticipating a sharp increase for agricultural credit and subsidies, from private sector investors moving into wheat production, the targeted level of spending included 18.7 billion riyals for the Ministry of Agriculture and Water and 8.2 billion riyals for the Saudi Arabian Agricultural Bank for an overall expenditure level of 26.9 billion riyals (See Table I-B).

The agricultural sector made dramatic advances during the Third Plan. The real value-added of this sector increased at an 8.7 percent average annual rate for this period (MOP, 1985: 180). The wheat production jumped over 13-fold to exceed 2 million metric tons by the end of the Third Plan period (see Table 2-B).

Fourth Development Plan

The objectives of the Fourth Five Year Development Plan (1985- 1990) for agriculture sector included: satisfactory rate of increase in farm output at minimum cost; improving the welfare of the rural population; and, attracting private capital investment (MOP, 1985: 192). The new emphasis would be on efficiency in agricultural production.

The agricultural sector maintained its phenomenal growth during the Fourth Plan. This sector grew at an average annual rate of 13.8 percent, exceeded 6 percent, the Plan's target rate.

The contribution of this sector to the GDP increased from 3.4 in 1985 to 8 percent in 1990. During the Plan period significant output gains were achieved in wheat, dates, meats and poultry production. In 1989 wheat output exceeded the domestic demand by 2.5 million tons (MOP, 1990: 195). Some of the negative effects that followed the steep rise in wheat production during the Third Plan, such as rapid depletion of non-renewable water resources, emergence of surplus, and excessive use of new machinery, would be dealt with during this period.

The targeted level of spending was estimated at 20.96 billion riyals for the agriculture sector (see Table I-B). The Ministry of Agriculture and Water would spend 10.81 billion riyals to maintain the fast pace of development in agricultural production while the Saudi Arabian Agricultural Bank would inject 10.15 billion riyals in new loans to this sector.

Fifth Development Plan

The Fifth Development Plan (1990-1995) shows the continuation of the extensive government financial support of the agricultural sector. The agricultural value added is targeted to grow at an average annual rate of 7

percent in real terms during the Plan period, twice the targeted growth rate for the entire economy. The relative share of the agricultural sector to the GDP is expected to reach 9 percent by the end of the plan period.

(MOP,1990:85). The targeted level of financial expenditure on the agricultural sector was estimated at 14.41 billion riyals (see Table I-B).

A number of structural problems developed during the Fourth Plan, such as the excessive use of non-renewable water supplies and the emphasis on wheat production, would be dealt with during the Fifth Plan. In this regard the Plan calls for adopting measures that encourage gradual shift from water-demanding crops in order to save the scarce water resources. The Plan also projects a decrease in wheat production due to replacement of wheat by barley.

DEVELOPMENT OF WHEAT PRODUCTION

Wheat Output

Among the major goals of the agricultural development are to increase output and to achieve self-sufficiency in basic food items. A high priority was given to wheat as strategic commodity. Wheat production would be boosted by improving technology; by introducing high yielding varieties of wheat; and, by adopting price support and subsidy systems to keep wheat farmers' incomes at profitable levels (MOP, 1970: 258). At the same time, the subsidies on imports of wheat would be eliminated.

Subsequently the Grain Silos and Flour Mills Organization (GSFMO) was established in february ,1973. The objectives of GSFMO include : purchasing grains at preferential prices, creating a convenient reserve stock, establishing an integral industry of grain storage and flour production, and marketing wheat and its' products inside and outside Saudi Arabia (GSFMO,1989: 8).

During 1979 the government began, through GSFMO, to purchase local wheat at a fixed price of 3,500 riyals per metric ton (MOP, 1980: 143). This price was about five times the prevailing world market price. Spurred by a combination of input and output subsidies, generous price support and free-interest credit wheat production has become extremely attractive. Saudi farmers began to utilize and reallocate their resources to produce wheat and Saudi businessmen and investors rushed to form large agro-businesses to enter into wheat farming.

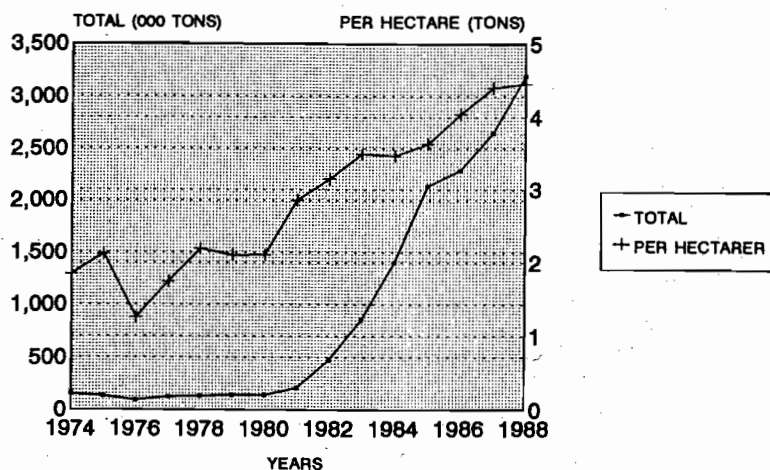
Wheat production, as Figure (1) shows, took off in 1980, where output increased from 142 to 199 thousand tons, or by 40 percent over a year. Since that time growth of wheat has been phenomenal. Production jumped over 15-fold to exceed 2 million tons by the end of 1985. As a matter of fact,

the Kingdom had already reached a full self-sufficiency position and began to experience surpluses in wheat production by 1984 (MOP,1985:184).

During 1980-1988 wheat output increased by 2149 percent, while the area under wheat cultivation rose by only 966 percent.

This suggests that a substantial portion of the increase in wheat production during this period was achieved through advances in yield levels. As shown in Figure (1), the average production of wheat per hectare has more than doubled, it rose from 2.11 tons in 1980 to 4.46 tons in 1988. The yield for some large companies had reached 7-8 tons per hectare (Lavell, 1987). Moreover, the average yields of wheat in Saudi Arabia is comparable with those in the EEC and exceeded the world average by 1.74 tons in 1986 (FAO,1986).

Figure (1) Wheat Productions 1974-1988



Wheat Projection

A forecast for the future growth of the planted area, production and yields of wheat is made on the basis of 1974-1988 data. Three trend forecasting models (linear, exponential and quadratic) have been used. Based on three statistical measures it was found that the Quadratic model gives the best fit for forecasting area and production, while the Linear model gives the best fit for yields per hectare (summary of the fit is shown in appendix A). Table (1) shows the projections for six years, 1989-1995. As it is the case in trends forecasting it was assumed that the projected variables will grow according to the past trends.

It must be recognized that the lack of adequate, consistent and reliable data imposes severe limitations on the complexity of regression and forecasting models that can be developed.

TABLE (1)

**PROJECTION OF THE PLANTED AREA, PRODUCTION AND YIELDS
OF WHEAT FOR 1989-1995**

YEARS	AREA (000 HA)	PODUCTION (000 TONS)	YIELD (TON/HA)
1989	907	3942	4.6
1990	1054	4632	4.8
1991	1212	5377	5
1992	1382	6178	5.3
1993	1563	7034	5.5
1994	1756	7945	5.7
1995	1960	8912	5.9

Wheat Exports

The success of the wheat production program has influenced the agricultural trading activities of Saudi Arabia. The Kingdom's position turned around from a major wheat importer to a world class wheat exporter. While importing 600 - 800,000 metric tons of wheat per year in the past, in order to close the gap between local production and consumption, Saudi Arabia exported 1.5 million metric tons of wheat during 1986 to a number of countries in the Middle East, Africa, Europe, and the Far East (NEWS, 1987). Some of the major purchasers of Saudi wheat included Indonesia, Jordan, South Korea, Portugal, Sri Lanka, Lebanon, and Kenya. In addition, the Kingdom exported wheat to Italy, Norway, Bangladesh, People's Republic of China, United Arab Emirates, Bahrain, Arab Republic of Yemen, Botswana, and Colombia. During 1987, Saudi Arabia continued its penetration of world's wheat markets at the strength of quality and price of its product (NEWS, 1988). The Soviet Union purchased 50,000 metric tons of Saudi wheat after ascertaining its quality by conducting a number of tests at the Soviet and European laboratories. In a repeat purchase contract, the Kingdom shipped another 300,000 metric tons of Saudi wheat to People's Republic of china. Despite the surplus production in European Economic Community (EEC), the Kingdom continued its successful marketing to EEC by exporting 60,000 metric tons to Britain and Portugal. The year before, two EEC countries, Italy and Portugal, had purchased over 156,000 metric tons of Saudi wheat. Thus, the Kingdom became the world's sixth largest wheat exporter with sales of close to 2 million metric tons during these two years.

According to International Wheat Council, Saudi Arabia maintained its position as world's sixth-ranking wheat exporter during 1988-90 period.

Saudi Arabia shipped around 2.4 million metric tons of wheat per year during this period (NEWS, 1989). Some of the large markets for Saudi Arabian wheat in this period included Indonesia (245,000 tons), Jordan (240,000 tons), Portugal (212,000 tons), China (445,000 tons), Soviet Union (190,000 tons), and Gulf Cooperation Council countries (200,000 tons).

PROGRAMS AFFECTING WHEAT PRODUCTION

Agricultural Credit Program

Wheat production gained significant momentum with the interest-free agricultural credit program administered by the Saudi Arabian Agricultural Bank. The credit extended by the program reached a peak at 15,447 million riyals for the Third Development Plan while the loan activities were at lower levels for the Second and First Development plans: 3,183 million riyals and 236 million riyals, respectively (see Table 2).

TABLE (2)

Loans and subsidies extended by the Saudi Arabian Agricultural Bank in Million Riyals in current prices.

	First Plan (1970-1975)	Second Plan (1975-1980)	Third Plan (1980-1985)	Fouth Plan (1985-1990)
Loans	235	3,183	15,447	3,411
Subsidies	46	1,378	5,316	1,614
Total	281	4,561	20,763	5.025

Note: First three years only.

Source: Annual Reports, Saudi Arabian Monetary Agency, Kingdom of Saudi Arabia.

According to the latest statistics, another 3,411 million riyals were disbursed as agricultural credit by the Bank during the first three years of the Fourth Development Plan (SAMA, 1988, 96- 100). Thus the total value of loans disbursed under this program since 1970 exceeded 22 billion riyals. Agricultural credit for 1988 amounted to 841.3 million riyals distributed among agricultural projects (29.4%), well drilling and casing (20.3%), irrigation equipment (16.4) engines and pumps (13.6%), farm machinery (15.0%), and other purposes (5.3%). The share of wheat was 46 percent of the total credit allocated for agricultural projects (SAAB,1988).

Agricultural Subsidies Program

Another program which had a major impact on wheat production is the subsidy program of the Saudi government. In order to encourage the

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Defying all the nature's shortcomings, the Saudi government embarked upon a multi-pronged program to become self-sufficient in wheat production. This program was instrumental in turning the Kingdom's position around from a major wheat importer to a world class wheat exporter. However, the rapid growth of wheat production has created some adverse effects such as rapid depletion of non-renewable water supplies, imbalanced agricultural production and spatial concentration of agricultural incentives. This paper describes the development of wheat and examines the factors that influence its' rapid growth. The paper also discusses the problems associated with the steep rise in wheat output and proposes a set of policy options to make wheat production more efficient.

TABLE (3-B)
PRODUCTION OF GRAINS
1974-1985
(OOO TONS)

YEARS	SORGHUM	MILLET	BARLEY	WHEAT
1974	116	11	15	153
1975	128	10	17	132
1976	153	17	12	93
1977	139	13	14	125
1978	152	13	14	132
1979	167	15	13	141
1980	109	9	6	142
1981	91	10	6	210
1982	61	6	5	476
1983	47	8	2	857
1984	36	4	2	1402
1985	14	4	2	2135

SOURCE: MINISTRY OF AGRICULTURE AND WATER, AGRICULTURAL
STATISTICAL SAMPLE SURVEYS, VARIOUS ISSUES.

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TABLE (1 - B)
FINANCIAL REQUIREMENTS OF THE MAIN AGENCIES IN
THE AGRICULTURE SECTOR
In Billion Riyals in current prices

GOVERNMENT AGENCY	FIRST PLAN	SECOND PLAN	THIRD PLAN	FOURTH PLAN	FIFTH PLAN
MINISTRY OF AGRICULTURAL AND WATER	(1970- 1975	(1975- 1980)	(1980- 1985)	(1985- 1990)	(1990 -1995
SAUDI ARABIAN	1.32	3.86	18.7	10.81	6.66
AGRICULTURAL BANK	.15	.83	8.2	10.15	7.75
TOTAL	1.7	4.69	26.9	20.96	14.41

SOURCE : DEVELOPMENT PLANS, MINISTRY OF PLANNING, KINGDOM OF SAUDI ARABIA.

TABLE (2-B)
WHEAT AREA AND PRODUCTION

YEARS	TOTAL CROP AREA (000 HA)	WHEAT AREA (000 HA)	WHEAT PRODUCTION (000 TON)	TON PER HECTARE
1974	601	83	153	1.84
1975	513	62	132	2.13
1976	586	74	93	1.26
1977	558	72	125	1.74
1978	561	60	132	2.19
1979	585	67	141	2.10
1980	609	67	142	2.11
1981	435	74	210	2.86
1982	597	151	476	3.15
1983	731	245	857	3.50
1984	783	404	1402	3.47
1985	946	587	2135	3.63
1986	947	566	2290	4.04
1987	10618	602	2649	4.40
1988	11623	716	3193	4.46

SOURCE: SAMA, ANNUAL REPORTS, VARIOUS ISSUES.
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APPENDIX - A TRENDS FORECASTING

Three models, quadratic, exponential, and linear, have been used to make projections of area, production and yields of wheat for 1989-1995 on the basis of 1974-1988 data. It was found that Quadratic model gives the best fit for projecting area and production, while Linear model gives the best fit for yields.

MODEL (1) : Projection of Area

Estimated Quadratic Model

$$Y = 125.950 - 43.343 t + 5.7599 t^2$$

(-2.785) (6.089) MODEL (2) : Projection of Production

Estimated Quadratic Model

$$Y = 457.53 - 226.222 t + 27.7513 t^2$$

(-5.249) (10.596)

MODEL (3) : Projection of Yields Estimated Linear Model

$$Y = 1.11295 + 0.218214 t$$

(11.023)

Summary of the Fit of the Three Models

	Model (1)	Model (2)	Model
(3)			
Mean Absolute			
Per Cent Error	24.1		41.4
11.5			
Standard Error	60.75		168.22
.33			
R-Squared	.95		.98
.90			

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from the export of crude oil. Developing a modern agricultural sector to usher Saudi Arabia toward self-sufficiency in food production is one avenue open to the government planners.

For Saudi Arabia, there are other reasons to emphasize agricultural development through programs such as wheat production. According to the latest statistics, the agricultural sector provides employment for almost 14 percent of the Saudi labor force. Government investments in agriculture improve the incomes of this important population segment.

In addition, increased efficiency achieved in this sector through modernization releases some of the redundant labor for use in other sectors. For a country with a small population base of around 10 million people, which suffers from a shortage of both unskilled and skilled labor, the availability of surplus labor from the agriculture sector is economically and socially desirable to importing labor from the Third World countries.

Furthermore, the advances in agricultural production will also increase the employment opportunities in other sectors of the economy such as transportation, processing, and domestic and international marketing. Finally, as shown by the wheat program, self-sufficiency in agricultural output will eliminate the need for imports while achieving substantial savings of foreign exchange.

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would adversely affect the growth and development of farming activities and communities of the small wheat producing regions. Further more, such concentration is incompatible with the national objective of achieving a balanced regional and rural development. Thus reducing the emphasis on wheat is a necessary step to tackle this imbalanced structure. It would not only promote agricultural diversification, but also would create a better, and probably more efficient , spatial distribution of agricultural incentives.

Rapid Growth of Specialized Projects

The large financial returns that wheat production brought has led to a significant growth of specialized (agro-businesses) wheat projects. Their number increased from 192 in 1985 to 808 projects in 1988 (MOAW,1988). The specialized projects are mostly owned by businessmen and investors attracted to wheat production by the generous price support and free-interests agricultural credit. These projects produced more than 50 percent of wheat output and accounted for 30 percent of wheat acreage in the same year.

Also these projects received a large share of the agricultural financial incentives. For example, in 1985 they received 45 percent of wheat subsidies, 45.5 percent of credit, and 77 percent of fallow land distribution (Al-Manif, 1987,162).

Although specialized projects are probably more efficient and their growth accordingly must be encouraged, there is a fear that the rapidly growing wheat agro-businesses may have strongly competed with and adversely affected the small and traditional farming sector. If that is the case, then small and traditional farmers deserve special attention and adequate supports to allow them to increase their output, and consequently to improve their welfare. The rationale of such attention is not only based on social grounds but also on economic as well. A number of studies, based on the experience of many countries in South America and South Asia, indicates that small farms are not necessarily less efficient, on the contrary, they could be more productive due to their low capital costs and efficient management(World Bank,1982).

CONCLUSION

As a closing note, it should be added that for what used to be a one-crop economy, production of crude oil, the recently achieved self-sufficiency in wheat production is a commendable development for Saudi Arabia. In the past, the Kingdom's oil-wealth provided the necessary hard currency to finance the importation of food. However, as the dramatic changes in crude oil prices show, there is a "window in time" for Saudi Arabia to diversify its economy and create additional revenue basis which presently comes mostly

TABLE (5)
THE AVERAGE SHARE OF AREA & PRODUCTION OF WHEAT BY
REGION. 1984-1988.

REGION	AVERAGE PRODUCTION (000 TON)	AVERAGE AREA (000HA)	PERCENTAGE SHARE OF PRODUCTION	PERCENTAGE SHARE OF AREA
RIYADH	1140	279	48.8	48.5
QASEEM	712	199	30.5	34.6
HAIL	284	47	12.2	8.1
NORTHERN	115	23	4.9	3.9
EASTERN	44	10	1.9	1.8
MEDINA	12	3	0.5	0.5
MAKKAH	5	3	0.2	0.6
ASEER	14	8	0.6	1.3
AL-BAHA	4	2	0.2	0.3
JIZAN	0	0	0.0	0.0
NAJRAN	5	2	0.2	0.4
TOTAL	2334	575	100	100

SOURCE: CALCULATED FROM THE AGRICULTURAL STATISTIAL YAER BOOK,
 MINISTRY OF WATER AND AGRICULTURE, V. SIX, 1988.

TABLE (6)
PERCENTAGE SHARE OF AGRICULTURAL LOANS & SUBSIDIES BY
REGION. YEARLY AVERAGE FOR 1979-1986.

REGIONS	INPUT SUBSIDIES	AGRICULTURAL LOANS	WHEAT SUBSIDIES	FALLOW LAND DISTRIBUTION
RIYADH	33.3	36	42.6	30.7
QASEEM	19.9	22	30	23.2
HAIL	5.6	8	6.7	20.5
NORTHERN	3.7	6	3.2	14.4
EASTERN	6.9	5	4.6	8
MEDINA	3.9	4.4	1	1.3
MAKKAH	18.3	9.7	2.9	1.3
ASEER &	6.4	6.3	8.3	1.3
ALBAHA				
JIZAN &	2.3	2	1.2	1.9
NAJRAN				

SOURCE: M. AL-MANIF, "Towards an evaluation of agricultural subsidies in Saudi Arabia",
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The Saudi government needs to embark upon a two-pronged program to achieve self-sufficiency also in wheat seed production. The Ministry of Agriculture and Water must improve its research programs in this area while expanding its seed multiplication facilities. Concurrently, the Government can seek private sector participation in this area. The Saudi Industrial Development Fund, which provides interest-free loans toward the capital requirements of new agro-industries, should begin to encourage the formation of private sector companies for seed production through a special loan program.

Input Subsidy System

First introduced in 1973, the Saudi government reimburses the wheat producers for 50 percent of their expenditures on fertilizer and machinery and equipment. The subsidy for the fertilizer is disbursed through the Ministry of Agriculture and Water, whereas, the subsidy for machinery and equipment is granted through the branches of the Saudi Arabian Agricultural Bank.

The subsidy on machinery and equipment needs to be revised. In its present form, this subsidy encourages excessive importation and use of machinery and equipment. This issue was also recognized in the Fourth Development Plan (MOP, 1985: 191). The outcome of this policy is not only a wasteful level of capital outlays but also a disincentive for local repair and maintenance services.

In light of the dramatic advances in wheat production, the protective role of the government through the subsidy program can be scaled down. Especially, the subsidy on farm machinery and equipment can be reduced by cutting back on the percentage of costs reimbursed and/or by placing an absolute limit on the amount of costs that can be reimbursed in this area within a specific time period.

Spatial Concentration of agricultural credit and subsidies

Most of the country's wheat is grown on the central plateau, namely in the provinces of Riyadh, Qaseem and Hail. These three provinces accounted for 91.5 percent of total wheat production and 91.2 percent of wheat acreage during the period of 1984-1988,(see Table 5).

As wheat is the largest and the most favorable crop, it is bound to bring significant benefits to the main producing areas. As a matter of fact, and as Table (6) shows, during 1979-1986 the three major producing provinces received 58.5 percent of input subsidies, 66 percent of agricultural credit, 79.3 percent of wheat subsidies, and 74.4 percent of fallow land distribution.

The concentration of agricultural credit and subsidies in few provinces

profitable and attractive crop. This suggests that without further revision of support price system, grains producers would, understandably, maintain their preference for producing nothing but wheat, or more wheat and less of other grains. IN fact the domestic output of barley has increased noticeably, however, it still is far much less than the demand. The output of barley reached 288 thousand tons in 1989, while the domestic demand was estimated at 4.3 million tons (MOP,1990,204). The Kingdom presently imports about 4 million tons a year, 14 times the amount of barley it produces.

Another policy measure that may be considered is regulating wheat acreage, particularly in large-scale and commercial farms.

The Fifth Plan aims at reducing wheat output and adopts a production target of 2.6 million tons by 1995, that is a targeted decrease of about 1.1 million tons from the production level of 1990, or a 6 percent per year during the Plan period (MOP,1990,208).

We estimated the relationship between wheat output, as dependent variable, and planted area, as independent variable, using a multiplicative model in the form of $Y = axb$ and time series data for 1974-1988. We found a strong statistical relationship with an estimated coefficient of the independent variable equal to 1.33. This value represents output elasticity of wheat with respect to planted area. Thus our estimate indicates that for the Plan to achieve the targeted reduction using acreage as policy variable, the planted area of wheat should be reduced by about 4.5 percent a year during the Plan period.

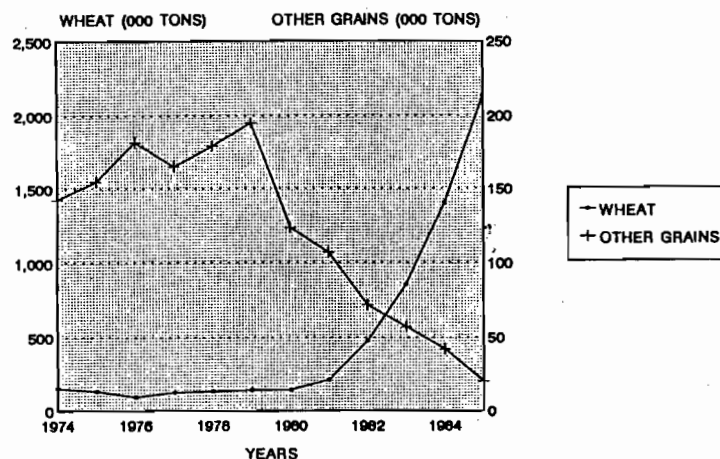
Seed Imports

The Saudi government's policy of introducing new wheat varieties, which had better agronomic characteristics, was a major contributing factor to the increase in wheat output. These new wheat strains, which were mostly imported from the United States, dramatically improved yield levels and also produced much higher quality wheat with superior bushel weight, richer protein content, and better resistance to pests and diseases than the local wheat varieties.

During 1986/87 cultivation season, the Saudi government imported 80,000 metric tons of wheat seed from the United States (Roberts, 1987). As the imported seed, which are mostly Yucarojo and Westbred 911 varieties, are well liked by the wheat farmers for their quality, these imports will remain at high levels for the foreseeable future. Thus, the Saudi wheat production program has entered into a new era, an era of dependence on imported wheat seed.

focused on wheat production which made agricultural development heavily dependent on one single crop, while the increasing demand for many food products is met through imports. Moreover, the rapid increase in wheat acreage has led to a noticeable transfer of resources from the production of other crops, particularly grains. For example, during 1974-1985, as Figure.

Figure (2) Grains Production 1974-1985



(2) shows, the output of wheat rose sharply, while the production of other grains such as barley, sorghum and millet significantly declined (see also Table 3-B).

This imbalanced crop structure requires adopting corrective policy measures in order to diversify agricultural production.

These measures may include imposing restrictions on wheat acreage, and/or reducing wheat price support, or alternatively, providing adequate price support for selected crops.

The government has already adopted some of these measures. In a move to encourage farmers to shift from wheat to barley, the government has decided in september 1986 to provide a price support for barley. GSFMO started to purchase domestically produced barley at one riyal per kilo. Also the government took an important complementary measure, first, it reduced import subsidy on barley in 1987, then later abolished it in 1988. Moreover, after reaching self-sufficiency in wheat in 1984, the price support of wheat was reduced from 3.5 riyals to 2 riyals per kilo.

However, these measures have not been effective in achieving the desired agricultural diversification. Wheat still dominates the total crop acreage, and despite reducing its price support, wheat remains highly

Surplus Wheat

As early as 1984, Saudi Arabia began to produce wheat in quantities larger than the local consumption. This surplus wheat production is estimated to have accumulated to about 2.8 million metric tons during the past three years. The domestic demand for wheat in 1990 was estimated at 1175 thousand tons and would reach 1291 thousand tons in 1995 (MOP, 1990). This may suggest that , if the present level of output continues , the surplus of wheat would be in excess of 1.5-1.8 million tons a year.

The Saudi government took a number of actions to alleviate the surplus wheat. First, the strategic reserve policy of storing wheat equivalent to six months' consumption was significantly expanded to maintain wheat reserve equivalent to about two years' consumption. To accommodate this policy, the Grain Silos and Flour Mills Organization began to construct additional storage facilities in order to increase present capacity of 1.6 million metric tons to about 2.5 million metric tons.

Second, the Saudi government's policy to purchase locally produced wheat at a support price of 3.5 riyals per kilogram through the Grain Silos and Flour Mills Organization was revised. The support price was reduced to 2.0 riyals per kilogram for the period between 1986 and 1989, thus leaving the option open for further Revisions.

Third, in light of the fact that almost 53.5 percent of the Kingdom's total cropland had been converted into wheat cultivation, the Saudi government switched its priority to barley production. Many large scale wheat producers were asked to release 30 percent of land from wheat production into barley cultivation (MEED, 1987).

Finally, the Saudi government began to reduce the surplus wheat through an aggressive policy of international politics and trading. On the one hand, the Saudi government started to provide food aid to brotherly and friendly countries in the form of wheat grants. The Kingdom's wheat donations totalled to 495 thousand tons during 1986-1989 (GSFMO, 1989: 14). The wheat grants given to Egypt, Syria, and North Yemen have affected their purchasing patterns and gave these countries additional bargaining power against their traditional suppliers in North America, Europe, and Australia. On the other hand, Saudi Arabia successfully penetrated the international wheat markets with its own product by selling wheat to a number of countries in Europe, Far East, Africa, and Middle East. During 1986-1989 the exports of wheat reached 5.8 million tons.

Excessive Concentration on Wheat Production

The policy of food self-sufficiency in Saudi Arabia has extensively

agricultural water. There is an urgent need for a cost-benefit analysis to evaluate the economic efficiency of various agricultural water uses .

TABLE (4)
PHYSICAL WATER REQUIREMENTS OF SELECTED GRAINS

GRAINS	WATER REQUIREMENT PER HECTAREA (M ³)	AVERAGE OUTPUT PER HECTAREA (KG)	WATER REQUIREMENT PER KG	WATER CONSUMPTION PER TON	RANK
WHEAT	6000	2710	2.214	2214	5
SORGHUM	6000	1830	3.279	3279	3
MILLET	6000	720	8.333	8333	1
CORN	6000	2330	3.575	2575	4
BARLEY	5000	1180	4.237	4237	2

SOURCE: AL MALLAH.G.AND N. AL-KAZAZ "Estimating the Economic importance of Alternative water uses in Al-QASSIM," JOURNAL OF THE GULF and ARABIAN PENINSULA STUDIES V.XV, 57, 1989.

Efficient water development and management are prerequisites for the continued success of investments in the national wheat production program. There are some major problems in the present irrigation operations (Abderrahman and Ukayli, 1986: 383-384). For example, lack of precise irrigation operation schedules could result in high irrigation water doses thus leaching many soluble plant nutrients below the plant root zone thus affecting growth and yield. This situation will also cause depletion of ground water resources and excessive water level draw-downs.

Other problems with the present irrigation operations are: lack of regional groundwater studies which are needed to determine size and location of water wells; lack of efficient management of technical data by some of the agricultural companies which are needed to determine exact water consumption in relation to yield;

and, manual operation of irrigation systems resulting in wasteful water use.

These problems can be better managed with the introduction of computerized fully-automated irrigation systems such as the ones that are operational in many parts of the United States (Abder- rahman and Ukayli, 1986: 386-387). While optimizing the amount of groundwater used, with the intention of conserving water resources and minimizing costs of pumping, the automated irrigation systems will also maximize crop acreage and yield.

cultivating nearly 71, 000 hectares of wheat throughout the Kingdom. The number of center-pivot systems and the water wells operated by these companies are also provided in the table to give an idea about the immense sizes of these companies.

These agro-businesses are significantly contributing to the Kingdom's wheat production. For example, while achieving a record yield level at an average of 7 . 714 metric tons per hectare, HADCO harvested 91, 809 metric tons of wheat during the production season between 1986 and 1987 (Lavell, 1987). Similarly, another giant agro-business called NADEC produced 104, 764 metric tons of wheat during 1986 (Hassan, 1986).

Table (3)
Major agricultural companies in Saudi Arabia

Company	Capital (million Riyals)	Land (Hectares)	Water Wells	Center-pivot Systems	Loctation
NADEC	400	31.763	311	602	Haradh, Hail, Wadi Addwasir
HADCO	500	15.000	150	300	Hail
TADCO	200	10,375	110	200	Tabouk
Asharqiyah	400	6,000	58	116	Ewastern Province
ENMA	100	8,000	90	90	Wadi Addwasir

Source: Abderrahman, W. and M.Ukayli (1986). "A Proposed Water Operation Plan for Irrigation Projects in Saudi Arabia," The Arabian Journal for Science and Engineering. 11(4), 382.

PROBLEMS AND POLICY RECOMMENDATIONS

Water Use and Management

The primary consideration in Saudi Arabian agriculture is the scarcity of adequate water supplies. Over 90 percent of the agricultural water supply is drawn from non-renewable underground water which is essentially classified as depletable resources . Wheat cultivation has relied primarily on irrigation from under- ground supplies. Water use by wheat was estimated at 5.3 billion m3 in 1987, 37 percent of the total consumption of the agricultural sector. This level of water consumption is considered by the Fifth Development Plan as " extremely high relative to the Kingdom long term supply of non-renewable groundwater" (MOP, 1990:196).

Although wheat is the largest water user crop in Saudi Arabia, it is estimated that in Al Qaseem, a major wheat producing area, wheat consumes less water per ton than other grains such as barley, sorghum, millet and corn (see Table 4). Thus replacing wheat by barley , as it is indeed the Plan objective, is not expected to reduce the demand for

Saudi Arabia. For example, the sophisticated oil exploration techniques were adapted for agricultural use to explore underground water aquifers. In addition, the technology used for drilling oil wells were adopted for drilling water wells to reach fossil water at depths up to 700 meters.

Infrastructure Construction Program

Wheat production was significantly helped by the government's massive infrastructure construction during the Second Development and Third Development Plans. For example, the Saudi Government put in place 33,576 kilometers of asphalted roads and 59,226 kilometers of agricultural roads linking wheat production areas with marketing centers. There were only 21,680 kilometers of asphalted and agricultural roads in the Kingdom during 1975.

The Saudi Government also constructed large numbers of dams, canals, and water wells since 1975. For example, the number of dams reached 180 while 4 others are still under construction. There were only 13 dams in the Kingdom during 1975. The electric power generation capacity increased by about 14-fold since 1975. In addition, the government also increased the local fertilizer production capacity to 1,730,000 metric tons per year with the construction of two new fertilizer plants in Jubail, located in the Eastern Province of the country.

Extension Services and Research Program

Wheat production also benefitted from the service projects provided by the Ministry of Agriculture and Water. Some of these projects include locust control, sand stabilization, salinity control, land analysis and classification, aerial survey and mapping, and comprehensive agricultural census.

The Ministry also undertakes a number of studies that help the wheat production program. These include hydrology and hydrogeology studies, economic studies, farm management and marketing studies, and crop variety and yield improvement studies.

Private Sector Investment Program

Substantial funds from the private sector were channeled into wheat production during the Third Development Plan. The purchase price given by the Grain Silos and Flour Mills Organization, about five times greater than the going rate at the world's markets, assured phenomenal profits to investors. Several large agricultural companies were formed by the Saudi businessmen to exploit these profit opportunities presented by wheat cultivation.

Table (3) shows some of the major companies producing wheat in Saudi Arabia. These companies alone have invested over 2 billion riyals in

wheat seeds of high quality and yield. The Ministry of Agriculture and Water imports and distributes the most suitable hybrid wheat varieties to farmers. This agency also conducts research to develop improved seeds for the Kingdom's harsh.

climatic conditions. Partly due to the seed improvement program, the average wheat production dramatically increased to reach above 7 metric tons per hectare. Average yields for wheat were only 1.25 metric tons per hectare during 1975 (MOP, 1980: 140).

The government monitors the production efficiency of the currently used seeds and switches to other varieties in order to maintain the expansion of yield levels. Some of the wheat varieties used in the past which gave excellent results include Super X, Jiory, Dirab, and Maxipak. At present, the Ministry permits the use of four varieties of wheat. These are Yucarojo, Westbred 911, Probred, and Venerine. Yucarojo alone accounts for almost 85 percent of the Saudi wheat cultivation while Westbred 911 make up around 10-14 percent. (News, 1988).

Technology Transfer Program

Adoption of the latest technology in wheat cultivation is another factor which brought substantial increases in wheat production. The traditional small-scale manual wheat farming in Saudi Arabia was replaced with modern production techniques including mechanized farming and efficient irrigation methods.

The center-pivot sprinkler irrigation technology which was developed in the dry areas of the United States was imported to Saudi Arabia. Today, these systems are widely used throughout the Kingdom for wheat production because of their efficient water use and their capacity to irrigate extensive areas. Properly designed and operated pivots can achieve up to 90 percent efficiency in water use (Harvey, 1980: 19). In Saudi Arabia, where the traditional open channel irrigation methods can lose more than 40 percent of water to evaporation and seepage (Buchan, 1979), the super efficiency of the center-pivot system in water use is a tremendous improvement.

The amount of area that can be irrigated depends on the length of the pivot arm which can extend up to 800 meters. In Saudi Arabia, 407-meter lateral arm which can irrigate about 52 hectares is common (Abderrahman and Ukayli, 1986: 383). Additional economies are achieved because these systems are not labor intensive. One mobile operator can manage up to 16 systems on a daily basis in Saudi Arabia.

Technology was also transferred from the ultra-modern oil sector in

levels by subsidies paid to the electricity companies to cover costs of providing service at controlled prices. The price of electricity to industrial and agricultural users has been fixed at .05 riyals per kwh since 1974.

Water Development Program

As there are no lakes, rivers, or permanent streams in Saudi Arabia, agriculture relies heavily on the discovery and efficient management of underground water resources. Hydrologic studies of the underground water resources conducted since 1973 revealed the existence of fossil water in deep aquifers in the Central, Eastern, and Northern regions of the country (SAMA, 1983: 89). Already, twenty main aquifers have been identified throughout the Kingdom. Some of these aquifers that are now used to support agricultural and urban water requirements include Al-Saq, Tabuk, Al-Wajid, Minjur, Al-Bayad, Al-Wasi, Umm Radmah, Dammam, and Niyojin aquifers.

Since the underground water resources used for agriculture are non-renewable, the Saudi government issued the Water Resources Conservation Regulation in 1980. This regulation empowered the Ministry of Agriculture and Water to take the necessary measures to conserve water resources and to protect them from pollution and over exploitation. During the Third Development Plan, the Ministry also initiated a National Water Plan which called for rationalization of water consumption through proper pricing policies and recycling of sewage water for eventual use in agriculture.

Land Distribution Program

The Ministry of Agriculture and Water conducts surveys throughout the Kingdom to determine topographic features, soil and underground water resources, and type of cultivation appropriate to each area. Reclaimable land is identified and then it is developed to be distributed to Saudi citizens and/or agricultural companies.

Since its inception in 1968, the Ministry has distributed a total of 1,054,242 hectares of reclaimed land to be used for agricultural purposes (SAMA, 1988: 98). This program provided benefits to 54,551 individual farmers, 4,077 agro-based projects, and 12 agricultural companies.

Even though separate statistics are not available, most of the land distributed under this program is thought to have been put into wheat production. With the help of this program, the area under wheat cultivation rose by about 7-fold since 1981 to constitute a quarter of the total acreage of land under cultivation in Saudi Arabia.

Seed Improvement Program

The Saudi wheat production has also benefitted from the introduction of

adoption of modern agricultural technology and to attract more land use, which together would help increase wheat production, subsidies are provided both for the resources needed for wheat production and for the produced output.

Input Subsidies: The government provides 50 percent of the cost of fertilizer to the Saudi farmers. Thus, subsidy is disbursed to farmers through the branches of the Ministry of Agriculture and Water. The government also subsidizes 50 percent of the cost of agricultural machinery and equipment and drilling of water wells. This type of subsidy is disbursed by the Saudi Arabian Agricultural Bank (SAAB). Input subsidies are intended not only to increase productivity by stimulating use of modern technology but also to increase farm income by substantially lowering production costs.

The input subsidies disbursed by SAAB reached their peak at 5,316 million riyals during the Third Development Plan. They were 1,378 million riyals for the Second Development Plan, and only 46 million riyals for the First Development Plan (see Table 2).

According to the latest statistics, the SAAB disbursed an additional 1,614 million riyals in input subsidies during the first three years of the Fourth Development Plan (SAMA, 1988, 100). Thus, the level of subsidies extended by the SAAB since 1975, the year when government began the input subsidy program, accumulated to over 8.4 billion riyals.

Output Subsidies: As mentioned earlier, the Saudi government began a policy of supporting the price of locally produced wheat during 1979. The GSFMO started to purchase wheat from the Saudi farmers at a fixed price of 3.5 riyals per kilogram.

In light of the wheat surplus which began to occur after 1984, the government made some changes in the output subsidy program (MOP, 1985:183). During 1985, as a transition to lower support price, farmers whose production did not exceed 500 metric tons continued to receive 3.5 riyals per kilogram while those producing above 500 metric tons were paid 3.0 riyals per kilogram. This support price was subsequently reduced to 2.0 riyals per kilogram for the period between 1986 and 1989, pending another review at the end of this period.

General Subsidies: Wheat production also benefitted from the policy of the Saudi government to control the domestic prices of refined oil products and electricity through price support subsidies. For example, prices of gasoline and fuel oil are controlled both at the wholesale and retail levels. The domestic prices are kept around one-quarter to one-fifth of the international prices. Similarly, the price of electricity is kept at reasonable