The Role of High-Elevation Areas

Peter Oram

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PROSPECTS FOR AGRICULTURAL PRODUCTION AND FOOD DEFICITS IN WEST ASIA AND NORTH AFRICA: THE ROLE OF HIGH-ELEVATION AREAS

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FOREWORD

This paper was prepared for a meeting held in Ankara in July 1987, sponsored jointly by the Turkish Ministry of Agriculture and the International Center for Agricultural Research in the Dry Areas (ICARDA).

A main objective of the meeting was to look at the technical potential for improving the productivity of cereals and food legumes in the high elevation areas that compose almost half of the agricultural land of the main producing countries of West Asia and North Africa (Algeria, Afghanistan, Iran, Iraq, Lebanon, Morocco, Tunisia, Turkey, and the Yemen Arab Republic), as well as important areas of Pakistan, India, Nepal, Mongolia, and China. These upland plateau and mountain areas have a harsh climate, with an abrupt transition from very cold winters (when most of the precipitation occurs) to hot arid summers, and very high variability of precipitation. This restricts the range of crops that can be grown there and increases risk. Because of difficult terrain and remoteness these uplands have remained somewhat isolated from the mainstream of agricultural research and development (especially compared to irrigated land in the plains), and in consequence their production potential has not been fully exploited. The key crops in much of the high elevation land are wheat and pulses, and the meeting explored the measures required to raise their productivity.

As a contribution to this meeting IFPRI was asked to provide a background paper that would review progress in agricultural production in West Asia and North Africa and identify the main constraints to growth, with particular reference to the problems of the high elevation areas.

In approaching this task it soon became obvious that those problems could be better understood if their situation were discussed in relation to the needs of the region as a whole. Therefore the paper commences with a broad view of the agroclimatic and socioeconomic characteristics of this region, which is unique ecologically, and which has undergone a dynamic social and economic transformation in the last four decades. Consequent to rapid population and income growth there has been a massive increase in demand for wheat, the staple cereal of the region, but even faster growth of demand for meat, fish, fruits, vegetables, and oilseeds.

Because the growth of production has failed to match that of demand for practically all of the countries listed above, large imports have been necessary: the region is projected to be the largest food, feedgrain, and livestock importer of any developing region by the year

2000. Despite oil resources, this is putting a serious strain on the balance of payments of many countries, especially since oil prices and revenues have begun to decline.

The paper explores sources of growth of agricultural production and draws attention to the rapidly shrinking potential for further "horizontal" expansion of both rainfed and irrigated arable area. It stresses that future growth will have to depend heavily on intensification on existing cultivated land, through more effective use of available technology, multiple cropping, reduction of fallow wherever feasible, and research to develop new technology and farming systems. In order to achieve this, prices will have to be adjusted to avoid distortions of comparative advantage in land use and especially to encourage barley, fodders, and related livestock production, for which imports will greatly exceed those of wheat by the end of the century. Investment policy needs to pay more attention to agriculture and to its integration with other sectors, especially through the development of infrastructure to open up high elevation areas and help integrate their production potential with that of the irrigated plains. Agricultural research and extension in particular are starved of funds in most countries of this region. As long as such circumstances prevail, it is unreasonable to expect a high rate of growth of production arising from the adoption of new technology.

The paper highlights the need for a holistic approach to developing the agricultural potential of the region, which moves away from the current unrealistic emphasis on food self-sufficiency in individual countries toward increased food security through exploitation of the comparative advantages of agroecological zones, and which develops their complementarities both within and between countries through intra- and interregional trade. This will require some major shifts in patterns of land use, from foodgrains to feed and livestock production and forestry in rainfed areas, especially at the cold and dry margins, and from cereals to horticultural crops, oilseeds, and fodder production on irrigated land, with much greater emphasis on meeting market requirements for fresh and processed produce with emphasis on quality and competitiveness.

Most countries in this region are now allocating higher priority to agriculture in order to create employment, save imports, and earn foreign exchange. With careful planning and a commensurate increase in investment, opportunities exist for a revolution in their agricultural sectors.

John W. Mellor

April 1988

1. THE SPECIAL CHARACTER OF THE REGION

The West Asia and North Africa region (WANA) is unique among developing regions in its climate, the composition of its diet, its natural resource endowments, its long history of settled agriculture, and its recent drastic socioeconomic evolution. The prospects and the rationale for the long-term development of the higher elevation areas have to be viewed in the context of the nature of the region as a whole and not in isolation. Indeed isolation--geographical, physical, and economic--has kept those higher areas relatively underdeveloped and politically neglected, even though they represent a significant portion of all agricultural land in WANA. Thus, a main objective of this paper is to look at opportunities for closer integration of high-elevation areas with other parts of the region, and for developing intraregional complementarities. It includes the 22 countries for which socioeconomic indicators are shown in Table 1. Although China, India, Nepal, and Pakistan are excluded, many of the points concerning agricultural development in high-elevation areas will have relevance to those countries also.

First, West Asia and North Africa as a whole will be reviewed, both to identify the singular character of this region and to define its key economic problems as they relate to its agricultural potential.

ECOLOGICAL SPECIFICITY, LAND USE CONSTRAINTS, AND THEIR EFFECTS ON FOOD HABITS

The food consumption pattern of the region, like that in most developing regions, has been dictated historically by its climate and geographical location. WANA's entire area (with the exception of Sudan and the south of the Arabian peninsula) lies outside the tropics and within the "Mediterranean" climatic zone, where the bulk of the rain falls in the winter and early spring.

Yet in many respects, the environment is harsh rather than temperate. Important agricultural areas of several countries (Afghanistan, Algeria, Iraq, Iran, Morocco, and Turkey) have a severe winter; most of the region is characterized as semiarid or arid; and even in the more favored areas, precipitation is highly unreliable both in timing and quantity. This gives it the doubtful distinction of having the highest coefficients of variation in agricultural production of any geographical region (Table 2). It also acts as a deterrent to risk-taking and innovation, especially if new technology involves additional cash outlays. Practically all countries experience searing summer tempera-

Table 1--Socioeconomic indicators for West Asia and North Africa

Country	1982 GNP Per Capita	Growth Rate of Agricultural GDP, 1973-82	Agricultural GDP as a Share of Total GDP, 1982	Farm Population as a Share of Total Population, 1984	Agricultural Exports as a Share of Total Exports, 1984	Agricultural Imports as a Share of Total Imports, 1984	Share of Imports Financed by Agriculture, 1984	Index of Per Capita Food Production, 1984[a]	Calories Consumed as Percent of Energy Required, 1984
	(US$)				(percent)				
Algeria	2,350	18.3	7	45	...	21	1	79	115
Morocco	860	8.0	16	49	16	26	9	91	105
Tunisia	1,380	8.1	13	37	7	16	4	84	121
Egypt	670	4.7	18	49	24	35	7	91	126
Libya	8,430	19.8	3	11	...	17	...	94	155
Sudan	430	4.2	22	75	87	17	37	93	90
Afghanistan	n.a.	n.a.	n.a.	76	24	11	21	102	95
Cyprus	3,900	7.9	10	32	39	14	16	110	137
Iran	n.a.	n.a.	n.a.	35	1	32	1	99	128
Iraq	n.a.	n.a.	n.a.	38	...	17	...	85	121
Jordan	1,690	14.8	5	23	20	20	5	136	125
Lebanon	n.a.	n.a.	n.a.	7	16	17	4	145	120
Saudi Arabia	15,820	24.7	1	58	...	3	...	98	134
Syria	1,680	22.0	18	46	20	18	9	123	127
Turkey	1,360	6.9	21	49	31	7	21	103	123
Yemen A.R.	500	13.3	27	73	26	35	1	84	92
Yemen P.D.R.	470	5.4	10	56	1	15	1	82	94

Source: Food and Agriculture Organization of the United Nations, The State of Food and Agriculture, 1985 (Rome: FAO, 1986).

Notes: Bahrein, Kuwait, Oman, Qatar, and the United Arab Emirates are not included because relevant data are not available. Average GNP per capita for these five countries was U.S. $16,820.

[a] 1974-76 = 100. In most countries the index of total agricultural production per capita is slightly lower than that of food production.

n.a. means data are not available.

Table 2--Variability in staple food production in developing countries, 1961-76

Region/Country	Staple Food Production Instability: Standard Deviation[a]	Staple Food Production Instability: Coefficient of Variation[b]	Probability of Actual Production Falling Below 95 Percent of Trend	Correlation Between Total Staple Food Production and Consumption	Correlation Between Cereal Production and Total Staple Food Production
	(1,000 metric tons)	(percent)	(percent)		
Asia					
Bangladesh	765	6.4	22	0.90	0.99
India	6,653	6.4	22	0.89	0.99
Indonesia	1,040	5.4	18	0.92	0.94
Korea, Republic of	445	7.1	24	0.20	0.96
Philippines	346	5.7	19	0.03	0.99
Sri Lanka	107	9.3	29	0.56	0.91
North Africa/Middle East					
Algeria	531	28.9	43	0.78	1.00
Egypt	282	4.5	13	0.29	0.96
Jordan	119	65.6	47	0.63	1.00
Libya	56	28.0	43	0.62	1.00
Morocco	1,156	27.2	43	0.98	0.96
Syria	702	38.8	45	0.92	1.00
Sub-Saharan Africa					
Ghana	121	5.8	20	0.98	0.93
Nigeria	958	5.7	19	0.99	0.92
Senegal	325	18.6	39	0.99	0.81
Tanzania	430	12.7	35	0.98	0.09
Upper Volta	128	9.8	30	0.95	0.99
Zaire	190	4.9	15	0.96	0.21
Latin America					
Brazil	1,600	5.2	17	0.92	0.60
Chile	215	11.1	33	0.54	0.99
Colombia	126	4.4	13	0.51	0.85
Guatemala	56	6.5	22	0.51	0.99
Mexico	1,060	7.7	26	0.53	1.00
Peru	197	9.8	30	0.37	0.97

Source: Alberto Valdés and Panos Konandreas, "Assessing Food Insecurity Based on National Aggregates in Developing Countries," in Food Security for Developing Countries, ed. Alberto Valdés (Boulder, Colo.: Westview Press, 1981).

[a] This is defined as the standard deviation of the variable $Q_t - \bar{Q}_t$.

[b] This is defined as the standard deviation of the variable $\frac{Q_t - \bar{Q}_t}{\bar{Q}} \cdot 100$.

tures. Evapotranspiration exceeds precipitation for several months of the year, and except where irrigation is available, or there is some summer rainfall (as in the Black Sea/Caspian region), the nature of the rainfall pattern and its distribution restricts the choice of annual crops to those that can be sown in late fall or early spring to mature by early summer.

WANA has the second highest proportion of irrigated land to total cultivated area of any region (23 percent), but the lowest ratio of useful cultivable land to desert and mountains. In upland areas (which occupy almost half of the arable land), cold tolerance is essential. Because of the rigidities imposed by this inhospitable environment, regional self-sufficiency in agricultural products has seldom been accomplished, although several countries of the region with oil or mineral resources have achieved food security by using those earnings to import food.

The main component of the cropping system under the ecological constraints described and the main staple of the diet is cereals, principally wheat and barley (see Table 2, col. 5, and Table 3), although sorghum is important in the southern Arabian Peninsula and the Sudan, which lie within the summer rainfall, semiarid tropics. A high proportion of irrigated land is sown to cereals, especially wheat. For example, about 40 percent of sown area in Iran, 20 percent in Syria, and 30 percent in Libya is in wheat, while virtually all of that grown in Egypt, Saudi Arabia, and the Sudan is irrigated. Wheat in WANA represents about 20 percent of all wheat production in the Third World, and barley 62 percent of the total barley production.

The other main components of annual cropping systems are grain legumes, especially *Vicia faba*, chickpeas, and lentils. Potatoes, melons, cotton, tobacco, sugarbeets, and various annual oilseeds are also grown. However, all these other crops occupy only about 27 percent of harvested area in the region, whereas cereals occupy 73 percent (Table 3). The mix of crops varies both with the availability of irrigation and with the constraints imposed by cold winters, frost hazard, and low and unreliable rainfall.

The share of cereals in the *value* of production in most countries is proportionally much lower than the area they occupy, but from a dietary viewpoint, they contribute nearly 60 percent of both calories and protein, of which wheat provides 40 percent. This is much higher than wheat in any other developing region. Compared with cereals, the other main rainfed crops of the region contribute far less to calorie or protein supply. For calories, grain legumes supply 2.4 percent, starchy crops 1.7 percent, and oilseeds 4.8 percent. Legumes supply 4.4 percent of protein and starchy crops 0.9 percent.[1]

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[1]Food and Agriculture Organization of the United Nations/Consultative Group on International Agricultural Research, Technical Advisory Committee, CGIAR Priorities and Future Strategies (Rome: FAO, 1987).

Table 3--Importance of commodities in the regional economy, West Asia and North Africa, 1979/80 and changes, 1969-7 to 1979-81

Commodity	Contribution to Diet, 1979-81		Value of Production	Harvested Area, 1979/80		Annual Rate of Change 1970-80		Growth of Yield, 1969-71-1979-81
	Calories	Protein				Production	Consumption	
	(percent of regional total)			(percent)	(million hectares)	(percent)		(percent/year)
Wheat	39.6	40.7	13.5	40.1	33.7	3.6	4.7	3.1
Barley	2.6	3.3	3.6	13.9	11.7	2.5	1.8	1.5
Maize	5.8	4.8	1.9	4.8	4.1	2.4	3.6	1.1
Sorghum/millet	3.5	4.2	1.6	9.8	8.2	1.9	1.3	2.1
Rice	6.0	5.1	4.7	3.7	3.1	2.0	3.3	0.7
Total cereals	58.5	58.1	25.3	72.3	60.8	2.8	3.9	...
Potatoes	1.3	0.9	2.4	0.7	0.6	5.8	7.1	1.6
Total starchy products	1.7	0.9	3.4	0.8	0.7	5.0	6.2	...
Chickpeas	0.7	1.2	1.0	2.0	1.7	0.6	0.8	-1.1
Lentils	0.3	0.9	0.4	0.6	0.5	2.1	2.8	2.0
Faba beans	0.7	0.9	0.6	1.0	0.8	0.8	2.3	0.2
Phalseolus	0.4	0.9	0.4	0.5	0.4	-6.7	2.4	0.3
Total pulses	2.4	4.4	3.2	5.3	4.4	0.9	2.2	...
Vegetables	1.7	2.7	10.4	2.4	2.0	4.3	4.6	...
Oilseeds	4.8	...	2.5	7.0	5.9	1.0	5.3	...
Other food crops	...	...	16.5	5.6	4.7	2.7	4.0	...
Total food crops	69.1	66.1	61.3	93.4	78.5	...	...	...
Large ruminants	1.1	4.2	6.5	...	...	2.3	3.4	...
Small ruminants	0.4	2.1	5.9	...	...	3.5	3.8	...
Milk	2.6	5.4	13.7	...	...	2.6	3.2	...
Other livestock	0.9	4.8	4.5	...	...	7.9	10.5	...
Total livestock	5.0	16.5	30.6	...	...	3.1	4.8	...
Fish	0.2	2.1	...	...	5.7	...	...	...
Other food commodities	25.7	15.8	...	...	...	...	...	...
Total food	100.0	100.0	91.9	...	...	...	...	...
Nonfood crops	...	...	8.1	6.6	5.6	0.2	5.4	...
Total	...	...	100.	100.0	84.1	2.7	4.6	...

Source: Consultative Group on International Agricultural Research, Technical Advisory Committee, CGIAR Priorities and Future Strategy (Rome: TAC Secretariat, 1987).

Livestock products supply 5 percent of calories and 16.5 percent of the protein. Large ruminants are fed mainly green fodder, straw, various by-products, and some concentrates: the natural grazings are dominated by annual species and sclerophyllous shrubs more suited to sheep and goats than to cattle. Livestock mortality in drought years is high, leading flock owners to maintain excessive numbers in better years as an insurance against losses in bad ones. Another device to help spread risk is migratory movements of animals in nomadic or transhumant systems of management, which are still important in this region.

A further consequence of the geoclimatic specificity of WANA is the limited spillover of benefits of research from other developing regions to that region.[2] There are only five developing countries with areas of comparable climate: Argentina, Chile, Mexico, Pakistan, and Peru. Transfer of technology from developed countries with climatic analogs (Australia, the western United States, South Africa, and southern Europe, especially Spain, Italy, and Greece) is more promising technically, but technology has proven difficult to adapt to socioeconomic conditions in WANA.

SOCIOECONOMIC DYNAMISM IN THE REGION AND ITS CONSEQUENCES

The 22 countries of the region had a collective 1980 population of about 263 million, about the same as that of North America, the U.S.S.R., or the European Community, but growing faster at 2.7 percent per year; a population density per hectare of arable land of 2.6 persons, low compared to Asia but higher than that in South America or Sub-Saharan Africa; a level of urbanization of about 40 percent, next highest to that in Latin America, and rising rapidly; and a high annual real growth rate of around 6.8 percent in GDP during the 1970s (Table 4).

Since 1980, however, growth of GDP has fallen sharply, both in the oil-exporting countries of the region and in the relatively poor labor-exporting countries. Growth in the oil importers has been affected by the decline in oil prices, and that in the labor exporters has been affected by economic retrenchment in richer countries of the region and by recession in Western Europe. It is noteworthy that although WANA has only two countries classified as "low income" by the World Bank,[3] it has the widest income disparities among its member nations of any region in the world.

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[2]Jeff Davis, Pete Oram, and James Ryan, Assessment of Agricultural Research Priorities: An International Perspective (Washington, D.C.: International Food Policy Research Institute and the Australian Center for International Agricultural Research, 1987).

[3]World Bank, World Development Report (Washington, D.C.: World Bank, 1986).

Table 4--Changes in growth rates of population, GDP, agricultural production, exports, and food imports, 1971-80 and 1980-84

Item	West Asia	North Africa
	(percent/year)	
Population[a]		
1971-80	2.75	2.83
1983-84	2.73	3.22
GDP[b]		
1971-80	6.76	6.81
1980-82	1.57	2.86
Net agricultural production		
1971-80	3.10	1.50
1980-84	2.09	0.84
Net food production		
1971-80	1.65	1.50
1980-84	1.03	0.68
Consumption, 1966-80		
Total	3.60	4.30
Food	3.50	3.90
Feed	4.10	6.90
Agricultural exports		
1971-80	-5.21	-8.31
1980-84	4.85	-12.64
Food import volume		
1971-80	14.42	11.97
1980-84	8.28	4.60

Source: Derived from Food and Agriculture Organization of the United Nations, The State of Food and Agriculture, 1985 (Rome: FAO, 1986).

Note: GDP growth and food imports have fallen since 1980 as a result of economic recession in the region.

[a] Total population in 1980 was 263 million (108 million in North Africa, and 155 million in West Asia).

[b] GDP is in constant local currency terms.

Similar disparities apply to the contribution of agriculture to the national economies. In 1980, this averaged 10 percent of total GDP, overall, which is low compared to other developing regions, but it varied from about 1 percent of GDP in the Gulf States to about 10 percent in Iran, Iraq, and Jordan, rising to between 20 and 40 percent in countries without major oil resources, such as Morocco, Tunisia, Syria, Turkey, Egypt, the Sudan, and the Yemen Arab Republic. These differences are closely reflected in the proportion of the economically active labor force remaining in agriculture, which averaged 42 percent in 1985 (still a relatively high figure). Nevertheless, it ranged from virtually zero in the Gulf States to 25-35 percent in Iran, Iraq, Syria, and the Maghreb countries of North Africa, 52 percent in Turkey, and more than 60 percent in Afghanistan, the Sudan, and the Yemen Arab Republic.[4]

Although these large differences among countries of the region make it hard to characterize WANA meaningfully in terms of simple regional averages, they reflect a dynamic social and economic flux that is probably unique among developing regions. These differences also provide opportunities for intraregional agricultural complementarities in trade and financial assistance, which have not yet been fully exploited.

Because incomes were low in many countries of the region until the 1960s, energy consumption levels were often below those recommended for adequate nutrition; El-Sherbini shows that 5 out of 6 Economic Commission for Western Asia countries surveyed in 1970 had less than adequate dietary energy intakes, and several countries had protein intakes below 60 grams per capita.[5] In aggregate, even during 1979-81, the Food and Agriculture Organization of the United Nations (FAO) listed 10 nonoil-producing countries out of 19 countries in West Asia or North Africa as having 41 percent of their population below the absolute poverty income level, although the region as a whole was stated to have only 14.7 percent of undernourished people.[6] This is a reflection of the huge income discrepancies between oil and nonoil countries shown in Table 1. Thus, substantial scope existed for a rapid increase in staple food consumption should there be a broad-based improvement in income levels over those existing in the 1950s and 1960s.

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[4]Food and Agriculture Organization of the United Nations, FAO Production Yearbook, 1985 (Rome: FAO, 1986).

[5]Abdel-Aziz El-Sherbini, "Short-term Possibilities for Increasing Food Production in Selected Arab Countries," in Food Security Issues in the Arab Near East, Part I, ed. A. A. El-Sherbini (Oxford: Pergamon Press, 1979).

[6]Food and Agriculture Organization of the United Nations, The State of Food and Agriculture, 1985 (Rome: FAO, 1986).

This, by and large, is what has happened. Annual growth rates of GNP per capita between 1961-65 and 1979-81 averaged 6.0 percent in West Asia and 3.8 percent in North Africa,[7] and growth was especially high in some of the previously poor countries as a result of oil discoveries in a few cases, and new employment opportunities for migrant labor in several others. Although cereals (especially wheat) have always been the major component of the diet, income elasticity of demand for cereals has remained quite high except in a few major cereal producers (especially Turkey); for livestock products it is much higher (see Table 5). Income elasticities of demand projected to 2000 are shown in Table 6.

In 1950 the region was a net cereal exporter with a surplus of 400,000 metric tons.[8] But production has failed to keep pace with demand since then, and rapid population and income growth have progressively narrowed the excess of production over consumption.

THE WIDENING FOOD GAP

Consequent to the rapid economic growth and social change in the region, an ever-widening gap has opened up between demand and domestic supply, both for cereals and for total staples.

In 1980, the net cereal deficit (consumption minus production) was around 16 million tons, and imports of livestock products were 840,000 tons of meat and 4.8 million tons of milk products. The region is now the major food importer of the Third World. Imports, valued at 21.6 billion dollars in 1981, represented nearly 40 percent of the total for *all* developing countries, 23 percent of the value of its agricultural production, and 4.8 percent of its total GDP.[9] For a relatively less affluent region, the latter would have been much higher. These imports, which rose in value between 1974 and 1984 by almost 14 percent a year, consisted largely of wheat, feedgrains, and livestock products.

The *projected* trend-based cereal deficit for the year 2000 would be 43.0 million tons according to Khaldi, but 24.9 million tons according to Goueli--smaller but still of major significance, and double

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[7]Derek Byerlee, The Increasing Role of Wheat Consumption and Imports in the Developing World, Working Paper No. 05/83 (Mexico City: Centro Internacional de Mejoramiento de Maíz y Trigo, 1983).

[8]All tons referred to in this paper are metric tons.

[9]FAO, State of Food and Agriculture, 1985.

Table 5--Estimates of income elasticities, selected Middle Eastern countries, 1975

Foodstuff	Iraq	Jordan	Syria	Yemen Arab Republic
Wheat flour	0.30	0.20	0.20	0.70
Milled rice	0.40	0.65	0.40	1.00
Sugar	0.30	0.45	0.50	0.90
Vegetable oil	0.50	0.65	0.40	1.00
Meat	1.00	1.00	1.20	0.96

Source: Abdul-Aziz El-Sherbini, ed., Food Security Issues in the Arab Near East (Oxford: Pergamon Press for the United Nations Economic Commission for Western Asia, 1979).

Table 6--Projected average income elasticities of demand for basic food staples, selected countries, 1980-2000

Country	Annual Growth of GNP Per Capita	Income Elasticity of Demand	
		Food Use	Feed Use
	(percent)		
Algeria	4.20	0.05	1.01
Morocco	2.41	-0.12	1.08
Tunisia	5.68	-0.28	0.91
Afghanistan	0.50	0.04	1.08
Egypt	3.87	0.05	0.89
Iran	6.00	-0.05	0.47
Iraq	6.00	0.04	0.90
Jordan	5.81	0.16	1.25
Kuwait	0.50	-0.08	0.39
Libya	0.50	-0.19	0.67
Saudi Arabia	6.00	-0.09	0.39
Sudan	0.50	0.30	0.77
Syria	5.55	-0.16	0.62
Turkey	3.52	-0.30	0.96
Yemen Arab Republic	6.00	0.23	0.86
Yemen People's Democratic Republic	6.00	0.38	0.91

Source: Leonardo A. Paulino, Food in the Third World: Past Trends and Projections to 2000, Research Report 52 (Washington, D.C.: International Food Policy Research Institute, 1986).

Note: Basic food staples include wheat flour, milled rice, sugar, vegetable oil, and meat.

Goueli's 1980 calculated deficit.[10] The gap between supply and demand for all staple crops rose from 8 million tons in 1973 to 19 million tons in 1980, and could be 64 million tons in 2000, according to a later projection of the International Food Policy Research Institute.[11] This is based on 1966-80 trend income growth. On the somewhat unlikely assumption that there would be no increase in per capita consumption of major food crops over the 1980 level, however, the deficit could be as low as 26 million tons by 2000. At the higher level, the deficit in the region would be well above that projected for any other developing region.

THE ROOTS OF FOOD DEFICITS

In looking at these estimates, one must ask whether the root cause of this widening food gap is the rapid growth and changing nature of demand or a failure to increase production fast enough. Certainly, the growth of demand in most countries has been exceptionally high, but since it is made up of several components, including population growth, income growth, and income elasticities of demand, and the growth rate of production in the region has not been adequate to keep up with even the first of these, a major cause of the problem must lie with an inadequate growth of production.

For the period 1961-80 population growth in the region as a whole was 2.7 percent per year (2.6 percent in North Africa and 2.8 percent in West Asia), whereas major food crop production (cereals, roots, pulses, and bananas) rose at an average of only 2.5 percent (2.3 and 2.6 percent, respectively, in North Africa and West Asia). This was below the average of 2.8 for all developing regions, except Africa, but in line with that for developed-country agriculture. Livestock production expanded faster at 3.8 percent annually between 1966 and 1980, with beef increasing at 2.9 percent, poultry meat at 10.6 percent, and milk at 2.2 percent.

Thus, it might be said that while production growth has been inadequate to keep up with population growth, it has not been shockingly bad. The question of whether it might have risen faster and why it has not will be addressed shortly.

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[10] Nabil Khaldi, Evolving Food Gaps in the Middle East/North Africa: Prospects and Policy Implications, Research Report 47 (Washington, D.C.: International Food Policy Research Institute, 1984); and Ahmed Goueli, A Future of the Food Economy in the Arab Countries, vol. 1 (Khartoum: Arab Organization for Agricultural Development, 1979) (in Arabic).

[11] Leonardo Paulino, Food in the Third World: Past Trends and Projections to 2000, Research Report 52 (Washington, D.C.: International Food Policy Research Institute, June 1986).

However, the main changes in food demand in the region, over the last three decades, have been those resulting from the growth of per capita incomes. This has been influenced by rising oil revenues, in particular, but also by increasing urbanization, which shifts the diet toward convenience foods, and by migration. People migrate *within* countries of the region from rural to urban areas, *among* countries of the region from those with a surplus of labor or skills to those that are short-handed, and *between* the region and other regions (mainly to work in countries of Western Europe).

Per capita incomes doubled during the 1970s in virtually all countries of the region except the Sudan and Yemen People's Democratic Republic (PDR). They increased at 10.5 percent annually between 1973 and 1980 in the oil-producing countries (which generated about 50 percent of the food imports) compared with 6.9 percent between 1966-73, whereas in labor-exporting countries the increase was from 2.7 to 6.4 percent over the same period. Net trade deficits in staples in the oil-exporting countries rose nearly sixfold between 1966-70 and 1976-80, whereas deficits in labor-exporting countries tripled. However, in the major food-producing countries, where the growth of per capita income was slower, deficits rose by only 40 percent. This group comprises Afghanistan, Cyprus, Morocco, the Sudan, Syria, Tunisia, and Turkey.

A crucial factor in this dynamic situation, which has major implications for land use and research policy, is the fast growth in consumption of livestock products--meat, milk, and eggs. Although livestock production, on the whole, has proven more dynamic than crops (see Tables 7 and 8), self-sufficiency ratios for virtually all livestock products declined, in some cases substantially, during the 1970s. This has led to rapidly increasing direct imports of livestock products with net deficits of meat and eggs rising about sevenfold and milk nearly fourfold between 1966-70 and 1976-80 (for meat, see Figure 1). Imports of feedgrains have also increased sharply, growing at an annual average of about 18 percent between 1966 and 1980, compared with about 10 percent for wheat.[12] IFPRI and FAO projections indicate a continuing escalation of direct imports of livestock products by the year 2000, with feedgrains, for which income elasticities of demand are much higher than grains for human consumption, representing an increasing share of grain imports (Table 6).

Table 9, adapted from IFPRI projections, highlights several crucial aspects of this situation:[13]

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[12]Khaldi, Evolving Food Gaps in the Middle East/North Africa.

[13]J. S. Sarma, Cereal Feed Use in the Third World: Past Trends and Projections to 2000, Research Report 57 (Washington, D.C.: International Food Policy Research Institute, 1986).

Table 7--Average annual growth rates of production, area, and output per hectare of staple food crops, by country group, 1966-80

Crop	Total Region			Oil-Exporting Countries			Labor-Exporting Countries			Major Food-Producing Countries		
	Production	Area Harvested	Output Per Hectare	Production	Area Harvested	Output Per Hectare	Production	Area Harvested	Output Per Hectare	Production	Area Harvested	Output Per Hectare
	(percent)											
Total staples	2.8	1.2	1.6	1.9	0.5	1.4	1.0	-0.5	1.5	3.5	1.7	1.8
Total cereals	2.8	1.1	1.7	1.8	0.3	1.5	1.0	-0.5	1.5	3.5	1.6	1.9
Wheat	3.8	1.0	2.8	2.4	0.5	1.9	2.3	1.7	0.6	4.4	1.2	3.2
Rice	1.2	-0.4	1.6	1.9	-1.2	3.1	0.5	-0.4	0.9	2.0	0.6	1.4
Coarse grains	1.7	1.4	0.3	0.4	0.3	0.0	0.7	-1.2	1.9	2.3	2.1	0.2
Total non-cereals	3.8	3.4	0.4	4.6	3.9	1.3	0.3	0.4	-0.1	4.3	3.6	0.7

Source: Nabil Khaldi, Evolving Food Gaps in the Middle East/North Africa: Prospects and Policy Implications, Research Report 47 (Washington, D.C.: International Food Policy Research Institute, 1984).

Table 8--Average annual growth rates of livestock production, 1966-80

Livestock Product	Total Region	Oil-Exporting Countries	Labor-Exporting Countries	Major Food-Producing Countries
		(percent)		
Total livestock products	3.8	6.2	1.8	3.2
Beef	2.9	6.8	1.5	1.9
Sheep	2.0	2.1	1.0	2.1
Poultry	10.6	15.4	3.7	9.3
Milk	2.7	4.4	2.7	1.9
Eggs	7.7	10.2	2.9	8.0

Source: Nabil Khaldi, Evolving Food Gaps in the Middle East/North Africa: Prospects and Policy Implications, Research Report 47 (Washington, D.C.: International Food Policy Research Institute, 1984), p. 27.

- The gap between production and consumption of coarse grains could be more than three times that of wheat by the year 2000.

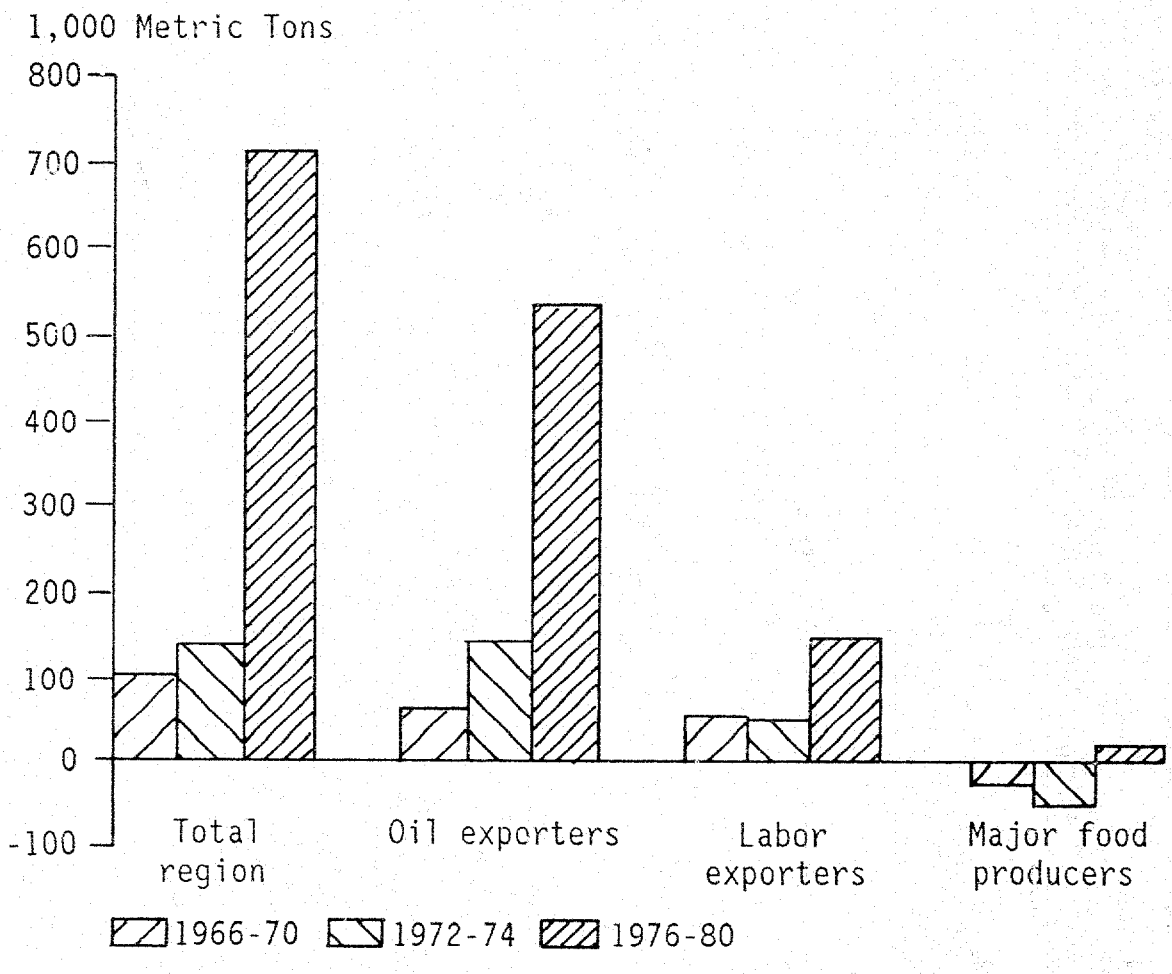
- The demand for cereals for feed will exceed their use for food in that year, whereas in 1980 cereal use for food was nearly double that for feed.

- The deficit in livestock products may grow nearly sixfold in value terms between 1980 and 2000, whereas that in cereals (including feedgrains) will only increase about three times.

- The value of the livestock deficit could be 3.5 times that of cereals by the year 2000, whereas it was only about 1.7 times as great in 1980.

These calculations, which are based on trend projections, are lower than those resulting from the high-income projection, but are obviously sensitive to assumptions about prices. Approximations of World Bank "world" price projections to 1995 were used for wheat ($130 a ton), coarse grains ($110 a ton), and meat ($2,000 a ton) deflated to constant 1983 dollars by the Manufacturing Unit Value Index (MUV). Since there are no price projections for milk and eggs, 1983 average import prices are used. These assumptions are open to challenge; but the magnitude of the difference between the cost of meeting the gap in livestock products, *plus* the cost of the feed component of the cereal gap, is so much greater than the cost of importing wheat and coarse grains for *food* consumption that tinkering with prices is unlikely to

Figure 1--Net imports of meat by country group, 1966-70, 1972-74, and 1976-80 averages



Source: Nabil Khaldi, Evolving Food Gaps in the Middle East/North Africa: Prospects and Policy Implications, Research Report 47 (Washington, D.C.: International Food Policy Research Institute, 1984,) p. 33.

Table 9--Production and consumption of cereals and livestock products: West Asia and North Africa, 1980, and projections to the year 2000

Commodity	1980 Production	1980 Consumption	1980 Deficit	1980 Use for Food	1980 Use for Feed	1980 Value of Deficit[a]	2000[b] Production	2000[b] Consumption	2000[b] Deficit	2000[b] Use for Food	2000[b] Use for Feed	2000[b] Value of Deficit[a]	Increase 1980-2000
	(1,000 metric tons)			(million metric tons)		(US$ million)	(1,000 metric tons)			(million metric tons)		(US$ million)	
Wheat	36,000	46,000	10,000	30.1	7.1	1,300	74,000	85,000	11,000	46.0	23.0	1,430	130
Coarse grains	23,000	29,000	6,000	10.3	15.4	660	30,000	66,000	36,000	16.0	46.0	3,960	3,300
Total	59,000	75,000	16,000	40.4	22.5	1,960	104,000	151,000	47,000	62.0	69.0	5,390	3,430
Meat	3,540	4,380	840	...	...	1,680	7,780	13,420	5,640	...	...	11,280	9,600
Milk	16,350	21,200	4,850	...	...	1,455	28,290	53,180	24,840	...	...	7,440	5,985
Eggs	825	935	110	...	...	110	3,170	3,630	460	...	...	460	350
Total	...	...	...	...	...	3,245	...	...	...	...	...	19,180	15,935

Sources: These projections are based on various reports of the International Food Policy Research Institute (IFPRI): Nabil Khaldi, Evolving Food Gaps in the Middle East/North Africa: Prospects and Policy Implications, Research Report 47 (Washington, D.C.: IFPRI, 1984); Leonardo A. Paulino, Food in the Third World: Past Trends and Projections to 2000, Research Report 52 (Washington, D.C.: IFPRI, 1986); Jeff Davis, Peter Oram, and James Ryan, Assessment of Agricultural Research Priorities: An International Perspective (Canberra: Australian Centre for International Agricultural Research and IFPRI, 1987); and J. S. Sarma, Cereal Feed Use in the Third World: Past Trends and Projections to 1990 and 2000, Research Report 57 (Washington, D.C.: IFPRI, 1986).

[a] Prices are based on World Bank data: price projections for major agricultural commodities (1984) 1995 prices in constant 1983 U.S. dollars--wheat, $130 a metric ton; coarse grains, $110 a metric ton; beef, sheep, and goat meat, $2,000 a metric ton; milk (fresh cow milk) 1983 price, $300 a metric ton (no projection available); eggs (1983 price), $1,000 a metric ton. It should be noted that farmgate prices of meat cited by FAO vary widely from as low as $843 a metric ton for sheep meat in Libya (1979) to as high as $5,795 a metric ton in Turkey (1979). Beef prices are about the same as sheep meat; goat meat is generally somewhat lower.

[b] These trend-based projections are below IFPRI's high-income growth assumption but above its low-income growth projection.

alter the picture substantially. Nor would the use of the low-income growth assumption change the essential direction of the conclusions, although it could reduce the size of the total food import bill. The sharp fall in food imports as the result of the oil price decline in the 1980s is clear from Table 4.

Thus, it is imperative to give the highest priority in production policy to reducing the livestock and feedgrain gap, or at least to preventing it from getting worse. Although there are differences in the magnitudes of the estimated cereal deficits, the analyses by FAO and the Arab Organization for Agricultural Development (AOAD) essentially corroborate IFPRI's projections of a large and growing gap by the year 2000, especially with respect to feed.[14] Despite the size of the potential import bill, it should be noted that even by the year 2000, projected per capita consumption of livestock products in WANA would still be well below that in the United States or Western Europe today.

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[14]Food and Agriculture Organization of the United Nations, Agriculture: Toward 2000 (Rome: FAO, 1981); and Goueli, Future of the Food Economy in Arab Countries.

2. THE RECENT GROWTH OF PRODUCTION IN THE REGION AND ITS SOURCES

Considerable attention has been devoted to the widening gap between food consumption and domestic production in the region not only because it is one of the key economic issues all countries in WANA have to face, but because it points to a need for urgent changes of emphasis in national agricultural policies and in research priorities if the region's inability to feed itself is not to deteriorate even faster. These changes have special reference to the rainfed and upland areas, which are the main sources of cereal and livestock production.

In order to clarify these needs, it is pertinent to look at the recent growth of production, which has been neither very dynamic nor stagnant, and to identify the main past and potential sources of growth. These are the expansion of rainfed arable area; the expansion and improvement of irrigation; the adoption of yield-increasing practices including increased use of improved varieties, inputs, especially fertilizers and mechanization, and new technology; and changes in the enterprise mix (the mixture of crops and livestock in the farming system), especially in irrigated land and in the rainfed areas with higher precipitation.

GROWTH OF ARABLE AREA

Area harvested increased overall by 1.2 percent annually between 1961 and 1970 and by 0.7 percent between 1971 and 1980. However, expansion of area under perennial crops was more rapid than that sown with annual species in both West Asia and North Africa. Area under noncereals grew faster than that under cereals, whereas the growth of area under wheat has declined markedly since 1972 in all of the major wheat-producing countries except Libya and Saudi Arabia (Table 10). For barley and sorghum/millet, however, area growth was the main source of increased production.

Looking ahead, area expansion cannot be expected to contribute as much as in the past, except possibly in the Sudan. FAO's agroecological zone studies for West Asia and North Africa show about 23 million hectares to be suitable to rainfed wheat production at the high input level and another 11 million hectares to be marginally suitable.[15] The

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[15]Food and Agriculture Organization of the United Nations, World Soil Resources Reports (Rome: FAO, 1978), vol. 1: Report on the Agro-Ecological Zone Project: Methodology and Results for Africa (48); and vol. 2: Results for Southwest Asia (48/2).

Table 10--Growth rates of wheat and barley production, 1961-72 and 1972-83, West Asia and North Africa

Crop/Country	1961-72 Area	1961-72 Yield	1961-72 Production	1972-83 Area	1972-83 Yield	1972-83 Production	Share of WANA's 1979-81 Total Production
	(average annual growth)						(percent)
Wheat							
Group 1 (North Africa)	2.02	2.37	4.39	-2.07	0.65	-1.42	10.72
Algeria	2.51	0.89	3.40	-4.01	0.28	-3.73	3.65
Libya	-1.86	2.28	0.42	6.71	5.08	11.79	4.31
Morocco	2.87	3.94	6.81	-1.19	0.25	-0.94	2.40
Tunisia	-0.40	1.25	0.85	-1.61	0.07	-1.54	0.36
Group 2 (West Asia)	1.83	1.87	3.70	-0.03	2.97	2.94	82.66
Afghanistan	0.43	-0.34	0.09	-0.85	1.64	0.79	7.91
Iran	4.97	-0.04	4.93	0.71	2.41	3.12	17.52
Iraq	1.99	5.08	7.07	-2.49	-3.00	-5.49	2.45
Jordan	-4.19	4.20	0.10	-5.16	-0.54	-5.70	0.19
Syria	-1.18	0.90	-0.28	-1.63	5.31	3.68	5.40
Turkey	1.17	2.96	4.13	0.45	3.81	4.26	49.00
Yemen Arab Republic	4.72	-0.40	4.32	0.78	-0.54	0.24	0.19
Group 3 (semi-arid)	0.05	0.95	1.00	2.25	0.31	2.56	6.42
Egypt	-1.03	1.66	0.63	0.64	0.30	0.94	5.35
Saudi Arabia	-8.22	0.71	7.51[a]	13.37	7.20	20.57[a]	0.47[a]
Sudan	23.45	-3.53	19.92	1.29	-1.98	-0.69	0.60
Total region - main producers[b]	1.81	1.76	3.57	-0.36	2.71	2.35	99.80[b]

(continued)

Table 10 (continued)

Crop/Country	1961-72 Area	1961-72 Yield	1961-72 Production	1972-83 Area	1972-83 Yield	1972-83 Production	Share of WANA's 1979-81 Total Production
	(average annual growth)						(percent)
Barley							
Group 1 (North Africa)	0.67	6.75	7.42	0.88	-2.04	-1.16	22.80
Algeria	0.47	3.45	2.98	-0.39	2.01	1.62	5.68
Libya	-9.10	7.12	-1.98	0.43	-5.99	-5.56	0.80
Morocco	3.09	6.92	10.01	0.90	-3.31	-2.41	14.10
Tunisia	-1.13	2.19	1.06	4.26	-1.11	3.15	2.30
Group 2 (West Asia)	-0.46	0.94	0.48	3.40	2.16	5.56	75.30
Afghanistan	-1.24	0.49	-0.75	-1.09	-0.41	-0.68	2.66
Iran	4.01	-0.60	3.41	2.50	3.95	6.45	11.61
Iraq	-5.22	3.14	-2.08	7.93	-4.15	3.78	6.00
Jordan	-6.50	-2.58	-9.08	1.28	2.23	3.51	0.17
Syria	-0.75	-2.72	-3.47	7.49	3.22	10.71	9.30
Turkey	-0.98	2.29	1.31	1.96	3.90	5.86	45.17
Yemen Arab Republic	-1.78	0.10	-1.68	6.84	-1.01	-7.85	0.39
Group 3 (semi-arid)	-1.05	-2.58	-3.63	0.69	0.59	1.28	1.00
Egypt	-2.65	-1.52	-4.17	1.98	-0.28	1.70	0.92
Saudi Arabia	6.19	-3.88	2.31	-5.43	2.56	-2.87	0.08
Sudan	...	...	...	...	...	...	0.00[c]
Total region - main producers[b]	-0.09	2.18	2.09	2.52	1.25	3.77	99.10

Sources: Regression analysis based on Food and Agriculture Organization of the United Nations, "FAO Production Yearbook Tapes," FAO, Rome, 1985.

[a] Saudi Arabian wheat production was only 160,000 tons in 1979-81 but rose dramatically to 1.7 million tons by 1985, 4.5 percent of the total.

[b] Excludes Cyprus, Lebanon, Oman, United Arab Emirates, Yemen People's Democratic Republic, and Gaza Strip. Their total 1979-81 production is equivalent to 0.02 percent of total wheat and 0.9 percent of barley.

[c] There is no production of barley in the Sudan.

actual 1984 wheat area was 26 million hectares, approaching the estimated limit for wheat production at the high input level, including the marginal land.

Considering that the better rainfed wheat areas are also those most suited to forage, pulses, potatoes, vegetables, and annual oilseeds, and that there are also 12 million hectares of barley, a good deal of which competes for more marginal land with wheat, the pressure on rainfed arable land appears immense.

Moreover, these figures refer to *harvested* areas, to which presumably fallow must be added to give a true picture of the actual cultivated land in cereals. If the ratio of fallow to cropland of 1:1 is applied, the land used for wheat plus barley would represent 77 million hectares out of a recorded 1985 total cultivated area of some 102 million hectares, of which 19 million is irrigated and 8 million is under permanent crops. In its study *Land, Food, and People,* FAO concludes that in 1975, Southwest Asia was already cultivating an area larger than its optimum cultivable area by extending cereal production to unsuitable land, and there is almost no room for further expansion.[16] In fact, 1.75 million hectares seem to have been withdrawn from cultivation between 1975 and 1985. The situation in North Africa is a little better, but not much; several authors have drawn attention to land degradation there due to overextension of cultivation.[17] About half a million hectares have been *added* to cultivated area in the Maghreb countries since 1975.

In this context, it is important to note that the very considerable expansion of total arable area in the region as a whole starting before 1960 has been largely at the expense of grazing lands, although the statistics do not reveal this clearly. Much of this has been in the upland or plateau areas of West Asia, which were less accessible and more difficult to farm prior to the advent of mechanization, and in the low rainfall marginal areas of North Africa. While these areas have come under increasing pressure from cultivation, they have also been carrying an ever-growing ruminant livestock population, expanding at a slightly slower pace than that of humans, but on a deteriorating

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[16]Food and Agriculture Organization of the United Nations, Land, Food, and People (Rome: FAO, 1984).

[17]Peter Oram, "Pastures and Fodder Crops in Rotations in Mediterranean Agriculture," Agricultural Development Paper 56 (Rome: FAO, 1956); F. DiCastro and H. A. Mooney, eds., Mediterranean-Type Ecosystems: Origin and Structure (London: Chapman and Hall, 1973), see especially "Human Activities Affecting Mediterranean Ecosystems"; and Carl Gotsch, "Wheat Price Technology and Demand for Technology in Jordan's Rainfed Agriculture," in Improving Dryland Agriculture in the Middle East and North Africa, ed. Carl Gotsch (Cairo: Food Research Institute, Stanford University, and the Ford Foundation, 1980).

resource. Since grazing lands supply almost 60 percent of animal nutrition in the region, it is urgent that further incursion of cultivation be halted or even reversed, so that policies of range regeneration can be adopted. This is of particular importance to the mountain and plateau areas of West Asia and the Atlas chain, where range grazings are of special significance.

THE EXPANSION AND IMPROVEMENT OF IRRIGATION

Irrigation is complementary to any overall policy for more rational land use in the region. In its various studies of actual and potential human carrying capacity, FAO assigns irrigation a heavy share of the total burden of future production--sometimes at a level that it may not be able to bear. During the 1970s, irrigated area in West Asia increased at a rate of about 1.3 percent compounded annually, and at 18.3 million hectares it now represents 22 percent of total arable and permanent cropland. To achieve the level of 27 million hectares predicated by FAO for the year 2000 would require the growth rate to nearly double--a difficult target.[18] Irrigated area in North Africa has almost doubled since 1963, but still represents only 6 percent of arable area, and the outlook for such rapid expansion in the future is not promising (Table 11).

It is important to note that not just *more* irrigated land, but more efficient use of water is essential in a region that has the largest proportion of arid to total land in the world and a massive salinity problem in existing irrigated areas. Rehabilitation, improved drainage, better system management, and improved water use are as important as new construction in relation to increasing irrigated output.

Moreover, as history has abundantly demonstrated, misuse of rainfed farming land and especially overgrazing and deforestation in catchment areas can cause rapid siltation, flooding, and other damage to costly irrigation investments downstream. Thus, for the latter to be sustainable, use of rainfed uplands for agriculture has to be sustainable too. There are also significant opportunities for small-scale water-harvesting and conservation practices in rainfed uplands, and, as a project in Baluchistan has shown, farmers will take advantage of these.[19]

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[18] FAO, Agriculture: Toward 2000.

[19] D. J. Rees et al., The Dryland Arable Farming System of Upland Baluchistan: A Case Study (Quetta, Pakistan: International Center for Research in Dry Areas and the Pakistan Arid Zone Research Institute, 1987).

Table 11--Some agricultural indicators, West Asia and North Africa

Country	Arable Land as Percent of Total Land, 1983	Forest Land as Percent of Total Land, 1983	Agricultural Population/ Hectare of Arable Land, 1983	Irrigated Land as Percent of Arable Land		Fertilizer Use/ Hectare of Arable Land		Number of Tractors/ Hectare of Arable Land		Percent of Area Wheat Under HYVs, 1983	Wheat Yield, 1983-85
				1961/65	1983	1961/65	1983	1961/65	1983		
						(kg/hectare)		(1,000 hectares)			(metric tons/ hectare)
Algeria	3	2	1.3	4	5	7	22	4	9	22	0.65
Morocco	19	12	1.3	3	6	6	29	1	3	30	1.13
Tunisia	30	4	0.6	2	4	5	16	3	6	36	0.94
Egypt	2	...	8.9	100	110	110	361	5	17	...	3.76
Libya	1	...	0.2	5	11	2	43	1	13	50	0.70
Sudan	5	20	1.2	15	14	4	7	0	1	94	1.29
Afghanistan	12	3	1.4	28	33	0	7	0	0	19	1.34
Cyprus	47	19	0.5	22	22	40	46	9	26	90	1.35
Iran	8	11	1.1	31	38	2	76	7	6	20	0.97
Iraq	13	3	1.0	24	32	1	17	1	6	50	0.77
Jordan	4	...	1.8	5	9	3	39	1	12	22	0.96
Lebanon	29	7	0.7	18	29	6	119	5	10	80	1.15
Saudi Arabia	1	1	5.4	39	36	6	217	1	1	95	3.21
Syria	30	3	0.8	9	10	3	32	1	7	50	1.35
Turkey	34	26	0.9	5	8	3	58	1	19	50	1.86
Yemen Arab Republic	7	8	3.4	12	9	...	12	0	1	n.a.	0.61
Yemen People's Democratic Republic	1	7	5.4	4	31	...	10	4	5	40	1.50

Sources: Food and Agriculture Organization of the United Nations, The State of Food and Agriculture, 1985 (Rome: FAO, 1986); Winrock International Institute for Agricultural Development, Agricultural Development Indicators, 4th ed. (Morrilton, Ark.: Winrock International, 1987); and Dana Dalrymple, Development and Spread of High-Yielding Wheat Varieties in Developing Countries (Washington, D.C.: Agency for International Development, 1986).

EXPANDING USE OF INPUTS AND GROWTH OF AREA UNDER HIGH-YIELDING VARIETIES

In its *Land Resources for Populations of the Future Project*, FAO estimates that at low input levels (no fertilizer) there would be 19 critical countries in WANA by the year 2000 from the point of view of food self-sufficiency, out of a total of 22 studied.[20]

At the intermediate level (about 75 kilograms of fertilizer per hectare plus some simple mechanization and pesticides), there would be 15 critical countries out of 22 by the year 2000, and at the high input level (150 kilograms of fertilizer per hectare), there would be only 12. With the exception of Turkey, West Asia is viewed as a very critical area, with land resources able to support little more than half of its present population *at current input levels* (averaging 41 kilograms of NPK per hectare overall), which lies in between FAO's low and intermediate levels. Out of 17 countries with an important agricultural sector, only 4 are now at the second level (75 kilograms per hectare) with respect to fertilizer use, and 2 (with a rather small total area) are at the 150 kilograms per hectare level, despite a growth rate of fertilizer use averaging 6.2 percent for the region as a whole over the last 20 years, but beginning from a low base.

A faster and more widespread adoption of fertilizer and herbicides appears essential, but much remains to be learned about profitable levels of input use in different agroecological zones, as well as concerning farmers attitudes and motivations for their use.

A yardstick not explicitly used by FAO is the growth of area under HYVs. Wheat is the major crop for which data exist,[21] and these indicate that approximately 35 percent of total wheat area is now sown to HYVs in West Asia and North Africa (Table 12). However, there is a higher proportion of HYV area in spring bread wheat than in durum or winter wheat, and the area is concentrated mainly in higher rainfall and irrigated land in lowland areas of mild winters.

This reasonably creditable rate of adoption has been reflected until recently in a more rapid growth of wheat yields, which have risen overall between 1972 and 1983 at a rate of 2.7 percent compared to 1.8 percent for 1961-72 (Table 10). Nevertheless, this performance is somewhat below that in the rest of Asia and in Latin America, and only

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[20]Food and Agriculture Organization of the United Nations, International Institute for Applied Systems Analysis; and United Nations Fund for Population Activities, Potential Population-Supporting Capacities of Lands in the Developing World (Rome: FAO, 1982).

[21]Dana Dalrymple, Development and Spread of High-Yielding Wheat Varieties in Developing Countries (Washington, D.C.: Agency for International Development, Bureau for Science and Technology, 1986).

Table 12--Area estimated to be under high-yielding varieties of wheat, West Asia and North Africa, various years

Country	Year of Reference	Total 1983-85 Wheat Area	Area of HYVs	Percent of Total	Type of Wheat
		(1,000 hectares)			
Afghanistan[a]	1978	2,320	433	19	Spring and winter wheat
Algeria[a]	1983	1,819	400	22	Spring, 31 percent durum
Cyprus[b]	1983	13	12	90	Spring, mainly durum
Egypt[b]	1985	516	259	50	Spring, mainly bread
Iran[b]	1983	5,980	1,196	20	80 percent winter, 39 percent irrigated
Iraq[a]	1985	1,215 (79-81)	600	20	Spring bread, 90 percent irrigated area under HYVs
Jordan[b]	1983/84	90	20	22	Spring bread
Lebanon[b]	1985	15	12	80	Spring bread and durum
Libya[a]	1983	260	130	50	Spring, about 50 percent durum
Morocco[a,c]	1983	1,877	625	30	Spring, 75 percent durum (10 percent HYV); bread, largely HYV
Oman[a]	1980	1	1	100	Spring bread
Saudi Arabia[b]	1984	414	395	95	Spring bread, mainly irrigated
Syria[b]	1983	1,081	540	50	Spring durum, 70 percent; irrigated, 22 percent (80 percent of irrigated area in HYV)
Sudan	1982/83	106	100	94	Spring bread, irrigated
Tunisia[b]	1983	954	344	36	Spring durum, 90 percent (80 percent HYV); bread, 10 percent (40 percent HYV)
Turkey[b]	1983/84	9,100	3,910	43	Winter, 75 percent (25 percent HYV): Spring HYV, 85 percent
Yemen Arab Republic[b]	1983	60	...	...	All durum
Yemen People's Democratic Republic	1983/84	10	4	40	Limited data
Total		25,771	8,977	35	

[a] Data were provided by Centro Internacional de Mejoramiento de Maíz y Trigo. Recent information on Afghanistan and Algeria are limited. Some varieties named are not strictly HYVs.

[b] Data for these countries were obtained from Dana Dalrymple, Development and Spread of High-Yielding Wheat Varieties in Developing Countries (Washington, D.C.: U.S. Agency for International Development, 1986). Area data cited for Iran (2.1 million hectares irrigated, 1.34 million hectares rainfed) are much lower than FAO data show. Varying Tunisian data on area of high-yielding varieties (HYVs) in durum and bread wheats are quite conflicting. A similar problem exists with total area and estimated percent of HYVs in Turkey.

[c] Data provided by the International Center for Agricultural Research in the Dry Areas.

about half that achieved since 1970 in China. Moreover, it has largely been confined to West Asia (Turkey, Syria, Iran, and Saudi Arabia), yields having fallen sharply in the Maghreb countries and in the Nile Valley. In the first half of the 1980s yields in West Asia seem to be leveling off also (Figures 2 and 3).

The main reason probably lies in the relatively low level of fertilizer used in most of the major wheat-growing countries of WANA, which (except in Egypt and Saudi Arabia) does not seem to have much correlation with the percentage of area irrigated or with that under HYVs. Cautious use of fertilizer may be a consequence of risk-aversion, linked to the high interannual variability of rainfed wheat yields throughout WANA (although the fact that much wheat is irrigated makes one question this). Other possible disincentives identified in various reports are high input prices relative to returns, inadequacies of seed or fertilizer distribution services, weak advisory services, and farmers' lack of familiarity with the agroeconomic requirements of the new varieties, including seedbed preparation and weed control.[22]

These are issues that will be discussed here in the wider context of how to increase input use generally, not only with respect to wheat. A main reason for this is that the opportunities for continued area expansion (except perhaps in the Sudan) are now so low that the principal hope of preventing a further escalation of imports is to raise yields, not just of wheat, but of all major crops.

The available crop-specific data are not sufficiently precise concerning input use on other crops, but the longer-term (1966-80) growth of coarse grain yields (principally barley) in the region has been low (0.2 percent per year), and although it improved between 1973 and 1980, it appears to have stagnated at somewhat below its 1980 level since then. This does not suggest that much fertilizer is being applied to barley or sorghum, a conclusion supported by several reports of low and erratic use. Apparent ups and downs in yields such as have occurred in North Africa (where 1985 was an exceptionally good year), are probably the result of weather variability. Maize area has not risen much, except in Egypt, but maize yields have improved there and in Turkey, probably reflecting better irrigation supply and the use of hybrids with fertilizer.

Except in the Nile Valley, pulse production is mainly rainfed. It presents a somewhat similar picture to that of barley; long-term growth has been around 1 percent. In West Asia, pulse yields have actually

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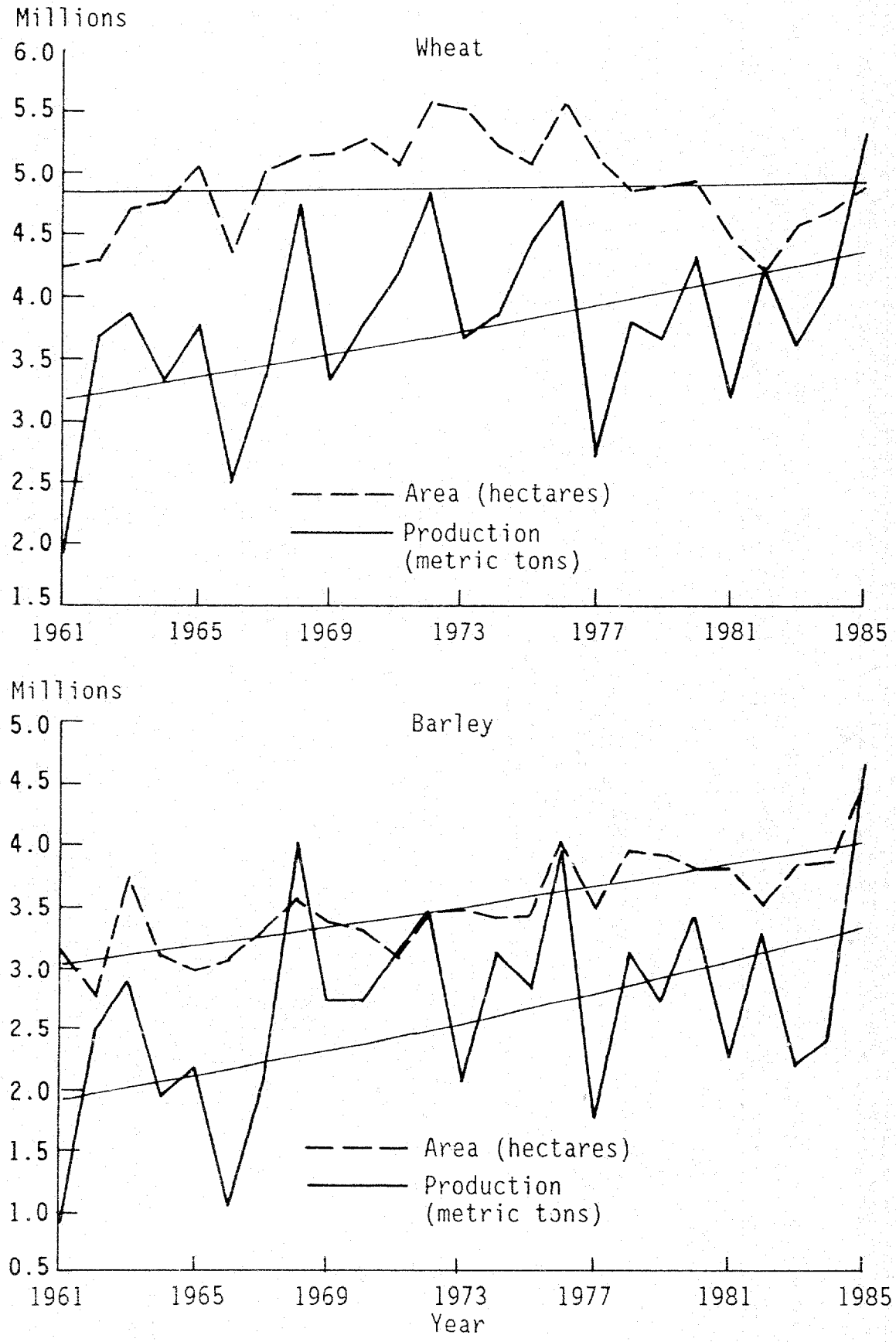
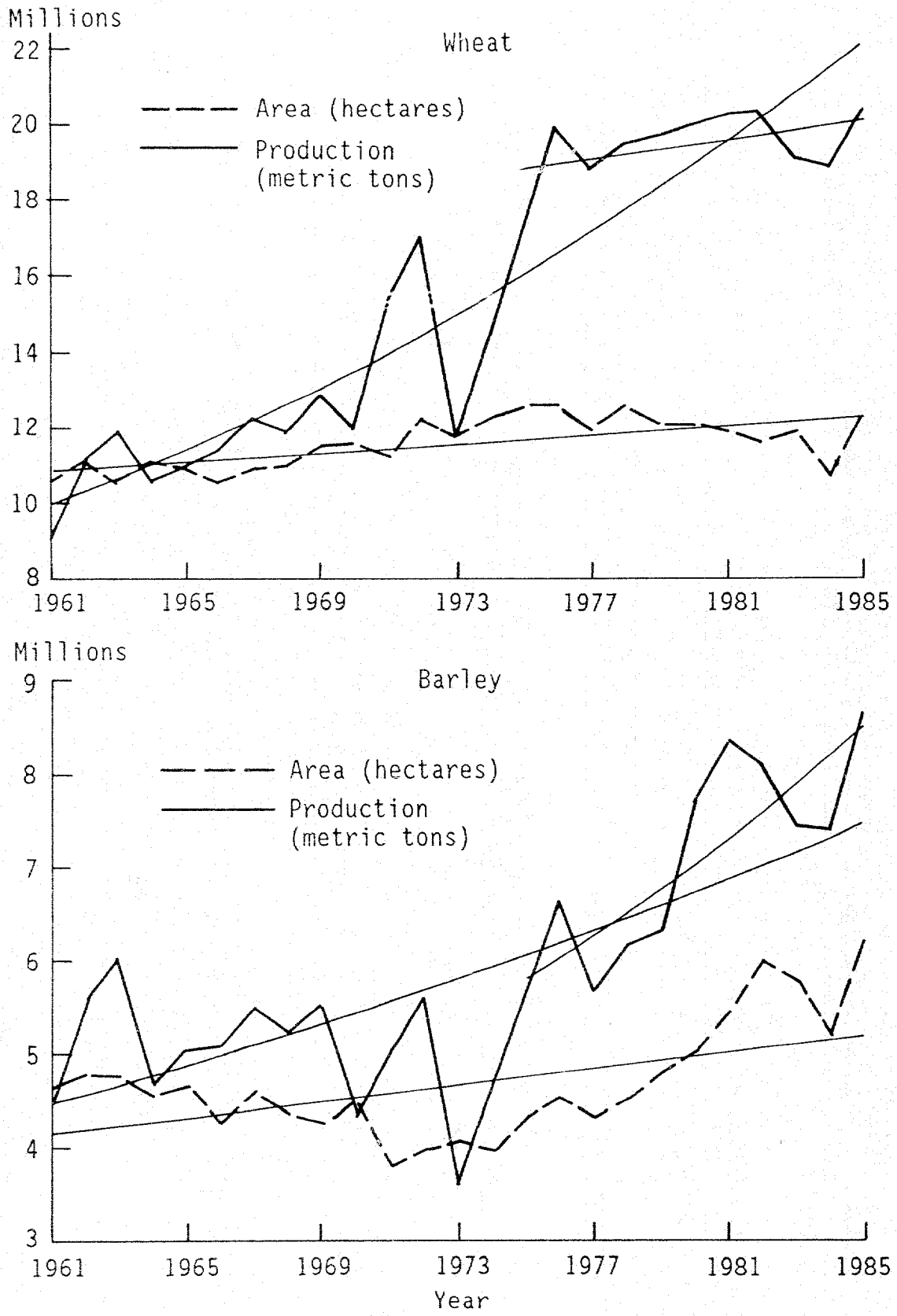
[22]Gotsch, "Wheat Price Technology"; El-Sherbini, "Short-Term Possibilities for Increasing Food Production"; International Center for Agricultural Research in the Dry Areas, Cereal Improvement Program Annual Report, 1985 (Aleppo, Syria: ICARDA, 1986). See "Barley Improvement," p. 8, and "High Elevation Cereal Research Program," p. 160.

Figure 2--Area and production of wheat and barley, North Africa, 1961-85



Source: Food and Agriculture Organization of the United Nations, "Production Yearbook Tapes, 1986," FAO, Rome, 1987.

Figure 3--Area and production of wheat and barley, West Asia, 1961-85



Source: Food and Agriculture Organization of the United Nations, "Production Yearbook Tapes, 1986," FAO, Rome, 1987.

fallen since 1980, although rising in the Maghreb. Only potatoes among food staples show a pattern of adequate growth of both yield and area, exceeding growth of domestic consumption in West Asia as well as North Africa. This may reflect the importance of irrigation and the stimulus of early potato exports.

The livestock sector, on the other hand, has been more dynamic, especially poultry production, reflecting the high income elasticities of demand for meat and milk and the contribution modern poultry production methods can make to rapid growth (Table 8). Nevertheless, poultry production rests heavily on a base of imports, both of feed concentrates and technology. Attempts to raise productivity of sheep and goats, which are so important in WANA, especially through improved range management, have had comparatively little success.

CHANGES IN THE ENTERPRISE MIX

There have been some significant shifts in land use in irrigated areas, generated partly by export opportunities for early vegetables and fruit on European markets but mainly by changes in domestic consumption patterns for those commodities and for livestock products, all of which have high income elasticities of demand and relatively high price elasticities of supply. However, as more European countries with areas of Mediterranean climate join the European Community (EC), expansion of exports from countries of WANA not having membership and thus facing tariff barriers may be restricted.[23]

Information on increases in the area under irrigated forage and feedgrains has not been published, but it seems likely that their area may also have increased, possibly at the expense of irrigated wheat or nonfood crops. Area and production of cotton and tobacco have not grown in recent years, partly because improved technology has allowed production to keep up with stagnant or declining world market demand, but also because of rising labor costs in some countries of the region that produce these more traditional and labor-intensive commercial crops.[24]

Trends toward more diversified farming systems involving a mix of cereals, vegetables, grain legumes, forages, and closer integration of livestock with crops are noticeable in some rainfed areas with more reliable rainfall, especially in West Asia. However, the total area is

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[23]Turkey is officially a candidate for EC membership; Morocco and Cyprus have recently made overtures to the EC Commission concerning membership.

[24]United Nations Economic Commission for Western Asia, Food Security Issues in the Arab Near East, ed. A. A. El-Sherbini (Oxford: Pergamon Press, 1979).

probably small relative to the vast areas at higher elevations and toward the drier margins, where, throughout WANA, the cereal-fallow system is still dominant. Here, change is slow, but not out of the question.

AREAS OF UNCERTAINTY

In looking at past sources of growth, there are some important areas of uncertainty that merit discussion. These are the contributions to growth of labor, government incentive policies, and government expenditures in agriculture.

Labor in Agriculture

In some developing countries where farm labor is abundant but technology limited, labor has been an important source of growth: for example, in India in the 1960s. This may have been the case in the past in WANA, where even in 1985 the share of the population that was economically active in agriculture represented 43 percent of total population. Richards claims, however, that illiteracy rates are higher in WANA than in Southeast Asia and consequently the quality of the labor force is lower in WANA.[25] The present situation is dynamic: the total active population has *risen* by 68 percent between 1965 and 1985, but the proportion of active population in agriculture has *fallen* from 58 to 33 percent in North Africa and from 64 to 44 percent in West Asia. This suggests a massive outflow from agriculture and possibly an aging labor force remaining. The rapid growth of tractor mechanization in the region--where the average number of tractors per hectare in most countries is two or three times those for developing countries as a whole--is obviously a compensatory response to labor migration and may have helped raise yields through more timely operations and fallow weed control. Labor productivity, however, has been low compared with Southeast Asia and Latin America and appears to be falling.[26]

Labor availability, rising labor costs, and the probable implications for the future development of mechanization and production technology in irrigated and rainfed areas of the region ought to be receiving considerable attention in research policy. Whether this is adequate at present is open to question.

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[25]Alan Richards, Food Problems and Prospects in the Middle East, Occasional Papers Series of the Center for Contemporary Arab Studies (Washington, D.C.: Georgetown University, 1984).

[26]FAO, State of Food and Agriculture, 1985.

Government Incentive Policies

The influence of price, subsidy, and other government policies on food production and consumption in the region is controversial. Byerlee considers that food aid (mainly in Egypt, Jordan, the Sudan, Tunisia, and Afghanistan), is a convenient way for governments to import wheat for urban use.[27] The high subsidies prevalent in the region to keep consumer prices for food down have played a role in promoting a rapid increase in wheat consumption and imports.[28] He states that bread prices in real terms in several countries of the region are about a quarter of those prevailing in countries that can be regarded as paying world market prices for their imports.

However, except in Egypt and the Sudan, he does not feel that wheat producers have been discriminated against, since farm prices have generally been set at levels above those of cereal imports.[29] On the other hand, Gotsch concludes from wheat/fertilizer relative prices in Jordan that the extreme consumer-orientation of wheat prices there rendered various attempts at introducing improved technology unrewarding, including the clean-fallow packages and the use of fertilizer at unsubsidized prices, thus defeating research and extension efforts.[30] El-Sherbini, in reviewing price policies in six West Asian countries during the 1970s, expresses concern that while consumer prices were fixed and often heavily subsidized for all basic commodities in five of those countries, producer prices, other than for wheat and rice, were generally free, and input prices were frequently excessive.[31] Changes in prices to producers lagged well behind those on international markets, whereas those for inputs were reflected immediately in local prices.

Thus, whether it is necessary to increase wheat producer prices (as opposed to maintaining price stability at levels commensurate with input costs) or to subsidize its production in the region remains in doubt, although rising agricultural labor costs make it necessary to keep real prices farmers receive for products under close review.

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[27]Byerlee, "Increasing Role of Wheat Consumption."

[28]The Near East region received the highest volume of food aid in cereals per caput of any developing region, both in the 1970s and in the present decade (FAO, State of Food and Agriculture, 1985).

[29]Byerlee, "Increasing Role of Wheat Consumption"; see also FAO, State of Food and Agriculture, 1985.

[30]Gotsch, "Wheat Price Technology."

[31]El-Sherbini, "Short-term Possibilities for Increasing Food Production."

More recent data shown in Table 13 suggest that Byerlee's judgment concerning wheat producer prices in the 1980s is correct; however, even if this is the case it does not necessarily hold true for livestock products or feedgrains.[32] Khaldi argues that prices of the former have been kept low by governments in order to favor urban consumers, and El-Sherbini's analysis supports this contention.[33] Barley prices in Table 13 are generally at a disadvantage compared to those of wheat, and they are less widely supported. This is not surprising: it is common for the prices of the main food staple to be supported, while those of other important but less politically sensitive commodities are left largely to market forces. This appears to be the case in WANA for pulses, root crops, and oilseeds as well as feedgrains and livestock products.[34] It may have been a disincentive to production of these commodities, as well as contributing to the extension of wheat to marginal areas.

However, prices or subsidies must be used cautiously as instruments of policy in the case of commodities for which improved technology is not available. They may lead to supply responses achieved only by shifts in area, without a commensurate increase in productivity. If this is at the expense of more productive commodities disadvantaged by price distortions, there may be a net short-term loss. Resources must, therefore, be channeled to research and other institutional measures directed to creating the necessary base for technological change before fiscal or other incentives are introduced to induce a different emphasis in land use. In some cases, where the technological innovation is seen by farmers to be sufficiently profitable, price changes or fertilizer subsidies may actually be unnecessary. In others, where prices have been unduly depressed or input costs are high, adjustments to prices or input subsidies may be needed to get new technology more widely adopted. This appears especially necessary where, as in WANA, the alternative is continually rising imports of food.

Government Expenditure on Agriculture and Its Adequacy

In this context, it is pertinent to look at government allocations to investment in the agricultural sector, particularly in research, because, if national research systems are inadequate, technological change will be slow.

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[32]Byerlee, "Increasing Role of Wheat Consumption."

[33]Khaldi, Evolving Food Gaps in the Middle East/North Africa; El-Sherbini, "Short-Term Possibilities for Increasing Food Production."

[34]Food and Agriculture Organization of the United Nations, "Statistics on Agricultural Support Prices 1973-1982," FAO, Rome, 1984 (mimeographed).

Table 13--Support prices for staple crops and livestock products, West Asia and North Africa

Country		Wheat	Barley	Rice	Maize	Groundnuts	Pulses	Sheep	Chicken	Cattle	Milk
Afghanistan		165	...	...	...	...	...	...	...	...	...
Cyprus	H	230	...	...	...	...	...	...	...	...	...
	S	178	194	...	122	...	...	...	...	...	...
Egypt		121	122	121	160	737	...	...	2,721	...	493
Iran		469	...	...	...	...	...	...	...	...	...
Jordan		223	...	...	...	...	...	...	...	...	...
Morocco		232	166	302	166	...	...	...	...	...	306
Sudan		298	...	...	...	235	...	...	...	...	...
Syria	H	351	...	...	...	...	...	...	...	...	...
	S	313	209	...	...	1,337	407	6,114	...	...	438
Tunisia	H	222	...	...	...	...	...	...	...	...	...
	S	202	162	...	...	...	...	...	...	...	...
Turkey	H	166	...	...	...	...	...	...	...	...	...
	S	147	98	644	225	523	...	...	...	1,699	...
Comparators											
United States		130	96	179	100	606	...	...	...	...	288
Canada		141	89	...	...	...	...	...	...	1,178	293
Thailand		...	...	143	108	...	...	...	...	...	...
New Zealand		153	...	...	...	...	...	1,099	...	1,167	178
India		150	...	137	124	312	183	...	...	...	...
Spain		185	150	237	185	...	264	...	1,046	2,858	241

Source: Food and Agriculture Organization of the United Nations, "Statistics on Agricultural Support Prices, 1973-82," FAO, Rome, 1982.

Notes: Wheat data are for 1982 except that for Afghanistan (1978), Iran (1981), and Tunisia (1981). Other dates are Cyprus, maize (1977); Egypt, barley (1979); Syria, sheep (1981); Turkey, barley (1980), maize (1981), and cattle (1969); and New Zealand, lamb and beef (1980).

H is for hard (durum) wheat; S is for soft wheat.
No support prices are listed for sorghum or millet in West Asia or North Africa.
Only Egypt pays a support price for potatoes.
New Zealand sheep and cattle prices are quoted for dressed weight, other sheep and cattle prices are for live animals.

An ellipse indicates that no support price is in effect.

Table 14 compares the 1980 share of agriculture in public investment for Arab countries of the region as well as the size of their agricultural labor forces and their share of agriculture in GDP and imports. Data on research expenditures for some countries are also cited. It shows that public investment bears little relation to the size of the agricultural labor force but is more closely aligned with the share of agriculture in total GDP and perhaps with the size of the import bill: in other words, with the economic rather than with the social importance of agriculture. This would be consistent with a policy that favored development of the high potential areas of a country (essentially irrigated and higher rainfall zones), which have a high value of output per hectare and probably a higher value-added off-farm in processing industries than land devoted mainly to cereals, pulses, and grazing animals.

Looking at the resources allocated to agricultural research in this relatively affluent region, more than half the countries are below the ratio of research expenditure to agricultural GDP of 0.6 percent, which is the current average for all developing countries. Some are close to the bottom of the list of the 84 countries for which IFPRI has gathered data for 1980 or later.[35] The targets suggested by FAO/UNDP and the World Bank are 1 and 2 percent of GDP, respectively.[36] Some countries (the Sudan, Egypt, Syria, Iran, and Turkey) now have considerable numbers of scientists, but compared with most African or Latin American countries, expenditure per scientist is very low. According to another study by Judd, Boyce, and Evenson, only one geographical region--South Asia--spent less on research relative to the value of its agricultural product in 1980 than West Asia, and only three spent less than North Africa.[37]

Public-sector expenditure on agricultural extension in relation to GDP in North Africa is high compared with any other region; that in West Asia is a good deal lower but not as low as for research. Thus, the inadequacy of support to research in the region and its consequent low productivity may be main reasons for the apparent failure of exten-

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[35]Peter Oram and Vishva Bindlish, Resource Allocations to National Agricultural Research: Trends in the 1970s (Washington, D.C.: International Service for National Agricultural Research and International Food Policy Research Institute, 1981).

[36]Food and Agriculture Organization of the United Nations and United Nations Development Programme, National Agricultural Research: Report of a Joint Evaluation Study in Selected Countries (Rome: FAO, 1984); and World Bank, Agricultural Research, Sector Policy Paper (Washington, D.C.: World Bank, 1981).

[37]M. Ann Judd, James K. Boyce, and Robert E. Evenson, Investing in Agricultural Supply, Economic Growth Center Discussion Paper 22 (New Haven, Connecticut: Yale University, 1983).

Table 14--Public investment in agriculture and agricultural research, 1980

Country	Share of Agriculture in Public Investment	Share of Agriculture in Total GDP, 1980	Ratio of Agricultural Imports to Total Exports, 1982-84	Agricultural Labor as a Share of Total Labor, 1980	Agricultural Research Expenditure as a Share of Agricultural GDP	Expenditure per Agricultural Scientist[a]
			(percent)			(US$1,000)
Algeria	11.0	6	19	25	n.a.	n.a.
Morocco	16.3	18	38	52	0.68	74.2
Tunisia	11.9	17	25	34	0.55	40.1
Egypt	3.5	23	108	50	0.33	4.6
Libya	17.6	2	10	19	0.80	31.2
Sudan	22.6	38	43	72	0.62	4.8
Iran	n.a.	n.a.	6	39	0.30	71.9
Iraq	23.6	7	21	42	0.16	12.6
Jordan	5.2	8	88	20	0.39	8.6
Saudi Arabia	0.9	1	9	61	n.a.	n.a.
Syria	23.9	20	38	33	0.23	12.1
Yemen Arab Republic	14.2	29	31	75	n.a.	n.a.
Yemen People's Democratic Republic	35.0	13	n.a.	45	n.a.	n.a.
Turkey	n.a.	23	7	54	0.24	27.1

Sources: Alan Richards, Food Problems and Prospects in the Middle East, Occasional Paper Series, Center for Contemporary Arab Studies (Washington, D.C.: Georgetown University, 1984); Winrock International Institute for Agricultural Development, Agricultural Development Indicators, 4th ed. (Morrilton, Ark.: Winrock International, 1987).

Note: n.a. means not available.

[a] 1980 or latest subsequent year in 1980 U.S. dollars.

sion staff to achieve faster adoption of technology by farmers. In fact, extension workers may have little of interest to offer to farmers because research is not producing much.

A commonly used test of the rationality of resource allocations to research is to examine the congruence of expenditure or scientist numbers devoted to a specific commodity as a proportion of the total value of all commodities. Data on research expenditure by commodity at the country level are quite limited, but comparisons of total numbers of scientists with the total value of the major commodities indicates a reasonably good fit for cereals (especially in North Africa), pulses, cotton, vegetables, and fruit, as well as for the crop sector as a whole. However, research on livestock and particularly that on pastures, range, and fodder crops seem to be well below what is merited in relation to the value of livestock products--especially in West Asia. Forestry research also seems to receive poor support, except in Iran, Turkey, and Tunisia.

It is important to note that this analysis is normally conducted in relation to the *value* of commodities, which is highest in unit terms for fruits, vegetables, industrial crops grown mainly in irrigated or high rainfall areas, and for animal products. Thus, a comparison on the basis of commodity contribution to calorie supply, or even of area cropped might give a different result. In fact, when allocations of scientists to commodities are compared with either of these criteria, research on cereals appears to be seriously inadequate, receiving only about 25 percent of total scientific resources. Pulses, however, appear to be relatively better supported in relation to their nutritional importance. It can be inferred from this analysis that the upland plateau, low rainfall, and mountainous areas may also receive insufficient research support, since the first two regions are the main cereal producing and grazing areas, and livestock and forestry are very important forms of land use in the mountains.

Thus, if the data are reasonably accurate (and it must be emphasized that research in West Asia/North Africa is not well-documented compared with most other developing regions), total levels of public expenditure on agriculture, the share of research in this expenditure, and the distribution of resources within research all need reappraisal and reinforcement. Unless they are strengthened overall and resources made more congruent with social as well as economic realities, there seems little prospect of making a significant dent in the increasingly large food deficits of the region. Perhaps the increased concern about lack of support for agriculture and the size of the food import bill, reported by FAO in 1985, will lead to a renewed commitment to the agricultural sector.[38]

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[38]FAO, State of Food and Agriculture, 1985.

3. THE TASK AHEAD: POLICY ISSUES ON CEREAL AND LIVESTOCK REDUCTION IN RAINFED AGRICULTURE AND THE ROLE OF HIGH-ELEVATION AREAS

It will be seen from this analysis that although agricultural growth in WANA has not been negligible, the contribution of technological change has not been nearly sufficient to enable domestic supply to match consumption. Nor is the outlook promising: an annual growth of production of about 5 percent would be required to meet projected demand for food by the year 2000, holding imports constant. No country in the world has been able to sustain such a growth rate in agriculture for long, especially where (as in WANA) new land and water resources for "horizontal expansion" are critically short, and almost the whole burden for increasing output has to rest on increasing yields and cropping intensities.

Given strong government support, agricultural growth in WANA can be accelerated, but it is doubtful if it can be doubled. Therefore, most countries of the region will have to face the reality of rising food imports, attempting to hold their import bills to acceptable levels by designing agricultural strategies that maximize their comparative advantages ecologically and technologically for import substitution. This may mean shifting emphasis from some traditional priorities to others more in line with future domestic demand and with developing opportunities for intraregional trade within WANA. The demand projections suggest that this applies especially to raising output of feedgrains, fodders, range grazings, and livestock, as well as deciduous fruits and forest products: a scenario for which the high-elevation areas have a particular vocation.

WHEAT PRODUCTION IN UPLAND AREAS

Although Turkey, with more than 4.4 million hectares of winter bread wheat and 850,000 hectares of winter durum wheat, has the largest area of wheat grown at higher altitudes in the region, there are also significant cold areas in Afghanistan, Pakistan, Algeria, Syria, Iran, Iraq, Lebanon, and Morocco. The International Center for Maize and Wheat Improvement (CIMMYT) has classified wheat-producing zones in 10 countries of the region representing about two-thirds of its total wheat area.[39] Of this, approximately 33 percent is winter bread and

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[39]Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center), Wheat Producing Regions in Developing Countries (Mexico City: CIMMYT, 1985).

durum wheat, 3 percent is facultative wheat (winter-spring crosses), and another 15 percent is spring wheat (bread and durum) with cold tolerance. The latter is mostly recorded in the Maghreb countries and Syria. A high proportion of the area that suffers severe winters is also subject to frequent moisture stress. The classification system used by CIMMYT does not include Iran, which according to Dalrymple has a majority of its irrigated wheat area of 2.3 million hectares sown with winter wheats.[40] When Iran is included, more than 50 percent of the wheat area in the region is located in higher altitude zones.

This presents a challenge to wheat breeders and agronomists because the proportion sown to HYVs is generally lower in winter and in facultative wheats than in spring wheats. Taking Turkey as an example, its wheat revolution took part in three stages; an initial phase of rapid area expansion through mechanization with little change in yields; the introduction of Mexican semidwarf wheats in the area of mild winters, which approximately doubled yields in about a decade in the spring wheat area; and a third phase of improvements in agronomy in the higher elevation zone to control weeds and store moisture in the fallow year, with changes in planting and fertilizer practices and herbicide use in the crop year.[41] Some improved varieties with winter hardiness have been introduced, but they have been adopted so far on only about 25 percent of the vast winter wheat area compared with an estimated 80 percent of the spring wheat area. The situation is reported to be about the same in other winter wheat areas of the region and in the analogous winter wheat zone of China.[42]

In reviewing the progress of production growth in the region, it is clear that yields of wheat have generally risen more slowly in recent years in most of WANA (Figures 2 and 3). From 1977 to 1984, they have been almost static or declined slightly in Afghanistan, Algeria, Cyprus, Lebanon, Iran, Iraq, Jordan, Morocco, Syria, the Sudan, Tunisia, and the Yemen Arab Republic. Only in Egypt, Pakistan, and especially Saudi Arabia (countries where most of the wheat is irrigated) has there been a continuing upward trend (see Figure 4). In this respect Table 10, which mainly reflects growth in the 1970s, may give an overly optimistic picture.

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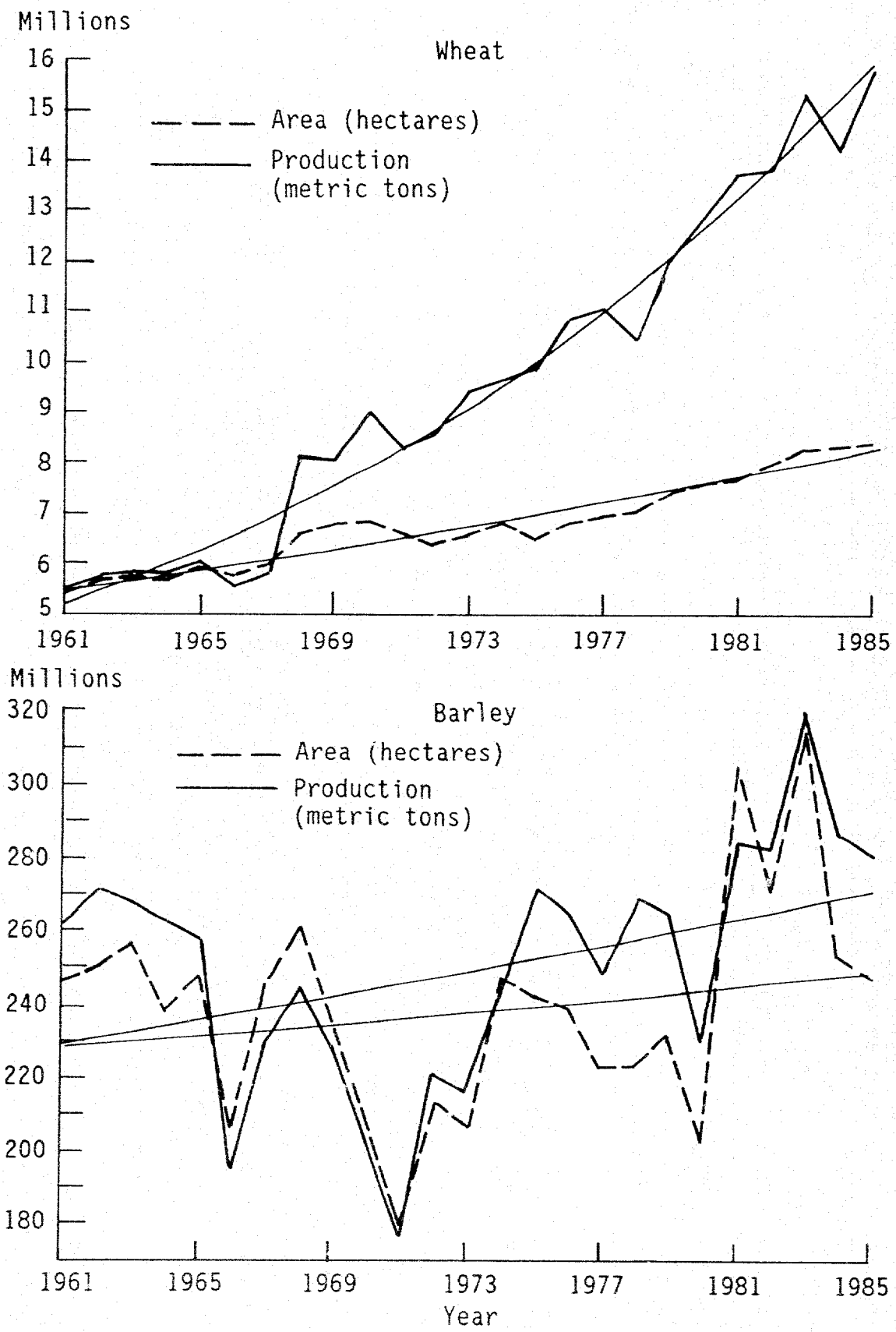
[40]Dalrymple, Development and Spread of High-Yielding Wheat Varieties.

[41]Haldor Hanson, Norman Borlaug, and Glenn Anderson, Turkey's Wheat Revolution (Mexico: Centro Internacional de Mejoramiento de Maíz y Trigo, 1982).

[42]Bruce Stone et al., "Agro-Ecological Zones for Wheat Production in China," International Food Policy Research Institute, Washington, D.C., 1985.

Figure 4--Area and production of wheat and barley on irrigated land, West Asia and North Africa, 1961-85



Source: Food and Agriculture Organization of the United Nations, "Production Yearbook Tapes, 1986," FAO, Rome, 1987.

A recent report notes that while wheat *area* increased by 1.2 percent per year in Afghanistan and by 2.0 percent in Iran between 1980 and 1984 with approximately a third of their cultivated area irrigated, *yield* remained static in the former and actually declined by 3.2 percent in Iran.[43] (Iran is the second largest wheat producer in WANA and Afghanistan is the third largest.) Yet, fertilizer consumption hovered around a low 50,000 tons in Afghanistan, but rose from 438,000 to 1.03 million tons in Iran. Why was there apparently so little response in Iran?

These paradoxes are hard to explain, but the situation as a whole is disturbing in view of the dominance of wheat in the diet, in land use, and in political and research priorities. In this light, one might ask if the wheat "revolution" is running out of steam, and if so what are the causes and the remedies? Several possibilities may be suggested:

1. Relative prices between wheat and inputs are out of line, and producers do not have sufficient incentives to increase input use. This might account for both the slow or negligible growth of yields and the decline in area in some countries--for example, in Jordan. Comparisons of growth rates with prices and benefit-cost ratios among different countries might be revealing.

2. Winter wheat and durum varieties are not as responsive to inputs as spring bread wheats. Because the latter represent only about a third of the rainfed wheat area, higher priority should be given to breeding work on winter bread wheats and spring and winter durum. Raising the yield plateau, thus, could avoid the need to use price mechanisms as an incentive.

3. More attention needs to be paid to agronomy, especially fallow and planting practices and weed control. It is often argued that there is considerable scope for further increases not only in winter wheats, but in yield of spring bread wheats, for which adoption rates are relatively high. Moreover, spring bread wheats have received much more attention from breeders than winter or durum varieties. Certainly, the size of the gaps between experimental and farm yields revealed in trials conducted by the International Center for Agricultural Research in the Dry Areas (ICARDA) confirms this impression. Much of the credit for success of the Turkish high altitude wheat program has been attributed to the emphasis placed on agronomy there. In Libya, it was found that timely seeding, herbicides, and fertilizer could raise wheat and barley yields threefold in the 300-millimeter rainfall zone, even without HYVs, although interannual and intersite variability was very high.

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[43]United Nations, Economic and Social Commission for Asia and the Pacific, "Review of Progress, Policies, and Issues in Food and Agriculture in the ESCAP Region," Economic Bulletin for Asia and the Pacific 37 (June 1986).

Nevertheless, experimental work cited from Syria, Turkey, Algeria, and Jordan shows that many issues remain controversial, especially those concerned with the economic value of fallowing. Many complexities of the interactions between variety, cultural practices, and input use also remain to be clarified. It may also be questioned why yields have not risen faster in countries such as Iran, Iraq, and Afghanistan, where a considerable proportion of the wheat is irrigated.

4. Weaknesses in government services, in some cases in research but especially in extension, are a main reason for farmers not achieving potentially higher wheat yields. It is clear from reports by ICARDA on Syria, El Hurani and Barghouti on Jordan, and Mann on Turkey that farmers in some countries have better access to new knowledge than others,[44] but even when information is available, adoption of the various components of the recommended package of practices is uneven. The more a practice departs from farmers' normal experience, appears risky, or conflicts with a perceived existing good, the less likely it is to be widely accepted. Common examples are the reluctance to adopt early fallow tillage or to use herbicides to control weeds in the crop, because weeds produce fodder at no perceived cost, which is of economic value to the farmer. Yet, in Jordan, use of herbicides gave the highest benefit-cost ratio in terms of increased crop yields of six inputs surveyed.[45]

Despite evidence that rates of adoption of a new practice are higher where a visible effect can be demonstrated and farmers can easily estimate the financial benefits, the use of improved varieties, herbicides, and fertilizer (all of which have high visibility) has not progressed rapidly. Among possible reasons are underinvestment in agricultural services by governments, elitist attitudes of researchers toward extension staff, and inadequate training of extension workers in understanding the attitudes and motivations of farmers and their families. Since improved technology benefits no one as long as it is not being used, scientists should devote more time to examining the human

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[44]International Center for Agricultural Research in the Dry Areas, Cereal Improvement Program Annual Report (ICARDA-112 EN) (Aleppo, Syria: ICARDA, 1986), "Barley Improvement," p. 8, and "High Elevation Cereal Research Program," p. 160; Shawki Barghouti, "The Role of Agricultural Cooperatives in Introducing New Technology in Wheat Production"; M. Haitham El Hurani, "Jordanian Farmers' Perceptions of Improved Wheat Technology"; and Charles K. Mann, "Lagging Adoption of an Element of a Package of Practices: Early Tillage in Anatolian Turkey," all in Improving Dryland Agriculture in the Middle East and North Africa, ed. Carl Gotsch (Cairo: Food Research Institute and the Ford Foundation, 1980).

[45]Barghouti, "Role of Agricultural Cooperatives"; and El Hurani, "Jordanian Farmers' Perceptions."

factors that may lie at the root of the reluctance of producers to make more effective use of results.

5. National average wheat yields are diluted by extending wheat cultivation to increasingly marginal areas. Even though area expansion has slowed down since the 1960s, the effects of the past will continue to be reflected in lower average yields and higher yield variability, unless there is a more drastic reallocation of wheat area to other uses with comparative ecological and economic advantage.

THE ROLE OF BARLEY IN DIFFICULT ENVIRONMENTS

Despite the relatively restricted cropping range and the dominance of winter cereals throughout most of the rainfed areas of West Asia and North Africa, there are considerable differences in annual average rainfall and its distribution, which, together with winter temperatures, determine the potential for crop and ruminant livestock production. This potential also sets boundaries to the type of technological improvement that is appropriate, to the use of HYVs, and to the economic use of purchased inputs.

The general assumption concerning barley is that it is better suited than wheat to the ecologically dry areas of the region (those with less than 300 millimeters of annual rainfall) and mild winters. Khaldi states that barley cultivation could be expanded by several million hectares.[46] While this assumption seems quite doubtful given the FAO data cited earlier,[47] wheat and barley do have distinct comparative advantages that could be exploited by shifts in their area distribution.

This is not immediately apparent in comparing their national average yields because in most WANA countries yields are higher for wheat. However, where disaggregated data are available, as in Jordan, Baluchistan, and Tunisia,[48] it is clear that this is because barley is generally relegated to areas of poorer soils and less reliable rainfall, where incentives to use inputs are low. This is compounded by lack of improved stress-tolerant barley varieties. These factors probably account for the erratic performance of barley area and yield

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[46]Khaldi, Evolving Food Gaps in the Middle East/North Africa.

[47]FAO, World Soil Resources Reports.

[48]El-Sherbini, "Short-term Possibilities for Increasing Food Production"; Rees et al., Dryland Arable Farming System of Upland Baluchistan; International Center for Agricultural Research in the Dry Areas and Republic of Tunisia, Ministry of Agriculture, Cereal Improvement in Dry Areas: A Report on the Tunisia Cooperative Cereal Improvement Project (1980-85) (Aleppo: ICARDA, 1986).

over time shown in Table 10. This is strikingly demonstrated by the contrasting growth patterns of wheat and barley in Figure 4. Wheat in the countries shown there is mainly irrigated, barley mainly rainfed under high moisture stress. Evidence from the Tunisian cereal improvement project and ICARDA's work in Syria nevertheless shows that substantial barley yield increases are possible even in the lower rainfall zones unsuited to wheat.

Most barley-improvement work has been undertaken in drier but milder areas; a question that merits further study is what role this crop might play in drier areas at higher elevations. Most traditional Mediterranean barley varieties have limited cold tolerance, while European winter barleys probably mature too slowly to avoid early summer drought during grain formation. Improved winter-hardy bread and durum wheats have had to be developed for the high-altitude zones; the same may have to be done for barley.

These ecological restraints have to be taken into account in examining the potential for shifting land use more toward livestock and feedgrains.[49] Moreover, it is important to recognize that ecological marginality is not necessarily synonymous with economic marginality. If prices are skewed in favor of a specific commodity, it may pay to grow it even in areas where it does not yield as well as some alternatives. This could well be the case when the price or market structure favors wheat rather than barley or animal products.

A further reflection of the wheat psychology in the region is the relative weakness of *research* directed to the improvement of barley yield, despite the fact that barley is generally grown in more difficult environments than wheat, with higher yield variability. In North Africa, local barley cultivars have weak but plentiful straw: thus they tend to lodge easily when nitrogen is applied, especially in years of adequate precipitation. This creates a dilemma when it comes to trying to increase grain yields by raising nitrogen use, because straw is prized for feed as well as grain. This is also reported to be a constraint on wider use of HYVs of wheat in some areas of the region, but whereas there is an extensive choice of potentially high-yielding wheat varieties, this is not yet the case with barley.

It is important to redress this imbalance, because at the moment the technical bias in favor of wheat compounds the price discrimination against barley. A step toward rationalizing this situation would be careful characterization of the environments most suited to cultivation of the two crops in the region and the identification of the constraints presently holding back adoption of existing technology in

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[49]The annual Medicago species developed in the mild areas of the Mediterranean for improved pastures in rotation with cereals also lack cold tolerance, and alternative species have to be found for higher elevations.

each, as a basis for designing appropriate research and extension packages. It would also be worthwhile to examine the need for changes in price or fertilizer subsidy policies to raise the incentives to barley production in the areas to which it is most suited, although price changes or subsidies on inputs in the absence of technological change where opportunities for area expansion are limited may have little effect in generating additional supply.

Another approach worth pursuing is to encourage barley-livestock integration. This would involve grazing of barley prior to harvesting it for grain, and either growing a fodder legume such as vetch in the succeeding year or summer fallowing and grazing the volunteer species. This does not necessarily imply maintaining sheep on arable holdings year-round; grazing rental agreements between farmers and flock-owners are not uncommon.

The value of a clean fallow versus a fodder crop or weedy fallow is an issue that remains in doubt.[50] Experiments to compare the value of the additional grain resulting from moisture or nitrogen conserved through clean fallowing, versus the feeding value of the weeds and the costs of the tillage, are inconclusive, possibly because of location-specificity.[51] Much depends on the rainfall in the fallow year, its distribution, the moisture-retaining capacity of the soil, levels of fertilizer use and its cost, and the relative prices of cereals versus alternatives such as grain legumes, fodders, and livestock.

One advantage of using barley as the base for an integrated crop-livestock system is that the driving factor in the price equation can be the value of the livestock products. Since their prices may be expected to rise more rapidly over time than those of grain, and better nutrition is the basic requirement of livestock improvement in WANA, this implicitly provides an incentive to raise barley yields, especially if governments are prepared to permit market forces to operate in the case of prices for animal products.

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[50]The author addressed this issue in an FAO development paper many years ago (Peter Oram, Pastures and Fodder Crops in Rotations in Mediterranean Agriculture, Agricultural Development Paper 56 [Rome: FAO, 1956]).

[51]Piero Bronzi, "Agro-climatological Constraints to Improving Dryland Production Technology," in Improving Dryland Agriculture, ed. Carl Gotsch (Cairo: Food Research Institute, Stanford University and the Ford Foundation, 1980); and Mann, "Lagging Adoption of an Element of a Package of Practices."

THE POTENTIAL FOR DIVERSIFICATION OF RAINFED AGRICULTURE: GRAIN LEGUMES, FODDERS, OR LIVESTOCK

Despite the limited opportunities for extending cultivation to new areas, and the problems of raising yield per hectare, it may be possible to increase income and output from the land by producing more per unit of area and per unit of time through reducing the fallow or by switching to higher value enterprises.

Where rainfall and temperature conditions are favorable (perhaps more than 400 millimeters of rain and no severe frost hazard), crops such as cotton, beets, potatoes, vegetables, and melons, as well as deciduous fruits, citrus, vines, and olives can be grown. Supplementary irrigation is not uncommon. Such conditions may exist in coastal lowlands, foothill areas up to 650 meters, and closed basins in mountain areas. Studies of cropping systems in Syria show that winter cereals represent less than 40 percent of land use in such areas, with 28 percent in summer crops (cotton, beets, tobacco), 13 percent in tree crops, 9 percent in grain legumes, and only 11 percent in fallow.[52] An extensive farm survey in Southwestern Greece, stratified by altitude, showed a comparable distribution of enterprises (Table 15).[53] In terms of value, the other crops and livestock may be worth twice as much as the cereals in mixed systems, and despite problems of small farm size and fragmentation, farmers are often progressive.

Even though the situation in these areas is different economically as well as ecologically from that of the drier and colder regions such as Anatolia, and many of the enterprises mentioned here are outside the scope of this paper, it is possible that they could contribute to the economy of the higher elevation and semiarid marginal areas through market linkages, off-season employment opportunities, and stratification of livestock movement so as to encourage rearing in upland or range areas and fattening on settled farms "downstream."

A better understanding of the importance of these areas--their economy, production potential, and the structural or other constraints to realization of potential on a country-by-country basis--would be a valuable contribution to assessing the overall capacity of agriculture in the region to meet future demands on its resources, to develop the possibilities for intraregional trade, and to determine research priorities.

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[52] International Center for Agricultural Research in the Dry Areas, Research Highlights for 1985 (Aleppo: ICARDA, 1986), "Measuring Sheep Productivity in On-Farm Grazing Trials," p. 58, and "Frost Tolerance in Annual Medics," p. 63.

[53] Food and Agriculture Organization of the United Nations and United Nations Special Fund, Economic Survey of the Western Peloponnesus, Greece, vols. 2 and 5 (8GRE General Report), 1965.

Table 15--Land use in Mediterranean zones with higher rainfall

Land Use	Northwest Syria	Southwest Greece
	(percent)	
Cereals		
Wheat	20.9	n.a.
Barley	18.8	n.a.
Total	39.7	42.1
Grain legumes and other winter annuals	8.7	13.3
Summer crops		
Irrigated (cotton, beets, etc.)	10.0	n.a., mainly vegetables
Rainfed	17.8	
Fodder crops	n.a.	12.2
Perennial crops (fruit, vines, olives)	13.1	22.9
Fallow	10.7	9.5
Share of income		
Crops	60.7	80.2
Livestock	13.5	19.8

Sources: Data for Northwest Syria is from the International Center for Agricultural Research in the Dry Areas, Annual Report, 1985 (Aleppo: ICARDA, 1986), on wheat-based farming systems and production practices in Northwest Syria. Data for Southwest Greece are from Food and Agriculture Organization of the United Nations and United Nations Special Fund, Economic Survey of the Western Peloponnesus, Greece, vols. 2 and 5 (FAO/SF: 8GRE General Report, 1965). Includes land from sea level up to 1,500 meters. Some land in the plains had supplementary irrigation.

Notes: n.a. means not available.
Data from Syria show that about 26 percent of farm family income comes from nonfarm activities. Comparable data are not available for Greece. On a prorated basis, using only on-farm income in Syria, the ratio of livestock to total income would be about the same as for Greece. It is interesting to note that in Greece, the gross revenue from livestock on farms surveyed in mountain areas was 49 percent of total farm income, in foothill areas it was around 25 percent, and in the plains around 13 percent. Farm family income was very low in mountain areas over 600 meters, and increased about two-and-one-half times with decreasing altitude to the plains where some supplementary irrigation was available. Higher rainfall is 325 millimeters or more annually.

Nevertheless, the bulk of agricultural land in the region lies either in the high elevation areas (1,000 meters or more) with cold winters and short growing seasons, of which the largest area is in West Asia, or in the semiarid steppe lands of the Mediterranean climatic zone with milder winters, which predominates in North Africa. Both subregions share a common problem in the limited range of enterprises the environment will permit. The upland areas have a somewhat less variable rainfall pattern, based on comparisons of yield variability between West Asia and North Africa, but both have a land-use pattern that is dominated by fall-sown cereals in the arable areas and by grazing of semimigratory small ruminants beyond the margins of cultivation.

The main alternatives to cereals appear to be grain legumes, annual oilseeds such as sunflowers or sesame, or fodders. Another possibility would be to reduce the arable area below its present and often risky limits and substitute improved pasture. Recent statistics do seem to indicate some retrenchment of harvested area under cereals, but what is being substituted is not clear. It might simply be that more land is being fallowed each year, rather than less.

Assuming that grain legumes could become competitive with cereals at current relative prices and yields, rising demand and increasing imports into high-income countries of the region appear to create promising opportunities for intraregional trade with others--perhaps with Turkey, Syria, Morocco, and Tunisia, which are grain legume exporters. WANA is in a strong trading position with regard to pulses, since the species cultivated there, mainly chickpeas, lentils, and *Vicia faba*, are not grown extensively elsewhere, except in Ethiopia, and in South Asia, which is a deficit area.

The directive given to ICARDA to work on grain legumes seems to be justified in view of their relatively low current productivity and good economic potential, especially if they can be grown in rotation with cereals as an alternative to fallow without unduly depressing cereal yields. Conflicts of opinion and even of empirical evidence on this possibility are by no means of recent origin,[54] but the criterion should be the return from the whole system, not just the cereal yield. A continuous cropping pattern should increase employment over the cycle, although in some parts of the region rising labor costs are now leading to pressures for mechanized harvesting of grain legumes, especially lentils.

The prospects for annual oilseeds are not so good: although a number of countries of the region are importers, there is a high degree of substitutability and cross-elasticity of price and demand among these products. Not only are by-products such as cottonseed oil

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[54]Bronzi, "Agro-climatological Constraints," and Peter Oram, "Pastures and Fodder Crops in Rotations in Mediterranean Agriculture."

produced in the region, but a number of other oils produced efficiently elsewhere--such as soya or palm oil--can compete in price with those that might be grown locally. Sesame, grown as seed for specific regional uses, might be a good prospect if its yields could be improved because both local and export markets exist.

Substitution of cereals by other crops becomes increasingly difficult where cold and drought constraints combine, as in Baluchistan, Afghanistan, Iran, and eastern Anatolia. Although some cultivars of chickpeas and lentils exhibit cold tolerance, winter kill is often high. The combination of disease, cold, and drought leads to such low yields of both grain and straw that the costs of growing legumes are not repaid, and, except in areas of better soils and higher rainfall, farmers prefer a cereal/fallow or continuous cereal system.[55]

For the more extreme climatic zones, the closer integration of cereal and livestock production offers the best hope of helping to meet future food needs but based on a more systematic association of crops and animals than has been the case in the past. Barley-sheep systems, with the animals grazing the barley at appropriate periods in the phenological cycle, as well as using the fallow and the weeds as feed, seem promising, but they are more prevalent in the Fertile Crescent than in the colder plateau regions or the marginal low-rainfall areas of North Africa.

The cultivation of annual fodder legumes in rotation with wheat instead of fallow also is more widespread in West Asia. Attempts at introducing the Australian wheat-reseeding Medicago system in North Africa--although apparently technically viable down to 300 millimeters of rainfall--are progressing slowly.

Why the experimental approaches to the problem of improving fodder resources have differed so much between the two areas of the region has never been clear, but the use of annual vetch or lathyrus species, which do not have to be grazed, is more in line with conventional farming practices and equipment suited to small farms. The Medicago or Trifolium species, which reseed themselves, were adapted for use on large Australian holdings, because the pasture species require careful grazing management and probably resident flocks of sheep if they are to persist.[56] Thus, the obstacles to their introduction are probably more

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[55]ICARDA, Research Highlights for 1985.

[56]John Doolette, "An Improved Crop Rotation Technology for Tunisia," in Improving Dryland Agriculture in the Middle East and North Africa, ed. Carl Gotsch (Cairo: Food Research Institute, Stanford University and the Ford Foundation, 1980).

social and psychological than technical or economic.[57] Nevertheless, some estimates of the potential for substituting grazing systems or fodder legumes for fallow in the milder areas of West Asia and North Africa, indicate a large potential for raising cereal yields and livestock-carrying capacity if these methods could be widely adopted.[58] An ECWA study states that substantial benefits could accrue to adoption of a wheat-vetch rotation, for which around 2 million hectares is said to be suited in Syria and Iraq.[59] Both the land capability estimates and the economics of growing fodders versus other possible substitutes for fallow need to be carefully evaluated, but there is clearly a latent potential awaiting development.[60]

Incorporating legume species for livestock use into farming systems in the cold upland areas is a different situation, however, because most annuals do not have sufficient cold tolerance (although there may be exceptions among Vicia and Medicago species). Perennials such as *Medicago sativa* and *Onobrychis viciafolia* have therefore been used in rotation with cereals in Turkey and Spain. The extent to which these have become accepted in normal farming practice is not well documented: it may be that ordinary farmers are reluctant to lock up much of their land in a four-year legume cycle, which also implies animals on the farm if its potential is to be fully utilized.

The size of the potential economic problems created by rising demand for animal products, especially for countries without large oil resources, indicates that high priority should be given to developing the domestic livestock sector. Past experience in Australia shows that this is an area where strong government support for research and for

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[57]Recent ICARDA studies on grazing Medicago species in Syria show a striking improvement in milk yields of sheep, which may change the present bias in favor of annual fodder legumes (ICARDA, Research Highlights for 1985).

[58]D. M. Leeuwrik, "The Relevance of the Cereal-Pasture Rotation in the Middle East and the North African Region," in Proceedings of the Third Regional Wheat Workshop (Mexico: CIMMYT, 1975); and D. Wynne Thorne and Marlowe D. Thorne, Soil, Water, and Crop Production (Westport, Conn.: AVI Publishing, 1979), Table 14.6, p. 211.

[59]United Nations, Economic Commission for West Asia (ECWA), Short-Term Possibilities for Increasing Food Production in Selected Countries of the ECWA Region, Sub. Prog. 3 (Amman, Jordan: ECWA, 1977).

[60]Peter Oram, "Crop Production Systems in the Arid and Semi-Arid Warm Temperate and Mediterranean Zones," in Soil, Water and Crop Production, ed. D. Wynne Thorne and Marlowe D. J. Thorne (Westport, Conn.: AVI Publishing, 1979).

the establishment of advisory services has really paid off, especially when linked to improved transport and marketing.[61]

Such support can be justified in this region on several counts. Economically, livestock represented about 25 percent of agricultural output in 1980, the highest share of any developing region next to Latin America, and not far short of that in Southern Europe. Socially, the range livestock sector includes some of the poorest people in West Asia and North Africa, whose livelihood is generally at highest risk. Yet, these nomadic graziers fill a unique ecological niche, and attempts to convert them to sedentary life have often failed. Raising the productivity of their stock by managing their grazing resources more conservatively, rather than maintaining high animal numbers as a hedge against climate-induced losses, seems an eminently rational proposition, but their life style and the variability of their environment does not lend itself easily to conventional technical approaches. Finding ways of integrating output with the potential of the arable lands for grazing and fodder production in order to raise total animal production has long been a challenge to crop and animal scientists and social scientists. It is particularly relevant to farmers in the upland and lower-rainfall arable areas, who have opportunities for producing fodders and improving fallow grazings but limited resources for maintaining breeding flocks year-round or for producing a wider range of alternative crops.

Cooperation among the graziers themselves, as in the Heema grazing system, and cooperatives working with crop and animal scientists to develop approaches to grazing management appropriate to local ecological and social patterns shows promise of success. ICARDA's approach to improving marginal land unsuited to cultivation near villages so as to increase ewe-carrying capacity in conjunction with fodder supplies derived from cultivated land is another interesting innovation.

There may be additional outlets for fattening range livestock on irrigated fodders or by-products in higher rainfall areas or even in feedlots. However, large ruminants may be more appropriate for feedlots.

In any case, the full range of opportunities for maintaining and managing livestock throughout the region in a way that will reduce the degradation of natural grazings and raise animal productivity needs to be exploited. The sector should be viewed holistically by national planners in designing research and development policies. ICARDA's present mandate gives it a relatively small role in this very important task, and perhaps this needs strengthening.

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[61]Derek E. Tribe, The Conservation and Improvement of Resources: The Grazing Animal (London: Philosophical Transactions of the Royal Society, 1977).

SUSTAINABLE LAND USE IN MOUNTAIN AREAS AND 'DOWNSTREAM' LINKAGES

A large share of the region is mountainous, including portions of northwest Africa, Lebanon, Cyprus, south and east Turkey, northwestern Iran, northern Iraq, most of Afghanistan, north and western Pakistan, and the southwest of the Arabian Peninsula.

Because both the difficulties and the opportunities of the mountainous areas are poorly documented and understood, compared with the upland plateaus such as Anatolia, the term "high-elevation areas" needs to be sharply defined.

The vocation of these dissected mountain and valley areas is quite different from that of the upland plains. For example, large-scale cereal culture is not a sustainable form of agriculture on steeply sloping lands (although in some countries, governments have subsidized cereal production in mountain areas on social grounds). On the other hand, forestry, controlled grazing of livestock, fruit production on protected slopes, and irrigated vegetable and fodder production in valleys are well suited to mountainous topography.

Despite the possible diversity of production in these areas, they are generally poverty-stricken, as the Greek study cited in Table 15 shows. This poverty stems largely from the social and economic situation of people living in isolated communities with difficult access to main centers of population and poor communications. These problems are often compounded by harsh winter conditions and lack of amenities. It is rare to find major urban centers at high elevations in temperate or continental climates: because the population is scattered there is little political pressure to devote large resources to such areas. Nor, apparently, are mountain environments particularly attractive work places for government officials. Hence, the physical difficulties of improving agricultural production may be compounded by a scientific and administrative vacuum.

In isolated communities, often cut off from downstream areas by snow, a considerable degree of basic self-sufficiency is desirable, although this may be augmented by trading vegetables, fruit, and livestock products for grain and pulses at urban markets when the latter are accessible and by appropriate storage techniques. Stratification of production is possible within the mountains and lowlands: for example, young animals reared on mountain pastures can be fattened on grain or irrigated fodders downstream. This is especially true if the government is prepared to invest in infrastructure (including roads, electrification, and water supply) and to encourage public or private transport services to operate in the area so that marketing, employment, and social linkages can be established. While there are undoubtedly technical opportunities for raising crop and livestock yields in mountain areas, the improvement of infrastructure may be an essential prerequisite for technical progress. Recent work by IFPRI in Asia and Africa shows how improved infrastructure augments access to knowledge

and production inputs, as well as enabling producers to achieve better prices for their produce.[62] Investment in terracing, tree planting, land consolidation, and small-scale irrigation in valleys or upland basins may be essential to the continuing sustainability of agriculture in mountainous regions.

The alternative is depopulation of mountain regions; abandonment of traditional conservation works for lack of labor to maintain them; increasing competition for remaining land between trees, animals, and annual crops; and accelerated erosion and flooding of downstream areas.

Land reform may also be necessary. Both of the United Nations Special Fund (UNSF) regional development projects in mountain areas of the western Mediterranean (Peloponnesus and Antalya) stress the difficulties imposed by fragmentation of holdings and disputed land titles: the Antalya project report states that 40 percent of the land ownership in that region of western Turkey was at issue in the 1960s.[63]

Rational resource management may require substantial shifts in historical patterns of land use imposed by isolation. Where yields are low and costs of cultivation and harvesting are high, cereals and vines have been cultivated on steep slopes and at high altitudes and the natural cover has been destroyed by uncontrolled free-range grazing. Rationalization implies specialization according to ecological and economic comparative advantage. It may require land consolidation and cooperation among producers to achieve a more uniform cropping calendar before it can be economically viable--especially if providing a reliable flow of produce to an economic-sized, modern processing plant is the objective. As has been demonstrated in some parts of West Asia, farmer cooperatives provide an additional sense of security, which enhances the use of improved technology.[64]

The basic objective should be to manage the resource in such a way that total income and employment from the land are increased and the physical and social disintegration resulting from mismanagement and erosion are reversed.

This can be achieved by expanding forests and managed watersheds at the expense of unimproved rangeland at higher altitudes and by replacing marginal cereal land with improved pasture and terraced fruit orchards or viticulture on intermediate slopes. Small-scale irrigation

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[62]Raisuddin Ahmed and Navendra Rustagi, "Marketing and Price Incentives in African and Asian Countries: A Comparison," in Marketing Strategy and Pricing Policy, ed. Dieter Elz (Washington, D.C.: World Bank, 1987).

[63]FAO/UNSF, Economic Survey of the Western Peloponnesus, Greece.

[64]Barghouti, "Role of Agricultural Cooperatives."

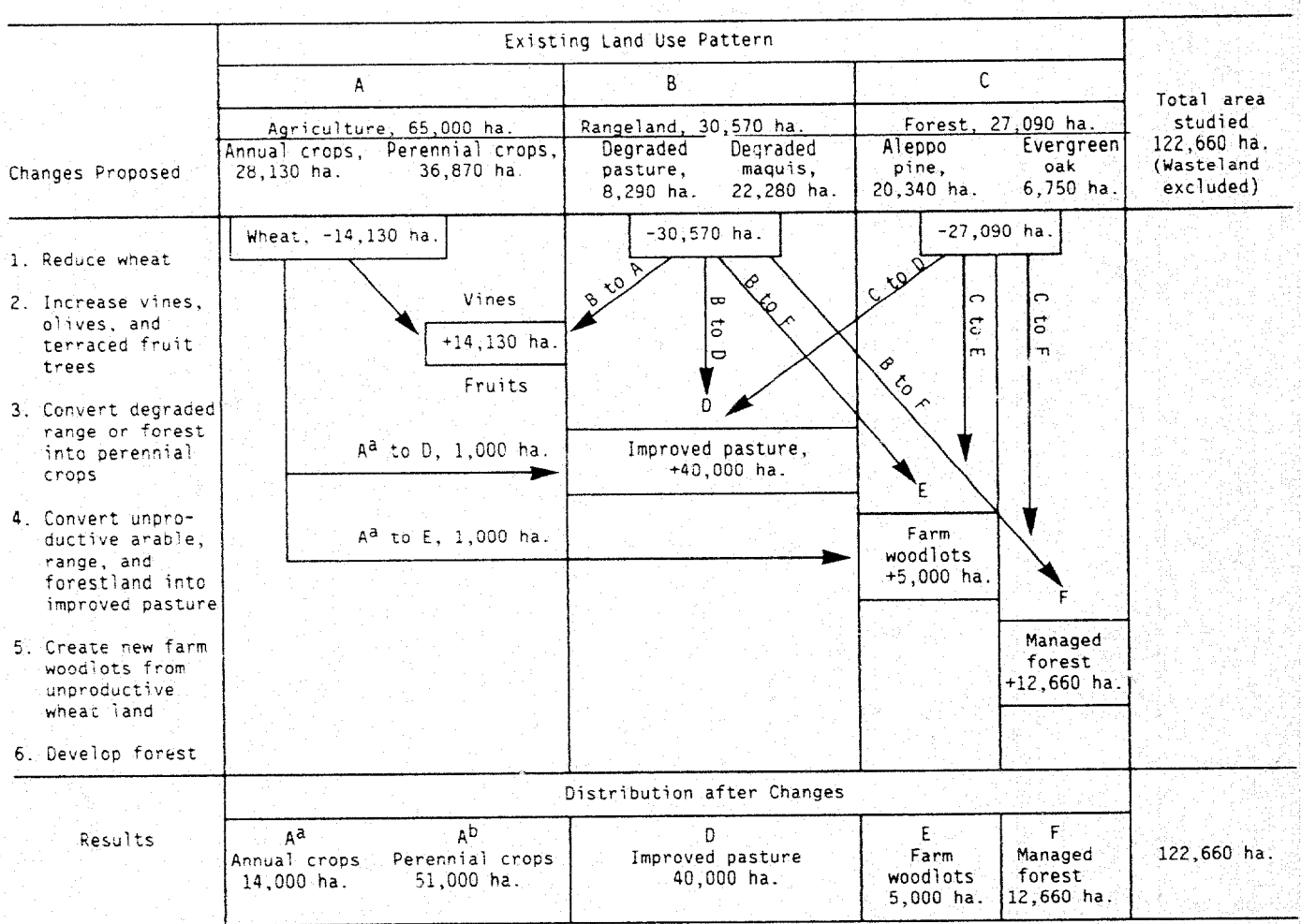
can be developed through drainage and impoundment in valleys and upland basins for fruits and vegetables, annual cash crops, and forage production, or for fast-growing trees such as poplars in wetter areas.

A combination of incentives and legislation may be needed to bring about the desired changes. For example, unrestricted range grazing might be prohibited in the high forests and in areas planned for new forest plantations, as was the case in Cyprus and Yugoslavia. But compensation for loss of grazing land might be paid and grants given for purchase of improved animals for tethering, for pasture improvement, and for fodder crop cultivation. Assistance may be provided for cooperative management of flocks and herds, for flock recording and improvement, and for marketing of dairy produce and meat or live animals, with appropriate price supports to discourage slaughter at excessively light weights and to provide incentives for fattening.

Technical and legislative measures would generally have to be accompanied by (1) the improvement of transport and communications; (2) the development of local market towns as poles for social activities, improved schooling and health services, and agricultural servicing and processing industries; and (3) where possible, the stimulation of tourism. The various works associated with forestation, terracing, torrent control, irrigation, drainage, transportation, and tourism can in themselves generate significant increases in income and employment.

Figure 5 shows the old and new land-use plans drawn up in 1965 for such an area in western Greece. These were not prepared with a view to making the area self-sufficient in food, but rather to develop sustainable land uses in mountain areas, increasing employment and living standards for low-income people and generating a marketable surplus of relatively high-value products, which might contribute both to exports and to import substitution. The improvement of productivity in mountain areas cannot provide an answer to the cereal deficits of the region, but it can contribute to the balance of payments, to the sustainability of agriculture in the plains, and to greater equity and social stability.

Figure 5--Mixed agricultural systems, foothill areas: potential for improvement through shifts in land use



Source: Food and Agriculture Organization of the United Nations and United Nations Special Fund, Economic Survey of the Western Peloponnesus, Greece (FAO/SF: 8GRE General Report, 1965).

Notes: Example is taken from actual land-use survey data in a typical coastal foothill area, southwestern Greece. It shows how conversion of 14,130 hectares of poor quality wheat land, 30,570 hectares of degraded pasture and scrub, and 27,090 hectares of degraded forest could be converted to provide an additional 12,130 hectares of vines, olives, and fruit; 40,000 hectares of improved pasture (=20,000 animal units); 5,000 hectares of farm woodlots for shelter, firewood, and timber; and 12,500 hectares of managed productive forest.

4. CONCLUSIONS

In summary, population growth and even more rapid income growth, accompanied by sweeping social change, have generated large increases in food consumption in West Asia and North Africa over the last 20 years, as well as shifting demand for food toward horticultural and livestock products as income elasticity for cereals has declined.

WANA is unique among developing regions in having a subtropical winter rainfall climate, with constraints on agriculture imposed by low and highly variable rainfall everywhere and by cold in the high elevation areas, which occupy almost half of its arable land. Compared with all other developing regions, it is critically short of new land and water resources for crops, especially for irrigated production, and while some technical progress has been made in raising productivity on existing land, this has not been sufficient to match the increasing demand for food. The reasons for this are complex and merit study by agricultural researchers and policymakers. Rising labor costs and a declining rural labor force are a further problem in a region of predominantly family farms. Government investment in agriculture and especially in research has generally been inadequate to accelerate technological change on the scale required to solve these problems: nor have price support or input subsidy policies, which are heavily oriented toward wheat, provided an incentive to the shifts in land use necessary to match the rising tide of demand for animal products, feedgrains, or noncereal, high-value foods.

The result has been an ever-widening gap between domestic supply and demand for food, which has been filled by imports. WANA is now the largest food importer of any developing region. Despite the economic recession of the 1980s, as the result of depressed oil revenues, the gap is projected to increase rapidly, with imports of feedgrains and livestock expanding much faster than imports of wheat and greatly exceeding them in value terms by the year 2000.

It is not apparent that the full implications of these trends are yet appreciated by policymakers in the region, who continue to give primacy to wheat. This is presumably because wheat is traditionally the staple of the diet, and they fear to jeopardize food security by shifting emphasis to other priorities. However, not only is demand for wheat leveling off (imports are projected to rise only 10 percent by the year 2000 if current growth rates of production can be maintained), but it is a much cheaper commodity on world markets than animal products for which demand is rising far more rapidly. Thus it would seem sensible economically and socially to try to keep imports of the latter

down through exploiting the production potential of the region for feedgrains (especially barley), for pasture, and for livestock, while allowing wheat imports to rise modestly.

This would not seriously threaten food security because only a small minority of countries in the region is more than 75 percent self-sufficient in production of cereals at present, and self-sufficiency is even lower for animal products. In the region as a whole, food security must continue to be achieved--as it is today--by traded imports paid for partly by agricultural exports, accompanied by sound purchasing and stock policies. Intraregional trade, based on complementarities for production within WANA, and financial and trade agreements between the countries of the region with a strong agricultural base and those that have other resources, offers opportunities not yet fully exploited.

If a more rational production and land use pattern is to be developed along lines that would maximize regional comparative advantages, some important measures must be implemented, with emphasis on the following:

1. Agroclimatic environments in the region must be characterized, with the primary aim of defining those best suited to diversified cropping systems, to barley-based farming systems (including component analysis), and to ruminant livestock rearing and fattening.

2. Constraints limiting optimum land use in each major agroecological environment must be identified and appropriate research and development policies must be formulated to overcome them. This might entail changes in pricing policies to stimulate livestock and feedgrain production, as well as investments in infrastructure and services. Particular attention needs to be paid to the high-elevation areas that seem to have underdeveloped potential for meeting demand for feedgrains and livestock.

3. A significant research program to increase wheat and pulse yields must be maintained, especially in high elevation areas. Agronomy should be combined with genetic improvement and accompanied by studies on fallow management and rotations with legumes and pastures.

4. High priority should be given to research on barley, the principal feedgrain, to develop stress-tolerant, fertilizer-responsive varieties suited both to semiarid areas with mild winters and to high elevation plains with cold winters.

5. Because variability in volume, rather than price, has been shown to be the primary cause of variability in food import costs, policies to decrease the high variability of domestic cereal production in WANA would help enhance food security. Breeding for yield stability of wheat and barley, concentrating production in areas of ecological suitability rather than distorting land use through price mechanisms,

monitoring sources of variability (whether due to climate, technology, or policies), maintaining adequate strategic stocks, and developing early warning systems would all contribute to this goal.

6. Socioeconomic studies of factors affecting adoption of improved practices in wheat- and barley-based production systems should be expanded in order to understand why yield growth has not improved more rapidly. These studies should include macropolicies (prices, subsidies, food aid, and research), reviews of government institutional effectiveness; farm-level analysis including issues related to labor availability and costs; and alternatives to fallow in rainfed cereal systems.

7. The results of these studies should be used to strengthen extension efforts to achieve higher adoption rates of improved varieties, fertilizer, herbicides, and agronomic practices on wheat, barley, livestock, and diversified farming systems, especially in areas of higher rainfall.

8. Research on crop-livestock integration and grazing management should be reinforced, especially in low-rainfall zones and in high elevation areas (both plateau and mountain topography). This should involve an interdisciplinary and holistic approach to policies for raising productivity of agricultural systems in the more difficult agro-ecological zones. Evaluation of the opportunities should focus on returns to the whole systems and not just on their effects on cereal production.

9. Socioeconomic and social potential of the dissected mountain areas should be reappraised as a basis for developing sustainable systems of agriculture there, based on commodities that earn high income, with supporting investments in infrastructure, marketing, and public services to improve standards of living in isolated areas and to promote tourism.

10. A regional market structure should be promoted that will draw on the complementarities and comparative advantages among the main agricultural countries of WANA to enhance food security and economic growth in the region through intraregional trade and finance agreements.

The two most crucial policy implications of these suggestions are, first, to give greater priority to feedgrains and livestock in research and incentive policies and somewhat less to wheat. And, second, to invest more rather than less in the agricultural sector, and especially in research, despite a declining rural population. After many years of technology-oriented research, there are still far too many unanswered questions concerning land use, the adoption of technology (or the lack of it), and what needs to be done to raise the growth of production. It is obviously important to halt the slowdown in growth of wheat production, and some concentration on areas of higher potential would

probably help to achieve this, but failing to increase the productivity of livestock (which implies principally feed and grazings) will be much more costly in the long run. This requires not only improved technology, but socioeconomic and policy research to provide the necessary effects.

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