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TECHNICAL APPENDICES

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RAINFED AGRICULTURE SUB-SECTOR STRATEGY

MOROCCO

Technical Appendices

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A. CROP AND LIVESTOCK PRODUCTION IN MOROCCO

I. General Adaptability for Crop Production

Morocco's climate is characterized by dry summers and mild rainy winters. The growing season, in the absence of irrigation, is the winter and early spring months. Because the growing season is cool, evaporation and plant transpiration are low. High temperatures, with hot searing winds occurring during the late spring and summer months, and lack of rainfall bring plant growth to a standstill. Consequently warm weather crops that flower and produce seeds after early May usually have low productivity, except in irrigated areas. Rainfall is most plentiful during the period October to April. There is little if any rainfall between June and October (Table A.1). Soils are usually quite shallow, and rock outcrops and broad expanses of stony land are common, thus they are quite droughty. Crops best adapted to Morocco are cool season species and those that are more drought tolerant. The more important crops adapted to the various rainfall zones are:

200 - 300 mm - barley, rye, broad beans.

300 - 400 mm - barley, durum wheat, broad beans, chickpeas, peas, rape, mustard.

400 - 600 mm - barley, durum wheat, bread wheat, broad beans, chickpeas, peas, bitter vetch, lentils, rape, mustard.

Over 600 mm - All the above plus maize, potatoes, alfalfa, dry beans and sugar beets.

II. Present Area in Cereals and Per Hectare Yields

Estimates of area and yields of durum and bread wheats and barley were made for the various rainfall zones based on Ministry of Agriculture data for 1979-80 and are as follows:

Rainfall Zone	Durum		Bread Wheat		Barley	
	1000 ha	qx/ha	1000 ha	qx/ha	1000 ha	qx/ha
200-300 mm	63.4	7.00	48.6	4.60	363.1	9.50
300-400 mm	410.5	9.05	140.5	6.76	958.3	8.56
400-600 mm	335.6	9.53	108.5	15.68	321.5	12.45
600+ mm	199.4	14.75	20.2	9.05	149.3	7.76
Total Rainfed	1008.9		517.8		1792.2	

The amount of cereals grown under irrigation is very small.

Table A.1 - LONG-TERM MEAN SEASONAL MONTHLY AND ANNUAL RAINFALL - MOROCCO

	Seasonal			Monthly mm												
	Oct. Nov.	Dec. Apr.	May Sept.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Tanger	244	561	82	118	102	112	85	35	15	1	2	25	108	136	144	887
Taza	154	443	72	81	93	86	70	42	8	7	4	15	62	92	113	669
Fes	135	348	67	54	64	68	69	37	14	2	1	13	51	84	93	550
Meknes	152	357	66	67	70	68	62	40	10	4	1	11	64	88	90	575
Rabat	148	326	49	62	62	65	44	30	9	0	1	9	54	94	93	523
Casablanca	111	261	33	52	46	48	38	21	6	0	0	6	42	69	77	405
Settat	109	249	31	53	47	49	37	18	5	0	1	7	45	64	63	389
Oued Zem	101	235	60	39	46	50	44	21	18	4	5	12	43	58	56	396
Safi	96	206	24	44	34	40	24	14	4	0	0	6	40	56	64	326
Marrakech	54	151	37	24	30	37	33	15	1	2	3	10	20	34	27	242
Oujda	66	197	78	38	36	36	46	37	13	2	5	21	33	33	47	341

Source: Tennessee Valley Authority, "Morocco - Role of Fertilizer in Agricultural Development," 1967.

The current GOM plans are emphasizing and increasing bread wheat production. There are at present about 683,000 ha of barley grown in the rainfall zones 400 mm and over. Any increase in the area of bread wheat should be directed to these zones by substituting wheat for barley, particularly on the deeper, better soils. Likewise, plans to increase overall cereal production should take into account that wheat is less adapted and yields less than barley in the less than 300 mm rainfall zone. For example, in Marrakech Province average yields per ha for the 2 year period 1979-80 and 1980-81 were 5.10 qx for durum wheat, 3.16 qx for bread wheat and 8.29 qx for barley. This Province is in the less than 300 mm zone. Thus the 268,000 ha of wheat presently planted in this zone could well be shifted to barley production. Shallow soils, even in somewhat higher rainfall areas, would better be planted to barley. As discussed later, the major increases in cereal production will need to come from reduction in fallow and higher yields.

Plans to increase oilseed production on rainfed land should take into account that warm season oilseeds such as sunflower, soybeans, castor bean and peanuts will have low productivity because of lack of moisture during their peak growing seasons. Only cool season oilseed crops such as rape, mustard and flax should be considered for planting on rainfed lands, and none should be planted in areas in which rainfall is below 300 mm.

Corn was produced on over 260,000 ha of rainfed land in both 1979-80 and 1980-81. Production and yields per ha in the various rainfall zones were as follows:

Rainfall Zone	Hectares		Yield (qx/ha)	
	1979-80	1980-81	1979-80	1980-81
200 - 300 mm	8,900	4,600	6.66	0.78
300 - 400 mm	247,800	234,300	6.37	2.35
400 - 600 mm	27,400	23,200	7.41	3.75
600+ mm	5,200	2,200	10.17	5.20

Surprisingly, most of the corn is produced in the driest (300-400 mm) zone. Per hectare yields are very low, with temperature the limiting factor when the corn plant is pollinating and moisture when it is producing seed. There appears to be little potential for increasing corn production. Consideration should be given to substituting cool season crops for corn.

Since climatic conditions are favorable for the production of a wide variety of crops at appropriate seasons on irrigated lands, plans for increasing production of warm season crops, such as maize, sunflower, soybeans, peanuts, castor beans and a variety of vegetable crops, should be directed to these areas.

III. Technical Constraints to Increasing Crop and Livestock Production

A. Improved Cereal Varieties

Efforts to introduce high yielding varieties (HYVs), particularly wheat, date back to the time of the Green Revolution. In the 1960s AID's strategy in Morocco emphasized a program to increase cereal production in rainfed areas which included the use of HYVs along with a fertilizer component. The report of Gayoso 1/ indicates that, by 1970, the program was on target and was expected to raise cereal production by 700,000 MT.

Comparisons of older, traditional varieties of bread and durum wheats and barley with newer HYVs have been made in variety x N fertilizer trials by several investigators and are summarized in Table A.2.

These data show the superiority of the HYVs of all three cereals over older varieties as well as the greater response of the HYVs to nitrogen fertilizer as compared to older varieties. Also, where HYVs of barley, and durum and bread wheats were included in the same tests at Khemis Zmamra and Sidi El Aydi, barley yields were much higher than the wheats, indicating that barley should be the preferred cereal in the 200-400 mm zone.

Hall also found that seeding rates for wheat in the range of 60-80 kg/ha could be safely recommended, resulting in a savings of 40-60 kg/ha relative to present rates of grain seeding.

To utilize the advantage of the potential yields of the HYVs they must be supplied with the necessary inputs, particularly fertilizer (in rainfall zones above 300 mm), and be accompanied by proper seedbed preparation and seeding methods and by adequate weed control. Both tillage and weed control should be directed to moisture conservation for the crop.

1/ A. Gayoso, "Agricultural Development Strategies in Morocco, 1957-70." USAID Report, 1970.

It is estimated that by 1980 twelve percent of the cereal seed used was that of HYVs; the rest was local seed. The low use of seed of HYVs is apparently due to an inadequate supply and poor distribution facilities of seeds, as well as to doubts of farmers about their superiority and to the lack of fertilizer.

Table A.2 - YIELD RESULTS OF SELECTED VARIETY X NITROGEN LEVEL TRIALS FOR DURUM, BREAD WHEAT, AND BARLEY IN MOROCCO

Species & Variety	Station: Merchouch 4/ Nitrogen Treatment (kg/ha) 0	80	Station: Sidi Kacem 4/ Nitrogen Treatment (kg/ha) 0	80
	(Yield, qx/ha)		(Yield, qx/ha)	
A. Bread Wheat (1972-73) 1/				
2306 (Old)	10.01	10.92	14.76	19.01
Potam (HYV)	12.67	15.51	14.51	24.68
	Station: Khemis Zmamra 4/		Station: Sidi El Aydi 4/	
B. Durum (1977-80) 2/				
2777 (Old)	14.3	18.3	13.2	13.7
Corcorit (HYV)	17.7	24.9	19.5	22.1
C. Uniform Fertilizer Treatment Trials 3/				
1. Barley				
Rabat (Old)	13.6		12.0	
13/75 (HYV)	22.2		24.4	
2. Durum				
Corcorit (HYV)	14.9		13.0	
3. Bread Wheat				
Potam (HYV)	13.9		16.7	

1/ W. E. Hall, Terminal Report: Agronomic Research in Morocco, 1968-73, CIMMYT and USAID/Rabat.

2/ M. Karrou, et al., "Resultats d'Essais sur Certaines Techniques de Production des Cereales en Zone Semi-Aride Marocaine." Seminaire sur l'Aridoculture, Settat, 1980.

3/ A. Ouassou, "Bilan des Travaux d'Amelioration des Cereales en Zones Aride et Semi-Aride." Seminaire sur l'Aridoculture, Settat, 1980.

4/ Merchouch and Sidi Kacem are in the 400-600 mm rainfall zone, and Khemis Zmamra and Sidi El Aydi are in the 300-400 mm rainfall zone.

B. Grain Legumes

Grain legumes (pulses) are an important food crop consumed locally as well as an export crop. About 37 percent of the production is exported annually, primarily to EEC countries. The area of the various grain legumes and the average per hectare yield in rainfed zones in 1979-80 were as follows:

Legumes	Area (100 ha)	Yield (qx/ha)
Horsebeans	139.4	6.66
Chickpeas	55.0	6.74
Dry peas	40.7	5.66
Lentils	35.7	4.31
Bitter vetch	18.5	3.50
Other	25.3	N/A
	314.6	

Over 70 percent of the total area in grain legumes is in rainfall zones of 400 mm and above.

C. Fallow

In 1979-80 there were an estimated 2.15 million ha of fallow, in 1978-79 the figure was 2.22 million ha, and the average for the years 1972-73 to 1971-78 was 1.79 million ha. It is estimated that 36.8 percent of the fallow occurs in areas of less than 300 mm rainfall and 23.5 percent in areas above 600 mm rainfall. Assuming that the area in fallow each year averages two million hectares, then the area in each rainfall zone would be:

Rainfall Zone	Area (100 ha)
Less than 300 mm	736
300 - 400 mm	472
400 - 600 mm	668
Above 600 mm	124

Fallow land represents about 37 percent of the rainfed cultivated land in the 200-400 mm rainfall zone; 34 percent in the 400-600 mm zone and 29 percent in the over 600 mm zone.

Thus a large area of land is not planted to crops each year, with the largest amount in the 200-400 mm rainfall zone. Here, since limited rainfall makes for greater risk in cereal and other crop production, and since there is need for feed for their livestock, farmers are prone to leave more of their land untilled and allowed to produce volunteer vegetation which

will provide some grazing at no expense or risk. Farmers are less likely to keep arable land out of crop production under more favorable rainfall, as indicated by the smaller fraction of area in fallow in the higher rainfall zones.

The term "fallow", as used in Morocco, is a misnomer since vegetation is not controlled during the dry period of the year to conserve moisture for the succeeding crop. Rather, the fallow consists of an annual crop of weeds and volunteer legumes and is grazed continuously by livestock. Where such heavily grazed areas are evident, the land is practically barren, even during the most favorable growing season (November to April) when forage should be abundant. Because of severe overgrazing, forage production is low. Lack of any vegetative cover subjects any land that is sloping to soil erosion, and all of the land to wind erosion during the dry season.

The pressure for livestock feed is great on all rainfed cropland areas. Practically no perennial forages are grown. From the time of cereal harvest until the next crop is planted livestock continuously graze the fields. Since most of the straw is removed when the grain is harvested, livestock are dependent upon what little straw stubble that is left and on volunteer broadleaf weeds and annual grasses for forage. Fallow land is utilized during the grain growing season for grazing. Harvested straw supplies the bulk of the forage fed during summer and fall.

Instead of a very unproductive crop of weeds from such land, a much larger amount of quality forage could be produced if this fallow land were planted to a forage crop which was properly managed, particularly in areas having 300 mm and more of rainfall.

D. Seed

Seed of HYVs is obtained by farmers from 64 seed distribution outlets of the parastatal company, SONACOS. Prices are fixed by the Government at 18 percent less than the imported price of similar cereals seed. An additional subsidy of 35 percent is given to cooperatives and one of 25 to 30 percent to farmers participating in the Government's "Operation Cereales". Other farmers can obtain cereal seed subsidies ranging from 10

and in 1981, 72,000 MT. In 1980 only 33,000 MT of the available improved seed was used, and 95 percent of that was in the rainfall zone of over 400 mm. This leaves nearly 90 percent of the total cereal seed coming from farmers' production, cooperatives or souks. Cooperatives do some treating of seed. If it is assumed that farmers should replenish their seed directly or indirectly every 5 years from certified stock, the present system is about one-third of needs (7 vs 20 percent of total seed planted). This is despite the SONACO capacity of 240,000 MT. The distribution system may be one of the factors. If, in fact, there are only 100 sales outlets, this would appear from experience in other countries to be grossly inadequate to serve the needs of most medium and small farmers, who generally lack transport. The problem would be even more serious for fertilizer use if a comparable distribution system is used. A network of 10,000 outlets for seed, fertilizer and pesticides would seem to be a minimum to serve small farmers.

E. Fertilizers

All fertilizers except phosphorus are imported and processed by a public enterprise, FERTIMA. Phosphorus is processed and distributed by Societe Cherifienne des Engrais (SCE). Until recently, farmgate prices exceeded border prices by about 30 percent for imported fertilizers due to indirect taxes. This was partly offset by subsidies paid to FERTIMA, SCE and farmers. More recently, indirect taxes on imported fertilizer have been removed, though subsidies to FERTIMA and SCE remain. With the worldwide increase in fertilizer prices, these subsidies range from about 20 percent for urea to about 43 percent for triple super phosphate.

Price relationships between fertilizer and grain are very favorable. For 1980-81 it took only 1.2 kg of wheat or 1.72 kg of barley or corn to buy a kg of nitrogen as shown in the following table.

Price Relationship Between Fertilizer & Grain

	Fertilizer per MT		kg of Grain to buy a kg of Nutrient	
	Per Product Ton	Per Nutrient Ton		
	1979-80		Wheat	Barley
	(.....dh/ton.....)			
Urea	790.90	1,719.4	1.27	1.72
Am. Nitrate	708.60	2,115.2	1.57	2.20
Potassium Chloride (61)	536.80	880.0	0.65	0.92
TSP (45)	533.40	1,185.3	0.88	1.23
SSP (18)	233.50	1,297.2	0.96	1.35
14-28-14	818.30	1,461.2	1.08	1.52

In 1979-80, it required 1.27 kg and 1.72 kg of wheat and corn, respectively, to pay for one kg of nitrogen. The price ratio has been even more favorable for P_2O_5 and K_2O. Mixed fertilizer, such as 14-28-14, is much more expensive, when it is considered that the need for K is not common, and the 14-28 ratio for N and P_2O_5 probably uses too little N relative to the P_2O_5. In marginal cost-marginal products terms, the 1980-81 fertilizer-grain price relationship means that fertilizer applications which yield at least an additional 1.2 kg wheat or 1.72 kg of barley or corn for each additional kg of nitrogen would cover costs of materials, ignoring delivery and application costs. A quick review of earlier USAID-sponsored agronomic research carried out by CIMMYT agronomists and others shows that responses much higher than this for both durum and bread wheat in rainfall zones of over 300 mm are very common for nitrogen applications of up to 40 kg per ha. Returns were typically in the range 8-20 kg of grain per kg of nitrogen. Insufficient information is available at this time regarding fertilizer applications on cereals in the areas where rainfall is less than 300 mm to recommend its general use in this area. Farm level fertilizer-grain price relationships in Morocco are much more favorable than in the United States. There it would take about 4.5 kg of wheat or 6 kg of corn to buy one kg of N or P_2O_5.

Mohamed, K., et al. 1/ conducted variety x N fertilizer experiments for a three-year period 1976-77 to 1978-79 at two

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2/ Mohamed, K., et al., "Resultats d'Essais sur Certaines Techniques de Production des Cereales en Zone Semi-Aride Marocaine," Seminaire sur l'Aridoculture, Settat, Morocco, 1980.

locations, Sidi El Aydi and Jemaa Shaim, in the 300-400 mm zone. From his data a comparison can be made of a traditional variety of durum wheat, No. 2777, and an HYV, Corcorit, fertilized with three levels of nitrogen. Results, in qx/ha, were as follows:

Location	Variety	kg N Applied			
		0	40	80	120
Sidi El Aydi	2777	13.2	12.1	13.7	14.5
	Corcorit	19.5	21.1	22.1	21.3
Jmaa Shaim	2777	14.3	16.0	18.3	16.7
	Corcorit	17.7	23.5	24.9	24.1

The HYV, Corcorit, was higher yielding than the old variety and had a greater response to N fertilization. Applications of 40 kg/ha of N increased yields of Corcorit by 1.6 qx/ha at Sidi El Aydi and by 5.8 qx/ha at Jmaa Shaim, with an additional increase of 1.0 and 1.4 qx/ha, respectively, at these locations when 80 kg of N was applied as compared to 40 kg of N/ha. With the 40 kg/ha application at Sidi El Aydi, 4 kg of durum was obtained for each kg of N applied, and at Jmaa Shaim the ratio was 14.5 kg of durum per kg of N. Improved seed and 40 kg of N per ha added 800-900 kg of durum for a ratio of 20:1 or more.

Moroccan researchers indicate that they feel they can safely recommend applications of 40 kg of N, along with appropriate amounts of P, on cereals in the 300-400 mm zone, with higher amounts recommended in rainfall zones above 400 mm, depending upon the crop rotation and soil.

The very favorable grain-fertilizer price relationship in Morocco is maintained by a combination of the very high price support for grain (near double the U.S. price) and government subsidies on fertilizer. Some analysts conclude that the subsidy on fertilizer has resulted in adverse production impacts such as:

1. Under-use of nitrogen relative to phosphate because nitrogen must be imported and supplies are closely controlled.

2. Use of P_2O where it is not needed because it is cheap and locally produced.

3 Various forms of non-price rationing are employed, especially of N, which favor larger over small farmers, irrigation perimeters over rainfed areas, and higher rainfall over lower rainfall areas.

4. Non-optimal use of available fertilizer.

F. Weed Control - Herbicides

Weeds are serious in many cereal fields, particularly wild oats in some areas where rainfall is above 400 mm. Commonly, weeds are pulled from the growing crop and fed to livestock. Weeds compete with the crop, particularly during the early stages of growth. When hand weeding is delayed until weeds are large enough to pull and provide sufficient bulk for livestock feed, crop yields already have been seriously affected. Weed control in crop fields should start with assurance that farmers obtain and plant clean, weed-free seed. Proper seedbed preparation and possible use of herbicides are other steps in controlling weeds. Little has been done to explore the potential of herbicides in arid and semi-arid zones. Use of herbicides, hand weeding and sweep tillage and mulch tillage methods should be researched to determine the most feasible combination of practices to use in controlling weeds.

G. Tillage and Seeding Methods

Present tillage practices are not conducive to moisture conservation or weed control. Deep plowing leaves the soil loose and subject to rapid depletion of moisture and buries crop residue that would otherwise help reduce moisture loss. Fertilizer, when used, is often broadcast before plowing, which gives the weeds an advantage over the crop in utilizing the fertilizer nutrients, particularly if seeding of the crop is delayed. Seeds are commonly broadcast after plowing and covered by use of a tandem off-set disk (cover crop).

Farmers with tractors may broadcast both seed and fertilizer with a fertilizer spreader or cyclone seeder and then incorporate them using a cover-crop. Thus, seed and fertilizer are commonly distributed at various depths in loose soil after fall rains have moistened the surface few inches of soil. Seeds which come in contact with moist soil germinate, but drying out can result in the heavy loss of seedlings. The broadcast seeding rate is high and replanting is costly. To reduce loss of seedlings from seeds left near or on the surface, seeding may be delayed until rains are more continuous but this usually is beyond the optimum date for best yields.

Better tillage methods, such as shallow seedbed preparation with tillage equipment such as sweeps, and proper methods of placement of seed and fertilizer are needed. These could result in moisture conservation, better weed control, substantial saving in quantities of seed used, improved stands, and

more efficient utilization of applied fertilizer by the plants, all of which will result in higher yields and lower costs.

H. Soil and Soil Testing

Soil surveys have been completed in some of the higher rainfall areas in the northern part of Morocco. Beyond this and the soil surveys in a few locations in Settat Province, little information is available on soils in the rainfed areas from which to estimate productive potential or to plan improved agricultural production programs. Support should be provided for completion of soils maps and land use capability mapping, beginning with areas used primarily for cropping and followed by mapping of lands primarily in range use.

The most reliable and efficient means of determining fertilizer need is soil testing. Soil testing in Morocco to date has been largely for physical structure and detailed chemical characters of samples. These analytical methods, used mainly for soil classification, are not adequate to estimate accurately fertilizer requirements or probable fertilizer response. Providing farmers with proper fertilizer recommendations requires that soil tests be correlated with crop yield responses obtained from field tests, conducted with a range of different fertilizer rates, over the range of soils that exist in the areas where a particular crop will be grown. Sound fertilizer recommendations require a substantial background of field trials conducted over a period of several years on different soil types.

Whether or not potassium should be included as a general fertilizer recommendation is still being debated. Several years of trials on corn, sugar beets, potatoes and onions (crops that normally require large amounts of K) conducted by Ministry of Agriculture scientists, showed that K fertilizer had no effect on yields of these crops. A response to K on cereals was not found in the limited research data available. Despite these results, average annual use of potassium on crops over the past five years, 1977-81, has been 38,000 tons of Muriate of Potassium having an import cost of about $8 million/year. Potassium is an element in the soil that can be readily determined with a soil test, and should not be applied where not needed. There are similar doubts about use of P on some crops and areas. An effective soil testing program is needed in Morocco to insure that farmers have the proper information on which to base decisions on the amounts and kinds of fertilizers to apply to avoid wasting their limited resources. Misuse of fertilizer by the farmer represents a loss to the economy, and with a substantial subsidy that loss

is proportionally higher. Thus the Society has an even higher stake than farmers in good soil maps, soil tests and soil fertility research.

I. Forage, Livestock and Range Production

Livestock production has long been a major economic activity in Morocco. When the French Protectorate was established in 1912, livestock production constituted the major source of income for most of the rural population. Frequent migrations and changes in occupancy of land were common. Under these uncertain circumstances, livestock ownership was a more stable investment, and livestock husbandry was more attractive than crop production.

Today, 70 percent of the population of Morocco is involved in livestock production and distribution of animal products. Nearly all agricultural units have some livestock, with sheep the most common species. Numbers and mix of species vary widely. A large percentage of the livestock is produced on the 8 million ha of the rainfed cropland area. It is estimated that livestock accounts for nearly one-half of the total value of agricultural output in the traditional sector.

The chief characteristic of the livestock industry is the large and growing animal population relative to feed supply. Numbers of sheep have more than doubled since 1930, while cattle and goats have increased by 67 and 68 percent, respectively, over the same period of time. Total stocking intensity increased by 84 percent between 1930 and 1974. Most animals are multipurpose. Most sheep flocks provide meat, wool and some milk, while goats provide meat, milk and mohair. Cattle are used for meat, milk and in some regions as draft animals. Specialized dairy cattle are kept mainly in most favorable areas such as irrigated areas near cities. Mixed herds of animals are seen in most flocks and herds. Improved European breeds are rare. Horses, donkeys and camels are used primarily for draft purposes but commonly find a final use as meat for human consumption.

Many years of mismanagement and overstocking have reduced forage production capacity on rangelands. It is estimated that the 12 million ha of semi-arid rangeland and 4 million ha of forest range is over-stocked by two to five times. This has resulted in the destruction of most of the native perennial grasses. Ironically, as the rangeland deteriorates, more animals are crowded on the cropland to offset the reduction in grains. The problem is compounded by increasing human population and the ever increasing demand and higher prices for meat and other animal products.

Forage for livestock is classified as coming from rangeland, fallowland, forests open to grazing and grazing on stubble and small amounts of cultivated forage. Nearly all of the rainfed region is used for grazing sometime during the year. Rangeland is generally too steep, dry and/or rocky to farm. Most forest land is owned and controlled, insofar as is feasible, by the Government. In contrast most of the rangeland is competitively grazed by many livestock owners with little or no control. Approximately 2 million ha of fallowland in the rainfed farming region are grazed. Livestock utilize crop residue and whatever weeds and other plants emerge.

Forage production on fallowland is understandably low because grasses and weeds are grazed so closely that they make little growth. Nevertheless, it is an important complement to other forage resources. The major grazing resource in the crop area is stubble, which is found on approximately 3.8 million ha. Livestock is placed on these fields following the crop harvest where they consume the crop residue as well as any weeds. The amount of stubble available is highly dependent on seasonal and yearly growing conditions.

Fields in rainfed areas are not sown specifically to forage crops to provide grazing. In the few instances where fields are planted to forages, the forage is cut and carried to the livestock. The failure to improve the forage supply, either by sowing improved species or better management is largely related to the system of tenure and land use which leaves little or no individual incentive for improvement or better management of the grazing land. Some efforts to stimulate group action where common interests coincide have been successful.

The traditional sector provides a precarious existence for livestock as well as man. In addition to facing extremes in climate, the farmer must contend with insufficient capital, land and technical understanding. Herds are much too large when compared to the ability of the land to produce forage. Wealth and prestige are measured in numbers of animals, with little attention being given to saleable increase in weight and meat products.

Lack of forage is the principal limiting factor to livestock production. The majority of the animals are undernourished. The increasing seriousness of the problem is indicated by the decline in the average carcass weight of sheep. When droughts occur, a lack of reserve forage forces farmers to sell at low prices or suffer a high rate of animal mortality. The 1980-81 drought resulted in usually heavy

losses, low prices and reduced reproduction rates in surviving animals.

Low livestock productivity is not due only to inadequate feed. Management also frequently is poor. Failure to castrate poor quality males makes breed improvement difficult. Disease prevention measures are seldom practiced.

Efforts aimed at getting livestock producers to reduce animal numbers have been ineffective. Because rainfall is unevenly distributed from year to year, producer strategy is one of security and risk avoidance. Size of flock or herd, not the condition of the animals, is the principal measure of success.

Morocco currently lacks the technical and administration capability to implement a program of research on forage and range production, improvement and management which is adequate to cope with this national problem. Past emphasis upon traditional European curricula has limited programs of forage and range education in both Hassan II and the Meknes Agricultural School. Lack of qualified personnel has restricted forage or range extension and supply of information to farmers and ranchers. Little research is directed at improving forage species for use on rainfed cropland or on ranges.

IV. Technical Elements of Increased Production

A. Improving Cereal Production

The yield potential of crops in the rainfed zones is much higher than at present. Achieving increased production of cereals, grain legumes, forages, and livestock will require that information, adapted to specific rainfall and soil conditions, be given to farmers as rapidly as research and experience warrants its release. Undoubtedly institutional and infrastructure adjustments will be needed to provide the technology and inputs required to maximize production.

On-farm increases in production can be achieved early with the extension and application of presently known technology to specific areas if the necessary inputs are made available. The potential for increasing yields of cereals for various rainfall zones are estimated herein utilizing the best known technology.

200-300 mm Rainfall Zone

Recommendations here at present are limited to the use of better tillage and seedbed preparation, timely seeding and

adequate weed control. Since barley is better adapted and more productive than wheat on the drier land, shifting some of the 63,400 ha of durum and 48,600 ha of bread wheats to barley would result in somewhat higher total cereal production. It is estimated that total cereal yields could be increased from present yields of about 4 to 5 qx/ha to 6 to 7 qx/ha by applying these practices.

By developing barley varieties better suited to this dry zone, and with the possibility that fertilizers may boost yields on the deeper, more water retentive soils, further increases in cereal yields might be expected in this zone.

300-400 mm Rainfall Zone

Research in this zone, as indicated previously, has shown that cereal yields can be increased substantially through the use of fertilizers and HYVs. Combining these practices with a package which would include: (1) better fertilizer placement and seeding, using grain fertilizer drills; (2) shallow and timely tillage methods with sweeps or stubble mulch tillage equipment to conserve moisture and provide firmer seedbeds; (3) adequate weed control by hand weeding or using herbicides; (4) use of clean seed and proper seed treatment to avoid spreading weed seeds and to control pests; (5) better crop rotations, including grain legumes and fully utilizing fallow land; and (6) proper grazing management where cereals, particularly barley, are grazed to minimize losses in cereal yields from untimely and excessive grazing, would materially increase total cereal yields. Present yields of 8 to 10 qx/ha might be increased to about 15 to 20 qx/ha in a typical year, by applying these practices.

Above 400 mm Rainfall Zone

Applying the same package of practices as listed above to cereal production in this zone, total cereal yields might be increased, in a typical year, from present yields of 10 to 15 qx/ha to 20 to 30 qx/ha.

B. Improving Grain Legume (Pulse) Yields

Moderate increases in grain legume yields can be expected with the use and proper placement of fertilizers, adequate plant populations (observations indicate wider row spacings than necessary for maximum yields), better tillage methods and timely planting. Increases from present yields of 4 to 6 qx/ha to 8 or 10 qx/ha should be possible with the application of these practices.

Breakthroughs have not been made in improving the yields of the various pulses. This is undoubtedly partly due to the low level of effort on selection, testing and breeding pulses. In recent years attention has been directed toward improving pulse production, and breeding programs are underway by international research organizations and others. An accelerated introduction and testing program with grain legumes should be carried on in Morocco and cooperative programs established with the international research organizations and others to rapidly screen and test varieties so they can be multiplied and released to farmers. Ultimately, development and distribution of improved varieties should result in further increased production of grain legumes.

C. Improving Forage Yields

Major improvements in forage production on farms will result from better utilization and management of land presently in fallow. Means of accomplishing this are outlined in the section which follows. However, in order to accomplish the latter as well as to expedite range improvement, adapted varieties of legumes and grasses must be made available, and a reliable source of seed established, whether by local seed production or importation.

As previously indicated, Morocco and other Mediterranean countries are where Medicagos (medics) originated, and many genotypes can be found in pastures, along roadsides, and in cultivated fields. Apparently, little is being done to utilize this rich source of germ plasm by identifying the better medic species and developing improved varieties. An expanded local selection and testing program should be initiated, as well as carrying out the collection and testing of medics and other annual legumes from other countries, particularly Australia and the United States. Both Australia and United States have made extensive collections of medics and clovers from the Mediterranean areas, have developed improved varieties of them, and are the main sources of seed. In initiating the program of forage production on fallow that is suggested, Morocco must rely on imported seed from these sources. However, a medic seed production program should be started immediately with the commercial seed available, later to be supplanted by production of seed from locally selected varieties.

Attention should also be given to selection and testing of oats, barley, rye, peas and vetch varieties to use as forage in rotations, and particularly to supplant some of the fallow. AID has sponsored a worldwide oat improvement project, carried on through the University of Wisconsin at Madison, and

a number of oats varieties have been noted for their forage producing characteristics. Some of these should be obtained and included in tests. Several woolypod vetch (Vicia dasycarypa) varieties have been selected and have been productive forages in California. Collections of these and other vetches and also forage pea varieties might be obtained from USDA through the USAID-USDA Cooperative Seed Program.

Observations and testing of perennial forage legumes and grasses should also be made, particularly in areas where rainfall is 400 mm and above. These should include legumes such as alfalfa, trefoils, and Onobrychis spps and such grasses as orchardgrass, tall fescue, hardinggrass, various species of wheatgrasses, ryegrasses, and possibly bromegrass. These perennial species, as well as the annual medics and clovers, can also be used in the range reseeding program if found to be adapted to certain sites.

D. Improving the Production on Fallow Land

Studies conducted in Mediterranean countries by Leeuwrik 3/ and Carter, 4/ together with experiences in Australia, have indicated the tremendous potential that exists for increasing forage and livestock production, as well as increasing cereal yields, by employing a cereal-forage legume rotation on presently fallow land. This involves the use of reseeding annual Medicago (medics) species and phosphate fertilizer, coupled with shallow tillage in preparing seedbeds and proper grazing management on present fallow land with a cereal crop in alternate years (one year wheat or barley and one year legume forage). Leeuwrik has estimated that if this rotation were followed in areas of over 300 mm annual rainfall, Morocco could realize an increase of 674,000 MT of wheat and barley, or 18.7 percent, above the total annual cereal production in the country in 1966-70 period (Table A.3). Estimates of additional stock carrying capacity from fallow lands managed in this manner in the various countries are shown in Table A.4. For Morocco an additional carrying capacity of 4,496,000 ewe equivalents is indicated. However, since livestock in Morocco

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3/ Leeuwrik, D.M., "The Relevance of Cereal-Pasture Rotation in the Middle East and North African Region." 3rd Regional Wheat Workshop, Tunis, April 28-May 2, 1975.

4/ Carter, E.D., "The Potential for Increasing Cereal and Livestock Production in Algeria, A Report Prepared for CIMMYT." International Maize and Wheat Improvement Center, Mexico 6, D. F. Mexico.

Table A.3. - ESTIMATES OF PRESENT FALLOW LANDS TO BE BROUGHT UNDER ANNUAL LEGUME PASTURES AND ESTIMATED BENEFITS IN TERMS OF N ADDED AND ADDITIONAL CROP YIELD

Country	Land under dryland wheat barley and lentils (av. 1966-70) '000 ha	Estimates of fallow to be sown to pasture '000 ha	Nitrogen added to soil by legume pasture 1/ tons	Additional cereals production 2/ tons	Average Production of wheat plus barley 1966-70 4/ tons	Percentage of increase in cereal production over 1966-70 av. %
Jordan	277 3/	83	4,980	49,800	152,000	32.8
Syria	1,787	536	32,160	321,600	1,200,000	26.8
Lebanon	62	19	1,140	11,400	65,000	17.5
Morocco	3,746	1,124	67,440	674,400	3,615,000	18.7
Algeria	2,635	791	47,460	474,600	1,647,000	28.8
Tunisia	1,140	342	20,520	205,200	472,000	43.3
Total	9,647	2,895	173,700	1,737,000	7,151,000	24.3

1/ It is assumed that nitrogen is added at an average of 60 kg N per ha per year.

2/ An average 10:1 conversion ratio of grain to nitrogen is assumed. The actual production depends on management and other factors and is likely to be somewhat less.

3/ Calculated from FAO Production Yearbook.

4/ Includes production from high rainfall and marginal areas. Particularly if proportion of crops grown in marginal areas is high, this may lead to over-estimation of the percentage increases.

Table A.4 - ESTIMATES OF POTENTIAL AREAS OF ANNUAL LEGUME PASTURE, ADDITIONAL DRY MATTER PRODUCED AND ADDITIONAL STOCK CARRYING CAPACITY

Country	Fallow lands sown to pasture ('000 ha)	Additional 1/ dry matter produced ('000 tons)	Additional 2/ sheep carried ('000 head)
Jordan	83	332	332
Syria	536	2,144	2,144
Lebanon	19	76	76
Morocco	1,124	4,496	4,496
Algeria	791	3,164	3,164
Tunisia	342	1,368	1,368
Total	2,895	11,580	11,580

1/ Assumes an average annual additional production of 4,000 kg D.M./ha (9).

2/ Assumes that, with proper management, 1 ton D.M. will maintain 1 ewe equivalent for a year (9).

are presently undernourished, rather than any increase in numbers, the increased forage from such an improved system should be used to improve nutrition for existing animals and thereby substantially increase the off-take of animal products per animal unit.

E. Strategy for Future Use of Present Fallow Land in Morocco

In the 200-300 mm Zone - 736,000 ha

In the Mediterranean region most observers believe that a cereal-medic rotation is best suited to the zone receiving 300 to 500 mm of rain annually and at elevations not to exceed 600 meters. In this zone, then, research should be conducted to determine: (1) whether or not medics can be extended; (2) if other suitable forages can be discovered for use here; and (3) what other practices should be investigated to best utilize fallow lands. Controlled grazing would appear to afford an opportunity for obtaining greater production of vegetation from fallow in this area.

In the 300-400 mm Zone - 472,000 ha

Great impact can be made on improving the production of fallow lands in this zone, particularly on the deeper, more moisture retentive soils. Volunteer stands of medics occur in many fallow, and cereal fields, particularly on deeper soils in the 350-400 mm rainfall zone where tillage has not been deep. Where substantial numbers of medic plants exist (40 to 60 plants per M^2) on fallow, they should be given a chance to reseed. The seedbed should then be prepared for wheat or barley with shallow tillage (preferably using sweeps or light discing with a covercrop). After wheat harvest, 40-50 kg/ha of P_2O_5 should be spread on the cereal stubble when the first autumn rains fall. If the fallow or wheat land has not visible signs of medics in it, then the last should be prepared (tilled only 8-10 cm deep) with the first autumn rains and medics seeded. Until local selections of various species of medics become available, seed from Australia can be used. Early maturing varieties have been developed in Australia, and these are particularly well adapted to low rainfall areas. Suggested medics for sowing in this zone are Ghor, Harbinger and Hemallong, barrel medics cultivars of *Medicago Truncatula*. These can be seeded (1 to 3 cm deep) in a mixture of 2-3 kg of each of the three varieties (total of 6-9 kg/ha) per ha. Good stands are possible with 5-6 kg/ha of seed with good seedbed preparation and seeding methods. Rose Clover, *Trifolium Hirtum*, is another species that could be included in this mixture. This species has been used in seeding mixture in

California under similar conditions to this zone in Morocco. This species survives harsh conditions of poor, rocky soils and low rainfall and is usually a good forerunner to other legumes on low fertility soils. Seed of the variety Wilton is available from California and that of Olympus, Hykon and Kondinin varieties from Australia.

Grazing management is important to insure maximum forage production and reseeding of the medics. Grazing or mowing should not be below a height of 8-10 cm during the growing period. To insure maximum seed set, grazing of new medic and clover stands during flowering and seed pod formation should be reduced. However, if the medic is suffering from severe competition by taller growing weed species, then there must be a compromise and the medic moved, or grazed rapidly at a height no less than 10 cm. During the dry-pod stage, grazing must again be a compromise between reasonable utilization of dry feed and ensuring an adequate carry-over of hard seed. Before planting wheat in the next crop season, the medic is grazed or cut close to the ground. In preparing the land for wheat, tillage should be shallow (8 to 10 cm deep) to avoid burying the medic seed too deep. After the wheat is harvested the straw should be removed, or the stubble grazed closely during the summer and early autumn. Otherwise the stubble will insulate the soil from the wide temperature fluctuations needed to break the dormancy (due to the hard seed coat) of the medic seed present in the soil. With the first autumn rains phosphorous (40 to 50 kg/ha of P_2O_5 or 200-250 kg/ha of single super phosphate) should be spread on the wheat stubble. This application stimulates the rapid growth of the legumes and enables them to overshadow most weeds.

Since medics do not produce early season (October-January) forage, part of the fallow might well be planted to a barley (or oats or rye) and pea or vetch mixture which will supply more forage during this period.

With an estimated increase of 4,000 kg of dry matter per ha on 472,000 ha, 1,888,000 metric tons of forage dry matter would be produced which would support 1,888,000 ewe equivalents annually if this system were applied to all of the fallow land in this zone. In addition, a soil N increase of an estimated 60 kg/ha per year from the legumes would result in an increased yield of about 0.6 MT/ha of cereal or 283,200 MT in total.

<u>In the 400-600 mm Zone - 668,000 ha</u>

Using similar cereal-forage legume rotations and following the same tillage, seeding, grazing and harvesting methods

as for the 300 mm rainfall zone, it is estimated that an increase of 6,000 kg/ha/year of forage dry matter could be produced. On the 668,000 ha of fallow in this zone this would amount to an increase of 4,008,000 MT of forage dry matter which would support an additional 4,008,000 ewe equivalents. In addition, it is estimated that, with an increase in soil N of 60 kg/ha provided by the legumes, an additional yield of 1 MT per ha of cereal would result in this higher rainfall area (or 668,000 MT for the zone).

An alternative in some of the higher rainfall (500-600 mm) areas in this zone is to use a barley (or oats or rye) and peas or barley and vetch mixture on the fallow land. Yields of forage dry matter might be increased by 7,000 kg/ha. However, this would require seedbed preparation and seeding as well as increased costs for seed each year.

On some of the deeper soils where rainfall is 600 mm annually, mixtures of perennial legumes and grasses might be used on the fallow land. Alfalfa varieties have been developed for dryland areas and these could well be tested under these conditions, along with perennial grasses such as tall fescue, bromegrass and orchardgrass. Yields of 8,000 to 10,000 kg of dry matter per ha annually should be possible, and stands should last for at least 3 or 4 years.

In the 600 mm and Higher Rainfall Zone - 124,000 ha

The 124,000 ha of fallow land in this zone could best be managed in a barley-pea or barley-vetch forage system or planted to alfalfa. Estimated increase in dry matter production is 8,000 kg/ha annually. This would provide an increase of 992,000 MT which would support an additional 992,000 ewe equivalent. Increased per hectare yields of cereal of 1,200 kg from the 60 kg of expected increase in N in the soil would result in 148,000 MT more annually.

F. Improving Productivity of Rangeland

Centuries of overgrazing and other abusive grazing practices have driven forage production on most of the rangelands far below their economic potential in both quantity and quality of forage produced. As a consequence, the quantity and quality of livestock products produced on the rangelands are much below the potential productive capacity of the breeding stock. Controlling the use of rangelands to prevent overstocking and overgrazing is a prime requirement for rangeland improvement. Past AID and other agencies' range management projects have encountered difficulty in achieving their goals because the

social and economic needs and cultural constraints of the herders and farmers were not well understood or were ignored. The range management project recently inaugurated by USAID in Morocco is taking this into account by making a careful social analysis of the range-users with a view to obtaining their participation in organizing grazing associations and in managing the grazing on the range. Some of the past work indicates that such an organization can be effectively employed.

The prime objective of this project is to conduct an extension and demonstration program to improve range vegetative conditions in a semi-arid 100-350 mm rainfall zone. This is to be brought about by some reseeding and by the introduction and implementation of range management concepts and practices. Forage species evaluation and seed production will be an integral part of the program also. This appears to be a logical approach to solving the problem of range deterioration and should demonstrate how to improve rangeland, providing the socio-economic aspects can be brought into balance with the available technology. The participation of the local livestock raisers is essential to the success of the project.

There are two main groups of livestock producers, cereal farmers who own small flocks of sheep and goats as a secondary enterprise and herders, usually with larger, more mobile herds, who may cultivate some cereals. Some of the former, the sedentary group located in the main cereal growing areas, may graze surrounding rangelands. In some cases they purchase feeder animals to fatten on available forage or crop residues. There is a definite linkage between range and cropland. Likewise there is a tie-up between forestry and livestock production since animals graze substantial forestry areas in the country. This inter-relationship requires that the cropland, range and forestry programs be coordinated and cooperation promoted wherever possible. One of the areas where such cooperation should be encouraged is in forage seed evaluation and production, since many of the species used will be similar on both cropland and range. Some such complementarity also exists between forest land forages and forages suited to range and croplands.

V. Research Needs

Considerable research on crops, soil fertility and livestock has been carried out over the years in Morocco. There apparently has been a lack of continuity in much of the work. Nevertheless, there no doubt is a mass of information that, if collected, could be of value in formulating recommendations and planning future research. Priority should be given to

providing financial and technical assistance for assembling and summarizing this backlog of research information. Perhaps one to two years of local professional input with some technical assistance would be required to complete the task. This might be suitable work for a graduate student's thesis with senior professional guidance.

The most urgent research needs to facilitate an expanded rainfed cereal, food and forage legume, and livestock and range management program are as follows:

A. National Research Program

The national research program, while emphasizing practical farming systems, should:

1. Develop strong integrated comprehensive national introduction, breeding and testing programs in barley, durum and bread wheats.

2. Collect and evaluate annual legumes, particularly medicagos, from local farms as well as worldwide and carry on a continuous selection program to determine the best cultivars for use in a forage program for the various soils in the different rainfall zones and in rangelands.

3. Collect and evaluate perennial grasses and legumes as part of long-term rotations on crop-livestock farms below 10 ha and in rangelands.

4. Collect and evaluate grain legumes varieties from local and worldwide sources.

5. Plan and develop, with researchers in the different rainfall zones, variety evaluation procedures and trials with cereals, forages and grain legumes and coordinate them nationally.

6. Develop a national program of fertilizer trials, assist researchers in the various rainfall zones in planning and organizing field fertilizer trials, and correlate results of trials with soil tests. Relate results to soil maps for extension.

7. Conduct foundation seed production programs for cereals, grain legumes, annual and perennial forages, and develop certified seed production and distribution capacity.

8. Conduct forage-livestock research to:

   a. develop appropriate forage management practices for production and harvesting to maximize feeding and forage nutritional value.

   b. develop storage, grazing, and feeding practices to maximize livestock product per hectare of forage produced.

9. Improve livestock herds and flocks for sedentary and for migratory operations.

10. Screen and research herbicides and pesticides for use in crop production.

11. Research suitable tillage, seeding and fertilizer placement equipment, field test and develop prototypes which can be turned over to industry for manufacture and distribution.

12. Accelerate soil survey and land capacity mapping to aid in individual farm planning and development program planning and extension.

13. Accelerate range management research, including grazing management, range reseeding techniques, species evaluation, seed production technology, and sociological studies to determine how best to enlist herders in properly managing ranges.

14. Conduct studies of factors motivating farmers to adopt yield increasing technology, establish criteria for suitable packages, and conduct experiments in which various approaches for overcoming major constraints are tested.

B. Applied Research in the Province

Research of all types is lacking in the rainfall zone below 300 mm. In general, insufficient information is available to enable extension workers to advise farmers regarding the use of fertilizers. Information is needed to determine whether or not N, P and K singly or in combination can be economically used and if so under what circumstances. Suitable varieties of different crops have not been developed or sufficiency tested in this drier zone for release to farmers. However, since barley is better adapted to drier areas than

wheats, efforts in this zone should be concentrated on developing drought tolerant and higher yielding barley varieties, and farmers can be advised to concentrate on barley rather than wheat.

The main recommendations about which researchers feel fairly confident are better tillage, planting as soon as rains arrive, moisture conservation and weed control. Farm level testing is needed on fertilizers and varieties when these practices are being tried. In other rainfall zones the following research is needed to accelerate increasing agricultural production on the rainfed cropland. Major emphasis should be in the 300-400 mm zone.

1. Variety trials of barley, durum and bread wheats to determine the best varieties, as well as which of these three cereals is most productive on specific soils.

2. Fertilizer trials with cereals, grain legumes and forages to determine the need for, and optimum and economic rates of, N, P and K, as well as minor elements on various soil types. Correlate these with soil tests.

3. Variety trials of grain legumes, annual forage legumes and grains (oats and barley).

4. Adaptability trials of rape and mustard for oilseed production.

5. Crop rotation experiments, including cereal-fallow, cereal-medic, cereal-grain legume sequences compared with continuous cereal culture.

6. Grazing management studies on forage mixtures where cereal-medic or cereal-oats or barley and pea or vetch mixtures replace fallow. Also studies of the feasibility and economics of cut-and-carry forage mixtures to confined livestock.

7. Studies of weed control methods.

8. Studies of tillage and seeding methods on various soils and testing of equipment developed specifically for this purpose.

Many of these lines of research are presently underway. Where such is the case, efforts should be intensified and

plans made for continuity of research over future years. New lines of research outlined herein should be initiated as soon as possible with USAID support given. This should include supplying U.S. technicians and training for Moroccan scientists who will run the on-going as well as new research. It should also include equipment and support of some local operating costs. Consideration should be given to supplying U.S. scientists in (1) forage production and management; (2) small animal livestock production and management; (3) seed technology; (4) soil survey and land capability interpretation; (5) weed science; (6) agricultural machinery and equipment design, testing and development; and (7) economics and sociology. These are in addition to continuation of the scientists now working on research related to crop, range and livestock production in rainfed areas.

B. MAJOR FOOD PRODUCTION, PRICE AND SUPPLY POLICIES

I. General Consumer Policy

Many of the current price policies date back at least to 1936-37. At about that time OCIC, the predecessor of ONICL (Office National Interprofessionel des Cereales et des Legumineuses), was established to promote cereal and grain legume production, trade and consumption. More or less continuously since then policies have been devoted to provision of what were considered adequate price levels to (1) stimulate production and (2) food supply and price stabilization to insure adequate supplies to consumers. Often these two farmer and consumer policies have conflicted. To reduce the conflict between consumers' objective of holding prices down and providing ample supplies and, at the same time, stimulating production, the Government has resorted to a wide range of subsidies on production inputs and on various foods and has financed liberal food imports.

II. Consumer Price and Supply Policies

As might be expected, these policies have come to have an inflation control and equity objectives, with the former sometimes run as a way of accomplishing the latter. Thus, for example, bread wheat flour is now heavily subsidized and prices have been held fairly stable despite general inflation. The impact, not unexpectedly, is a shift from other foods to bread wheat flour by urban and, recently, even rural consumers.

Prices of flour and other grain products produced in traditional mills are based on the local cost of indigenous grain and a small milling charge. However, flour produced in larger commercial operations is controlled and subsidized by the Government, whether from local or imported grain. The total subsidy for "commercial" grain operations has been about 1,000 million dirhams[1/] annually for the past years.

Imported flour is moved to consumers with all costs of receiving, transport, milling, storage, etc., borne by the Government. This is estimated at about DH 375/mt. In addition, millers and bakers may be subsidized for lower value products directed to the "masses". Wheat procured internally is subsidized to bring costs down to equality with imported wheat. Since imported wheat costs are equalized internally, at all points, to CIF cost, this in effect makes imported

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1/ The exchange rate has been in the range $1.00 = DH 5.50-DH 5.70 in recent months.

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wheat available to consumers (including producing families) in the interior at about 60 percent of the local support price ($160 vs. $270/mt). It makes imported bread wheat cheaper than unhulled and unmilled barley.

Clearly this must create a stimulus for farmers to look to other means than production to meet their own family wheat needs and for other consumers to take Government flour, rather than wheat or barley from the local market. The real consequences are not measurable and in fact may not yet be fully felt since this more serious distortion has occurred so recently.

One would hypothesize that interior consumers would buy more Government wheat flour, and farmers would look for other more profitable enterprises than grain. If they produce grain they would find it profitable to sell to the Government and buy Government cereal commodities. This would of course be restricted by available Government supplies and perceived quality differences.2/

However, the effects of a variety of policies over 50 years has been to shift away from barley as a food to bread wheat, which formerly was in surplus but has been imported in rapidly growing amounts in the last two decades.

Other commodities, most notably dairy products, sugar and vegetable oil, have been subject to similar consumer subsidies and production distortions.

The Government has undertaken an expensive public program to reduce dependence on sugar imports, and in two decades has increased domestic production from 0 to 60 percent of consumption. Lower cost options than large, highly modern technology might have been selected, but this might have conflicted with internal consumer price policy. Village based sugar production, using simple low cost equipment, is widely used in other developing countries.

Recently the Government launched a major program to increase production of dairy products. Many milk collection and processing plants have been established. The production response has been very favorable. Good local cheese products now are available and imports restricted. But butter imports still are about 25,000 mt/year and non-fat dried milk is still imported.

2/ The official market structure and costs are discussed briefly in Section III.

Recently vegetable oil consumption has been growing very rapidly, based almost totally on imported oil and oilseeds. Production of olive oil, the traditional oil used, has been stagnant, even declining. New trees are not being planted and old trees reported to be poorly cared for. This despite a large area best suited to olive oil production. Local competition from cheap imported oils and the uncertainty of access to the EEC have tended to discourage production of olives for oil.

Policies and programs to stimulate production of oilseeds to fill part of the growing vegetable oil deficit have been very modest in scale despite the belief by analysts that oilseeds, particularly cold season oilseeds, would fit well into an improved cropping system for rainfed areas.

III. Grain Price Structure

A. Background

The flour milling association which became OCIC and later ONICL was created in 1937. The objective was to organize production, regulate sales, use supplies, and support prices. Prices were, and are, based on cost of living, wages, cost of inputs, storage costs and cost of production. OCIC also regulated seed wheat and its subsidies.

A detailed analysis was made in 1966 of the price structure for flour. This analysis is interesting in that it shows the nature of the price structure almost mid-way between the initiation of the current policy structure and the present. It also marked the start of a major effort by AID similar in many ways to what is being proposed now.3/

Table B.1 shows the results of that analysis. Consumer subsidies going to millers varied over the seasons reaching 25 percent of the flour price in June. (They currently are somewhat higher.) Bran (21 percent of the total) was billed at only DH 12.5/qx, while barley was supported at DH 27/qx. The feed value of bran is only slightly lower than for barley. The net energy is about 10 percent lower, but protein content is 15-20 percent higher.

3/ F. L. Corty. "Cereal Production and Marketing Procedures on Morocco." USAID, April 1967.

Table B.1 -- STRUCTURE OF FIXED PRICE FOR FLOUR BASED ON ONE QUINTAL OF BLE TENDRE (BEGINNING JULY 1966 AND FOR SELECTED MONTHS THEREAFTER)

		July	October	January	April	June
1.	Dealer pays producer (of which 0.70 is withheld and paid as tax to OCIC)	40.00	40.00	40.00	40.00	40.00
2.	Handling and storage fee charged by OCIC	.55	2.20	3.85	5.50	6.60
3.	Total cost to dealer	40.55	42.20	43.85	45.50	46.60
4.	Dealer margin	1.00	1.00	1.00	1.00	1.00
5.	Cost of grain to miller	41.55	43.20	44.85	46.50	47.60
6.	Transport cost of wheat to mill	.70	.70	.70	.70	.70
7.	Transport cost of flour from mill	.70	.70	.70	.70	.70
8.	Storage of flour	.125	.125	.125	.125	.125
9.	Total cost of flour to mill	43.075	44.725	46.375	48.025	49.125
10.	Less value 21 kg. of bran	2.625	2.625	2.625	2.625	2.625
11.	Net cost to miller (77 kg. of flour)	40.45	42.10	43.75	45.40	46.50
12.	Milling margin	6.00	6.00	6.00	6.00	6.00
13.	Amount miller must receive (77 kg. of flour)	46.45	48.10	49.75	51.40	52.50
14.	Converted to 100 kg. of flour	60.32	62.47	64.61	66.75	68.18
15.	Fixed wholesale price of flour	56.30	56.30	56.30	56.30	56.30
16.	Amount OCIC reimburses miller per quintal	4.02	6.17	8.31	10.45	11.88

As of 1966 ceiling prices of flour had been held constant since 1952. Bread flour was DH 0.563/kg wholesale and DH 0.65 retail. Corresponding prices for durum flour were DH 0.58 and DH 0.65, respectively. An 800 gram loaf of bread (Bordelais) was DH 0.46 (DH 0.570/kg).

In June 1966, there was an average gain of DH 150/mt ton on U.S. imported wheat between port and sale price to the miller, of which over DH 80 was profit to the equalization fund allocations and DH 60 went for storage.

OCIC was estimated to gain DH 140/mt from imports to support other operations (including storage operations).

B. Current Cereals Marketing Structure and Costs

The ONICL currently can be defined as a commodity stabilization board which serves as a contractor for government importation. It has the monopoly on all the imports of cereals and pulses.

It receives advice and direction from the Ministry of Agriculture regarding its operation and management, while the Minister of Finance maintains control of its financial operation.

The ONICL is administered by an interprofessional council consisting, on the one hand, of representatives of the administration (Agriculture, Interior, Finance, Commerce) and, on the other hand, of delegates of all activities classified as interprofessional: producers, dealers, cooperatives, industrial users, and consumers.

The ONICL has the responsibility to manage cereals distribution in each province and maintain prices equal to the GOM support price. It controls about 10 percent of the grain production that enters the commercial channel plus all imported cereals. It operates through licensed cereals dealers, the industrial millers, the office of transport, and in crisis time, the local authority is also involved.

Cereals availability and distribution in each province is inspected daily by ONICL local representatives. In case of shortage instructions are given by the ONICL headquarters in Rabat to move cereals from surplus existing in an area or from imported wheat stocks to provinces where a shortage starts to appear. Through this movement prices are stabilized.

Price stabilization involves three major subsidies to the consumer:

1. The cost of port handling and temporary storage.

2. The cost of the transport to internal centers for final consumption.

3. The cost of the storage at the terminal elevators prior to consumption.

1. The Cost of Port Handling and Temporary Storage

The ONICL absorbs the cost of all seaport operations such as unloading, temporary storage, transport inside the seaport, etc. For the last two years this subsidy, by far the most important, was evaluated by the Agriculture Ministry at about DH 300 per metric ton.

2. The Cost of the Transport to Internal Centers for Final Consumption

The transportation costs of the major cereals (bread wheat, durum wheat and barley) entering commercial channel or imported, are entirely absorbed by ONICL. The goal of this subsidy, estimated by the Ministry of Agriculture to be about DH 30/mt annually, is to have the same price for wheat and flour all over the country.

The cereals' transportation is either done by the transport office, the railway company, the industrial millers or the cereals' cooperatives.

Approximately 20,000 miles of paved road link all the cities in Morocco, and the major cities such as Oujda, Fes, Meknes, Kenitra, Rabat, Casablanca, Safi and Marrakech are linked by a modern railroad system (around 1,100 miles).

Morocco is also served by ten seaports among which four are used to unload the imported cereals. Casablanca seaport is by far the largest one with a cereals unloading capacity of 17,000 mt/day.

3. The Cost of Storage

This third cost is also absorbed by ONICL for the benefit of the Moroccan consumer. It is estimated by the Ministry of Agriculture to be around DH 40/mt per year.

It covers the cost of the seaport storage facilities and the storage cost at the terminal elevators, warehouses, storage facilities of the millers and those of private licensed dealers.

The farmer does not get any allowance to cover use of his storage facility. The average farm storage facility is very limited, usually an underground chamber or a small warehouse that can hold a maximum of 10 mt of wheat.

The small dealers have no storage, usually own a truck and buy in small quantities at the weekly souks and sell to the legitimate dealers, more commonly called "Collectors".

The collectors have very limited storage facilities, usually in small villages or near a souk. They collect the grains from different souks of the area, and they sell them to the licensed dealers. Like farmers, most collectors have no official incentive to store. A few well-organized collectors do get a payment for storage.

Most licensed dealers and millers have good storage facilities to store grains for a short period (2 to 4 weeks). The cost of this storage is totally absorbed by ONICL.

The largest cereal storage facilities in Morocco are owned by the cereals cooperatives (CMA and SCAM) and some private dealers.

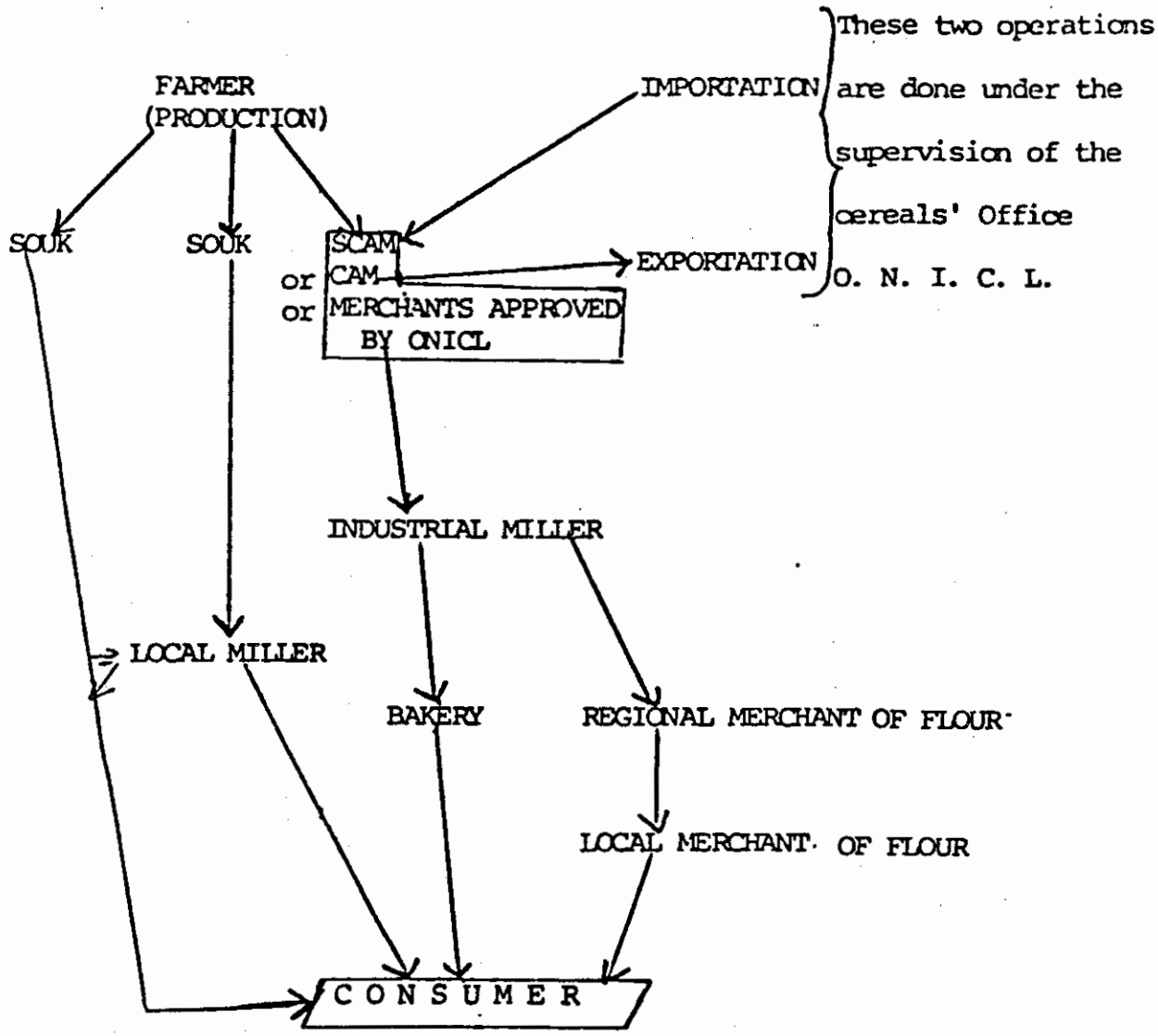
These two last categories play the largest role in this business. They own most of the grain purchasing, storage, and handling facilities in Morocco. Their terminal elevators and their large warehouses are located in the major cities where the milling industry is concentrated. They handle both domestic and imported grains. They generally are equipped to handle bulk as well as bagged grain by rail or trucks. The ONICL absorbs all the storage cost of the cooperatives, the millers, and the legitimate dealers, but does not own directly any grain handling facilities. The allowance is considered quite attractive.

Table B.2 -- STORAGE CAPACITY

	Cooperatives		Dealers and Millers		Total
	Silos	Warehouses	Silos	Warehouses	Capacity
Casablanca	104,000 mt	80,000 mt	38,000 mt	94,800 mt	316,800 mt
Safi	24,000	36,000	-	30,000	90,000
Meknes	24,400	8,500	-	86,000	118,900
Marrakech	17,000	13,000	-	27,000	57,000
Fes	16,000	64,500	-	36,000	116,500
Oujda	10,800	13,700	-	27,000	51,500
Kenitra	17,000	34,000	-	220,000	271,000
Rabat	10,800	22,000	-	13,000	45,800
Agadir	4,000	12,500	-	-	16,500
Taza	3,300	7,000	-	7,200	17,500
Oued Zem	-	28,000	-	41,000	69,000
El Jadida	-	23,000	-	28,000	51,000
Tetouan	-	3,000	-	-	3,000
Essaouira	-	10,000	-	20,000	30,000
Total	231,300	335,200	38,000	630,000	1,254,500

Source/ Ministry of Agriculture

FIGURE 1 -- CEREALS AND FOOD LEGUMES MARKETING IN MOROCCO



C.A.M.: Cooperative Agricole Marocaine
S.C.A.M.: Societe Cooperative Agricole Marocaine
ONICL: Office National Interprofessionnel des Cereales et Legumineuses

The O.M.I.C.L. has the monopoly on all the cereals and food legumes imports and exports

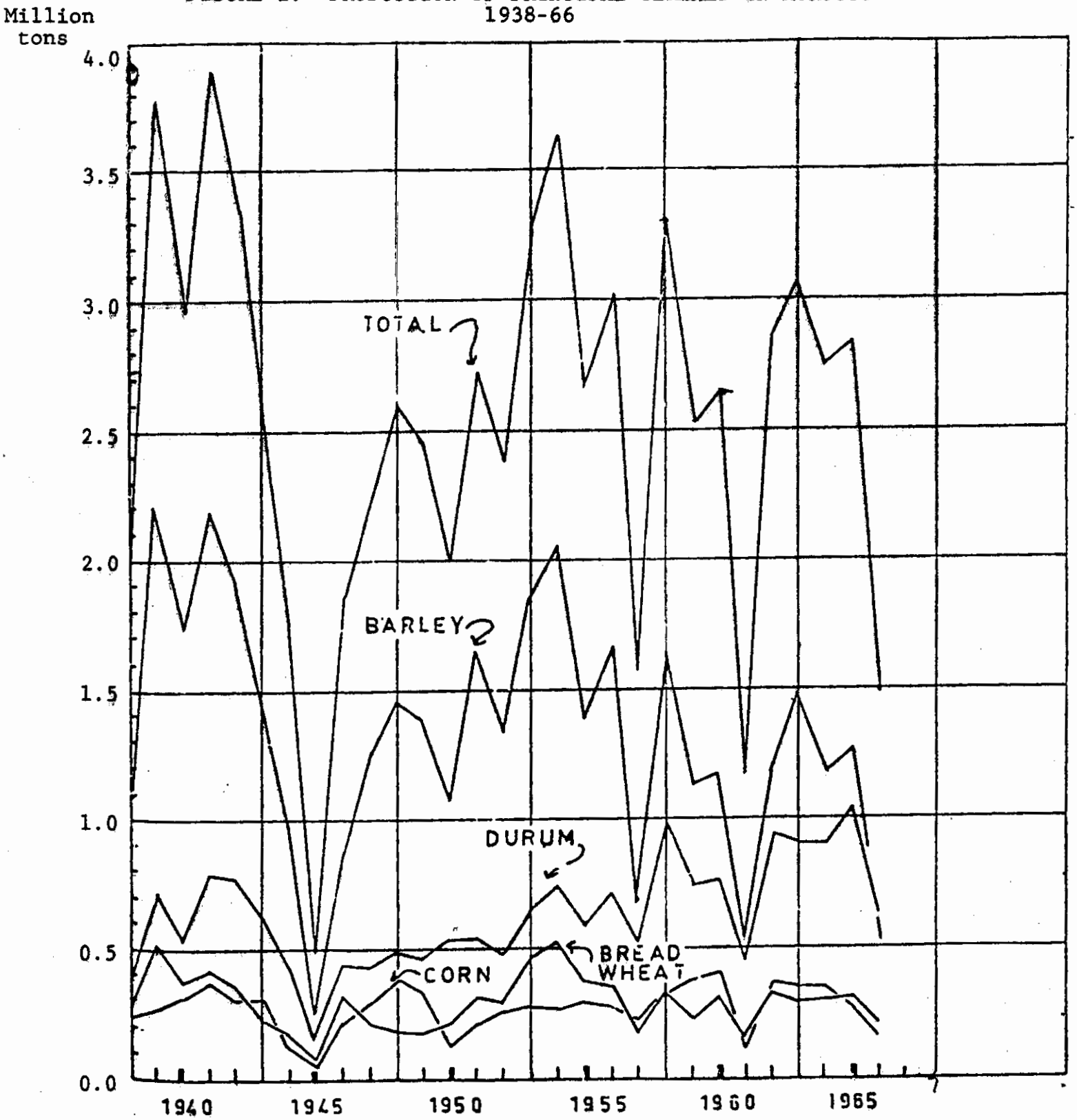
Table B.3 -- VOLUME OF FOUR PRINCIPAL CEREALS
MARKETED THROUGH VARIOUS AGENCIES
REGULATED BY OCIC -- 1963-1964

	COMMERCIALIZED 1963-1964 -- A Normal Year							
	Ble tendre		Ble dur		Orge		Mais	
Agencies	Tons	%	Tons	%	Tons	%	Tons	%
Dock Silos	20,709	13.5	24,473	13.2	3,483	4.5	1,359	2.25
SCAM & CAM	49,855	32.5	31,518	17.0	17,802	23.0	755	1.25
Licensed Merchants	82,836	54.0	85,840	46.3	56,115	72.5	58,286	96.50
Industry	--	--	43,569	23.5	--	--	--	--
Total	153,400	100.0	185,400	100.0	77,400	100.0	60,400	100.0

IV. Trends in Cereal Production (Figure 2)

The wide year to year rainfall fluctuations and consequently weather-induced crop production variations make it difficult to draw conclusions about the effect of policies and programs over the short run. Since many of the types of production price support and subsidy policies currently in effect had originated in the late 1930's, it is useful to focus briefly on what has happened to cereals production as the Government has experimented with different price relationship and subsidies. Between 1938 and 1940 total cereals area jumped from 3.36 to 4.22 million ha, coincident with the establishment of the predecessors of the current ONICL-managed policies and programs.

FIGURE 2. PRODUCTION OF PRINCIPAL CEREALS IN MOROCCO
1938-66



During 1939-1943 total cereals production averaged 3.5 million mt, with barley almost 60 percent. Between 1941 and 1946 total cereal production declined from 3.8 million mt to 0.5 million mt. Barley area declined from 2.13 to 1.01 million ha (-53 percent), while wheat area declined by only 28 percent. Clearly, economic incentives had led to a sharp shift from barley to wheat. This shift, which resulted in invasion of barley areas by wheat, probably was an important factor in the long run lower levels of cereals production through the 1940s, 1950s, and early 1960s, due to reduced area and yields. It was not until 1968-1972 that Morocco again achieved 4 years of over 4 million mt output annually. By 1968-1972 fertilizer and improved seed were becoming important factors. Barley yields increased from about 8.5 to 12.5 qx/ha and wheat yields from 7 to about 11 qx/ha. Bread wheat area peaked in 1940 at 588,000 ha and has not again achieved that level. By the 1960s Morocco was importing wheat (175,000 mt in 1960 and 855,000 in 1967), and by 1980 bread wheat imports were exceeding 1.5 million mt/year.

The two different data series available give different impressions about what has happened to production between 1938 and 1980.

All Cereals (Million mt)

	Old Series	New Series
1960	2.8	3.7
1961	1.2	1.7
1962	2.9	4.1
1963	3.2	4.3
1964	2.9	3.8
1965	2.9	4.0
1966	1.6	2.2

Production data from 1960 are available from the Ministry of Agriculture. Where the data overlap (1960-66), the former series is lower by 500,000 to 1,200,000 mt with high differences in high production years.

Extrapolating with one series or the other would give production in the 1939-44 period as high, or higher than the average, for 1976-80. It would show that barley had declined considerably while durum had increased substantially. Some imports of feed grains were being made.

Table B.4 -- HARVESTED AREA OF FOUR, 1938-72

	Bread Wheat	Durum	Total Wheat	Barley	Corn	Total Cereals
	(.....1,000 ha.....)					
1938	376	838	1.214	1.682	462	3.358
1939	489	900	1.389	1.977	493	3.859
1940	588	1.011	1.599	2.134	484	4.217
1941	506	998	1.504	2.193	536	4.233
1942	447	1.066	1.513	2.083	506	4.102
1943	372	1.054	1.426	2.138	495	4.059
1944	290	864	1.154	1.832	510	3.496
1945	244	773	1.017	1.591	490	3.098
1946	375	603	1.078	1.012	497	2.487
1947	370	849	1.219	1.499	473	3.191
1948	293	693	986	1.573	547	3.106
1949	265	782	1.047	1.832	502	3.381
1950	323	936	1.259	1.962	522	3.743
1951	384	942	1.226	1.885	506	3.717
1952	509	972	1.481	2.030	482	3.993
1953	517	867	1.384	2.003	509	3.896
1954	655	964	1.619	2.096	497	4.212
1955	611	1.053	1.664	1.955	495	4.114
1956	499	955	1.454	1.864	472	3.790
1957	400	1.030	1.430	1.381	462	3.273
1958	491	1.339	1.730	1.957	479	4.266
1959	433	1.277	1.710	1.797	513	4.020
1960	439	1.220	1.659	1.754	497	3.910
1961	442	1.154	1.596	1.561	410	3.567
1962	377	1.079	1.456	1.535	447	3.438
1963	396	1.257	1.653	1.935	462	4.050
1964	375	1.553	1.938	1.717	453	4.098
1965	391	1.267	1.658	1.645	434	3.737
1966	352	1.372	1.724	1.773	542	4.039
1967	430	1.220	1.650	1.774	471	3.895
1968	530	1.399	1.929	2.105	498	4.532
1969	478	1.467	1.945	2.037	465	4.447
1970	454	1.438	1.892	1.890	510	4.292
1971	489	1.517	2.006	1.998	453	4.457
1972	494	1.503	1.998	1.932	480	4.412

Source: 1938 - 1965 : O.C.I.C.
1966 - 1972 : Secretariat d'Etat au Plan.

Table B.5 -- FOUR PRINCIPAL CEREALS
1938-1972

	Bread Wheat	Durum	Barley Orge	Corn
	(.....qx/ha.....)			
1938	7.0	4.4	6.5	4.7
1939	10.5	8.0	11.03	5.3
1940	6.1	5.1	8.0	6.7
1941	8.2	8.0	9.9	8.2
1942	8.0	7.5	9.0	6.3
1943	6.6	5.8	6.6	6.8
1944	6.0	4.8	5.2	3.2
1945	2.7	1.5	1.5	1.4
1946	8.2	7.3	8.4	4.4
1947	5.5	5.0	8.1	6.1
1948	6.7	7.0	9.0	8.1
1949	6.5	5.9	7.5	8.0
1950	6.8	5.7	5.4	2.4
1951	8.0	5.6	8.6	4.2
1952	5.8	4.9	6.5	6.0
1953	9.0	7.4	9.0	5.8
1954	8.2	7.5	9.7	5.1
1955	6.0	5.6	7.0	5.9
1956	6.3	7.4	8.8	6.1
1957	4.0	4.9	4.7	4.7
1958	6.4	7.2	8.1	7.7
1959	5.5	5.6	6.2	7.7
1960	7.3	6.1	6.6	8.0
1961	3.7	3.9	3.0	2.6
1962	8.6	8.6	7.7	7.8
1963	7.7	7.0	7.6	7.5
1964	8.2	5.7	6.8	7.4
1965	7.8	8.0	7.3	6.4
1966	6.4	6.7	6.7	2.9
1967	7.8	7.7	8.7	5.0
1968	13.4	14.8	16.6	8.3
1969	7.7	8.4	10.8	9.7
1970	8.4	9.9	10.3	6.3
1971	11.2	10.8	12.9	8.6
1972	10.7	10.8	12.7	7.6
1973	7.0	8.0	6.2	
1974	8.9	9.9	12.1	

Source: 1938 - 1965: O.C.I.C.
1966 - 1972: Secretariat d'Etat au Plan

Yields of wheat and barley were fairly consistently lower from 1945 through the early 1960, compared with 1939-1942. Beginning in 1968, yields made a major jump.

V. Production and Producer Prices

The data on past area planted and yields do indicate a significant degree of sensitivity to relative barley and wheat prices. They suggest too that there is a significant degree of yield sensitivity where barley area is displaced by wheat. Presumably this occurs with wheat invading more drought prone soils and lower rainfall areas.

In 1953-1954 fixed and support prices to producers were DH 36/qx for bread wheat, DH 40/qx for durum and DH 19/qx for barley. Subsequently, the bread wheat price was reduced and continued fixed.

In 1960 soft wheat was DH 33/qx and durum DH 39/qx. By 1965 soft wheat was DH 40/qx and durum DH 49/qx just before the release of durum to a free market price on June 1965. By January 1967, with a drought in 1966, durum had risen from DH 45/qx in 1965 to DH 80/qx. The price of bread wheat in the unregulated markets had gone to DH 65-70/qx.

It seems clear that until the 1970s, pricing policies for wheat with respect to barley encouraged a shift in area from barley to durum. In the first years of the series (1938-1955) barley area averaged more than twice the durum area, and yields were consistently 20-25 percent higher. Barley area was 4 to 7 times the soft wheat area and yields averaged about the same. By 1954 soft wheat was already one third the barley area, and after that total wheat was about the same as barley compared with only 2/3 as much before. Yield in total and for barley suffered from this shift and probably the overall drought risk increased, and variability in total cereals production was increased.

The current policy of pricing domestic cereals at above world prices began during the 1950s.

During the 1950-1966 U.S. wheat prices declined by about 25 percent while Moroccan price supports were increased by about 25 percent, going from 25 percent below U.S. to 25 percent above U.S. prices (Table B.6). By 1966 the wheat support price exceeded the U.S. price by about DH 8/qx for bread wheat and DH 11/qx for durum. Price supports were held constant, even reduced some, between 1966 and 1972, increased in 1972 and 1973 and again in 1974, then held constant until 1977. Since that time they have been increased steadily. Barley has been increased more rapidly than wheat, going from

Table B.6 -- WHEAT PRICES, UNITED STATES AND MOROCCO, SELECTED YEARS, 1950 to 1966

	United States Wheat Prices		Morocco		
	Wholesale 1/	Export 2/	Freight Costs 3/	Cost at Port	Support Price
	(Dirhams per Quintal)				
1950	40.88	35.92	6.70	42.62	32.00
1955	41.43	31.89	6.70	38.59	32.94
1960	36.48	30.98	6.70	37.68	33.00
1965	28.59 4/	29.88	6.70	36.58	40.00
1966	32.82 4/	33.55	6.70	40.25	40.00

1/ Hard Winter #2, Kansas City

2/ Excludes shipments for relief of charity

3/ Based on estimated freight rate of $13.40 per metric ton

4/ Hard Winter #1, Kansas City

Source: Statistical Abstract of the United States, 1966, p. 361 and Wheat Situation, ERS, USDA, July 1966, p. 23.

slightly over half to 72 percent of the durum price. Barley area and production have responded to this price increase. Soft wheat has now been raised to the durum price (Tables B.7 & B.8).

Table B.7 -- PRICES OF WHEAT AND BARLEY IN MOROCCO, 1953-1966

	Soft Wheat 1/	Durum 2/	Barley 2/
	(Dirhams per Quintal)		
1953	36	39.05	17.50-23.00
1954	35.50	40	19
1955	32.94	37.88	19
1956	34.50	39.70	18
1957	36	39.70	22
1958	33	39	17
1959	33	39	17.50
1960	33	39	19
1961	34.50	40	22
1962	35	41	23
1963	35	40	23
1964	37.50	42.50	25
1965	40	44	27
1966	40	44	27

1/ Fixed price to producers

2/ Support price to producers

Sources: 1. Kebbaj, Abd El Khalek, L'Economie Cerealier Au Maroc, 1962, p. 49.

2. Service du Commerce de Casablanca

Table B.8 -- MOROCCO: Guaranteed Prices to Farmers for Principal Commodities 1970-1980

Year of Product	Durum	Bread Wheat	Barley	Corn	Sugar-beets	Sugar-cane	Sun-flower	Cotton
	(.....DH/qx.....)				(DH/ton)		(DH/qx)	(DH/kg)
1970	44	40	25		60		64	
1971	44	40	25		60		64	
1972	47	43	27		60		64	
1973	49	45	28		66		73.5	
1974	63	60	40	45	76	59	90	2.1
1975	63	60	40	45	96	65	130	2.0
1976	63	60	40	45	96	65	130	2.6
1977	85	85	65	65	96	65	130	2.6
1978	85	85	65	65	115.2	81.25	130	2.6
1979	105	105	80	80	115.2	81.25	130	3.2
1980	125	125	90	90	135	95	185	3.2
1981	135	135	96	96	135	95	185	3.2

Source: Ministry of Agriculture and reported by the Office of the U.S. Agricultural Attache, Rabat.

By 1981 the support price of wheat in Morocco had been increased until it was about double the actual U.S. price for bread wheats, which is about U.S. $140 (DH 700)/mt. The price of feed corn is about $105 (DH 525)/mt compared with Moroccan support price of DH 960. Fertilizer is substantially subsidized. As a result the amount of grain required to buy a kg of N is only about 30 percent of that required to buy a similar type fertilizer in the U.S. This should provide a major stimulus to grain production.

XI. Production Policy Orientation in the 1981-1985 Plan Period

As part of the means for achieving cereals production targets set for the period of the current five-year plan (1981-1985), the Government, in the Plan, is adopting the policy of converting 90,000 ha of irrigated land and 250,000 ha of rainfed land in the higher rainfall zones from the production of barley to that of wheat.

A comparison of limited data on regional wheat and barley yields with international prices for these commodities suggests that such a substitution, at least that of bread wheat for barley in the high (above 450 mm) rainfall zone, would be to Morocco's economic benefit. (See Tables B.9, B.10, and B.11)

To the extent, however, that domestic price policies create pressure for the extension of that substitution into the dryer areas, these policies work against regional comparative advantages in cereals production. In this regard, the policy picture is mixed.

On the one hand consumer price subsidies encourage the consumption of bread wheat relative to durum and barley, and these are supported by a current financial incentive for farmers which favors bread wheat.

On the other hand, that financial incentive is not as strong today as it was during most of the period from the 1940's and early 1970's. In 1979 and 1980 the bread wheat-barley support price ratio was just over 1.3:1, while in 1972-1974 the ratio averaged over 1.5:1, and earlier it had been over 2:1.

At any event, in a climate of year to year crisis in the availability of basic foods, consumer and producer price policies which do not encourage increased caloric output would appear to be anomalous. A program of improvement in economic analysis of demand and supply relationships for major food commodities would help provide a more rational basis for policy

Table B.9 -- YIELDS OF DURUM, BREAD WHEAT, AND BARLEY ON RAINFED LAND IN SIX MAJOR CEREALS PRODUCING PROVINCES, 1979-1980 1/

Provinces	Average Yield		
	Durum	Bread Wheat	Barley
	(.....qx/ha.....)		
High Average Rainfall 2/			
Khemisset, Meknes	11.4	16.5	14.4
Maximum Average Rainfall 2/			
Settat, Essouira	6.5	7.9	9.7
Low Average Rainfall 2/			
El Kalaa, Marrakech	6.9	5.2	9.6

1/ The 1979/80 season was one of average or above average nationwide cereals yield.

2/ High: above 450 mean annual average rainfall.
Medium: 300-400 mean annual average rainfall.
Low: 250-350 mean annual average rainfall.

Source: Ministere de l'Agriculture et de la Reforme Agraire, Direction de la Planification et des Affaires Economiques. Enquete Agricole, Principles Productions Vegetales, Compagnes Agricole 1979-80, January 28, 1980.

Table B.10 -- ECONOMIC[1/] AND DOMESTIC[2/] PRICES OF WHEAT AND BARLEY
1979 AND 1980

Year	Durum Economic	Durum Domestic	Bread Wheat Economic	Bread Wheat Domestic	Barley Economic	Barley Domestic
	(.....DH/t.....)					
1979	81	105	90	105	82	80
1980	96	125	108	125	92	90
Average	89	115	99	115	87	85

1/ Economic prices are defined as c.i.f. prices for imported commodities or f.o.b. prices for exported commodities adjusted for transport and handling cost lack to the farm gate. The World Bank has estimated these prices, projected to 1985, for Morocco as percentages of the Government's support price to farmers:

Durum	86%
Bread Wheat	77%
Barley	102%

See: IBRD, "Memorandum on Morocco's Agricultural Sector, Identification of Issues and Bang Strategy. 1979 (?)

2/ Domestic prices are those paid by the Office National Interprofessionel des Cereales et Legumineuses (ONICL). By comparison with prices reported from village markets, they have tended to favor bread wheat relative to barley, and barley relative to bread wheat.

Table B.11 -- WHEAT AND BARLEY: YIELD RATIOS AND PRICE RATIOS

Item	Provinces by annual average rainfall		
	High	Medium	Low
A. Yield ratios 1/			
1. Barley to Bread Wheat	0.87	1.23	1.84
2. Barley to Durum	1.26	1.48	1.39
B. Price ratios 2/			
1. Economic			
a. Bread wheat to barley	1.14*	1.14	1.14
b. Durum to barley	1.02	1.02	1.02
2. Domestic			
a. Bread wheat to barley	1.35**	1.35**	1.35
b. Durum to barley	1.35**	1.35	1.35

1/ Based on yields for 1980, Table B.9.

2/ Based on average of two years' prices, 1979 and 1980, Table B.10.

* Indicates a gain to the economy from substituting bread wheat for barley.

** Indicates a financial gain to farmers from substituting bread wheat or durum for barley.

formulation. Improved information from the accelerated development of the area sampling frame in Morocco and the preparation of soils classification maps, both of which appear as useful areas of expanded USAID assistance, would enhance such analysis.

VII. Fertilizer Price Policy and Fertilizer Consumption

Like grain pricing and distribution, many of the current fertilizer price policies have been in operation in various forms and to varying degrees dating back to the 1960's or earlier. The official concern and sensitivity over crop and input prices goes back much further. In 1965-1967 ammonium sulphate and single super phosphate were priced to farmers at DH 17/mt, but a subsidy of DH 50/mt was available to some farmers. Until recently special groups, usually farmers above 20 ha as well as cooperative farms, received a special subsidy of 20 percent (30 percent for cooperatives).

At the subsidized price in 1965-67, it took 1.25 kg of durum to buy one kg of N and 1.8 kg of durum at the unsubsidized price.

For 1981-82 all individual farmers pay essentially the same price at government sales points. These prices, shown in the table below, have been constant since 1979-80.

Table B.12 -- PRICE RELATIONSHIP BETWEEN FERTILIZER AND GRAIN, 1981-82

Fertilizer	Fertilizer Price Product Basis	Fertilizer Price Nutrient Basis	Kilograms of grain required to pay for one kilogram of nutrient* Wheat	Kilograms of grain required to pay for one kilogram of nutrient* Barley & Corn
	(.....DH/ton.....)			
Urea (46-0-0)	790.90	1,719.35	1.27	1.72
Amm.Nit. (33.5-0-0)	708.60	2,115.22	1.57	2.20
Pot.Chlor.(0-0-61)	536.80	880.00	0.65	0.92
TSP (0-45-0)	533.40	1,185.33	0.88	1.23
SSP (0-18-0)	233.50	1,297.22	0.96	1.35
Mixed (14-28-14)	818.30	1,461.25	1.08	1.52

*Grain support price for 1981-82: Wheat, DH 1350/mt; Barley and Corn DH 960/mt.

Currently, the ratio of prices of fertilizer to support prices for wheat are almost the same as that for farmers getting the special subsidies in 1965-67. It now takes 1.27 kg of wheat or 1.72 kg of barley or corn to buy one kg of N. By contrast in 1978/79 it took 1.56 kg of wheat or 2.07 kg of barley or corn to buy a kg of N. Mixed fertilizer (14-28-14) prices are about 10 percent higher per kg of nutrients.

Considering that results found in research stations show increases of 10 to 25 kg of grain for each kg of N applied at lower levels, the returns potentially are very good indeed.

The fertilizer costs shown in the table are sharply lower than U.S. farmers pay for the same forms of N and P_2O_5 in bulk. At current prices in the U.S. it requires about 4.5 kg of wheat, 6 kg of corn to buy one kg of N or of P_2O_5. Thus, it takes about four times as much grain to buy a comparable quantity of nutrients in the same form in the U.S. as in Morocco.

The very favorable price relationship in Morocco is maintained by a combination of the very high price support for grain (near double the U.S. price) and subsidies on fertilizer. It is generally concluded that the subsidy on fertilizer has resulted in adverse production impacts such as:

1. Under-use of imported nitrogen relative to local phosphate.

2. Use of P_2O_5 where it is not needed because it is cheap.

3. Various forms of non-price rationing, especially of nitrogen, favoring larger farmers over small farmers, irrigation perimeters over rainfed areas, and higher over lower rainfall areas.

4. Generally low in efficiency of use of available fertilizer.

AID supported a major GOM fertilizer and HYV seed program beginning about 1966-67, but the program encountered some difficulties, especially in efforts to improve seed varieties.

HYV of wheat were imported in quantity and distributed to farmers without adequate testing. The import of HYV was widely publicized, and influencial farmers lined up first for seed. The year was wet and septoria disease swept the new non-resistant varieties. The powerful farmers, who got caught, ultimately were reimbursed for their losses.

The second mistake of the late 1960s appears to have been over expectation. Results were expected in 1-2 years. For example, Operations Engrais (fertilizer) was started in 1966. In 1968 High yielding varieties were introduced in large quantities. By 1972/73 the program was practically closed.

The real catastrophe seems to have been the excess expectations from seeds, not fertilizer. In 1970 the Guayaso report indicated excellent results with fertilizer development efforts.

Between 1966 and 1968 fertilizer consumption grew by almost 40 percent, then declined in 1969 and grew slowly thereafter. By 1981 consumption was only double the 1968 level (Table B.13). Further, nitrogen use is only about three-quarters that of phosphate (P_2O_5) and 2 1/4 times K_2O use. There is considerable question about the returns from P, and even more so of K, especially without high rates of use of N. If used only on irrigated areas, the 72,000 mt of N would only be sufficient to fertilize one crop per year at a rate of 100 kg of N per Ha. This is a modest rate for many irrigated crops, especially sugar crops. The amounts used for different crops is not available, but clearly use of N on cereals is much too low.

Table B.13 ESTIMATED FERTILIZER CONSUMPTION BY YEARS 1/

Year	N 2/	P_2O_5 2/	K_2O 2/	Total Nutrients 2/	Total Product 2/
				(1000 tons)	
1965				56.5	NA
1966	(Specific nutrient			67.6	NA
1967	data not available			79.9	NA
1968	prior to 1977)			95.9	NA
1969				87.0	NA
1970				NA	272
1971				NA	274
1972				NA	320
1973				NA	376
1974				NA	428
1975				NA	444
1976				NA	450
1977	72	64	26	163	459
1978	69	73	24	164	492
1979	83	82	34	199	563
1980	80	85	27	192	548
1981	72	92	32	194	553

1/ 1965-1976, From data assembled by USAID/Morocco.
1977-1981, U.S. Attache data adjusted for exports

2/ The available data do not permit a complete series for any of total products, total nutrients, or specific nutrients.

At present nitrogen use is only a fraction of likely optimum use in an average year, assuming some improvement in tillage practices is made and suitable seed varieties used.

VIII. Inadequacy of Price Policy without Other Supporting Efforts.

Factors other than input and product prices appear to intervene. Nitrogen fertilizer and quality seed have been short of needs. Only about 7 kg of N/ha is used on an average, compared with an apparent need of about 40 kg/ha, (less for lower rainfall and more for higher rainfall areas).

Further, low subsidized prices of bread wheat flour may discourage production, especially among small scale producers, since they find it more economic to produce other crops or livestock and buy flour.

Barley production, which had been the major cereal, has been discouraged by low past prices. The price relationship currently is better, though it is priced along with corn as a feed not food.

Clearly cultural practices, including rapid and improved land preparation, are major obstacles to increased yields. Yet the traditional farmer, if anything, may be declining in ability to till his land as feed supplies relative to livestock numbers decline, and improved implements requiring less power are not developed or produced.

The current policy is to tractor mechanize at a relatively modest pace with no attention paid to improved tillage methods or tools for use with animal power. There is considerable question whether even the tractor mechanization may have gone astray by concentrating on tractors and neglecting suitable tillage implements and planters for the soils and rainfall of Morocco. The latest data suggests that tractor mechanization has stagnated recently despite a relatively low price for tractor diesel fuel.

C. Rationale for Strategic Choices

1. Target population: Speaking of agriculture as a whole, rather than the somewhat smaller area which will be the focus of AID activity, there are roughly 1.5 million farm families in Morocco. Of these, about 25 percent are landless, and 55 percent have holdings under 5 ha. An additional 11 percent have holdings between 5 and 10 ha. Thus, over 90 percent of Moroccan agricultural families are small or medium holders. Moreover, the income levels of this group on the average, are low. In 1974 the average net income per person (measured in 1960 dirhams) for these groups was respectively 206, 226, and 506 dh. However, because of skewed patterns of ownership, this group (10 ha or less) holds only 45 percent of the cultivated area. If the AID strategy is to seek a broad production impact, it will be necessary to cast the net more widely. If one goes up to the 20 ha level (roughly 50 acres), one encompasses 95 percent of those that hold land and two-thirds of the cultivated land.

Focusing on those with 20 ha or less (and within that group giving priority to the poorer farmers) is recommended for several reasons:

a. Presumably these are the people most in need of assistance, and those whose productivity will not increase unless there are special efforts to provide them with assistance.

b. This is where the numbers are. Broad sale improvement in the standard of living in rural areas helps take pressure off the cities. Long-term progress on the population problem will be absolutely necessary if the food/population equation is ever to balance in Morocco. Ne reasonable expectation of cereal production growth is more than a part of the solution. This long-term decline in population growth rates is not likely to occur unless there is widespread income growth, particularly in the rural areas where birth rates are highest, and among poorer families where contraceptive use is lowest.

c. Finally, only by so focusing does one conform to the legislative purpose of Development Assistance (i.e., "the participation of the poor in a process of equitable growth").

2. Rainfall Target Zone

The following table shows how (1967) total area devoted to wheat and to barley was distributed across rainfall zones:

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	Barley		Wheat
	(	percent	)
Less than 300 mm	36		15
300 - 400 mm	32		27
Above 400 mm	32		58
	100		100

Relatively equal amounts of land are in barley production in each of the three zones, but most of the wheat is produced in the zone over 400 mm. It is recommended then that the strategy focus on all three zones. It is recognized, however, that the kinds of interventions which may be appropriate in the higher rainfall zones may not be possible (at least in the short run) in the low rainfall zones. The proposal to include the over 400mm zone represents some broadening of the target zone beyond the present focus of the Rainfed Agriculture Research Project which is restricted to 200-400 mm. In view of the significant amount of cereal grown in the rainfall zone above 400 mm, and because of the potential for relatively rapid production impacts in that zone, we feel that, with appropriate targeting on the poor majority, such expansion is warranted. It is difficult operationally to restrict development activities to particular rainfall zones since boundaries are irregular and generally not precisely fixed.

3. Short Term Production Impacts vs. Long Term Efforts

It is neither desirable nor necessary to choose between short-term production impacts and longer term development impacts. The approach advocated herein is to make an appraisal of what the short-term possibilities are as well as an appraisal in each rainfall/soil zone of the longer term needs and potentials. In so far as short-term production impacts can be identified, it is desirable to move on them as soon as possible. However, even in regions in which there is no known technical package which can be expected to have a major impact on yields, it would be unwise to write off the area (and the population therein). The stance adopted is that potentially all can have significantly higher yields. Where little in the way of a technical package is presently available initial development efforts will have to be very restricted and emphasis placed on research.

4. Sequencing

The strategy should assume a long-term AID and GOM effort to develop the rainfed area. It should assume that over that long term reasonably high levels of resources will be available both from GOM sources and from international donors. Within that assumption, it is important that progress be initiated on the requisite inputs for broad scale

development in such a way that bottlenecks and time lags are minimized. For example, research results may be coming to fruition, but several years of testing and demonstration may be necessary before large scale extension will occur. In this case efforts should be started to develop the extension capability, to expand the seed and fertilizer supply, and credit availability on the assumption that they will soon be needed. Such planning should take into account the well-known delays in project approval, and the early phases of project implementation. In order to get a better fix on just what aspects of the system will need to be strengthened and by what time period, it is suggested that the AID resources contain some monies set aside for a thorough-going resource planning analysis.

5. Time Frame for AID Projects

Because of the long-term dimensions of the development process involved in the rainfed areas, the need to insure continuity of personnel and resources, and the need to demonstrate to the GOM the long-term nature of the U.S. effort in this area, it is suggested that projects be developed with a ten year time frame, with full scale evaluations required in the 4th and 7th years.

6. Integrated Approaches

It has been argued that there is high degree of interaction among the cereals, range and forest areas and thus a high degree of integration is needed in activities to solve production and equity problems. It was argued that the total effect, especially on equity, would be greater if AID helped assure an integrated approach by contributing to all three areas.

The interaction and need for integration may be argued on several bases. One is the importance to individual families of two or all three sectors as sources of feed for migratory livestock, their only source of livelihood. The second is the competition which exists among these areas as a source of feed for a given national herd size. Thus unless success is made in range and forestry areas, which include limitations on herd size, numbers will rise to overwhelm progress in cereals areas. Closely related, is that demand for livestock with no control on prices will, in the absence of improvement in range and forestry feed production, put sharply increased pressure on land available for cereals. The last and most critical for the cereals production objective is that without development of farming systems in cereal areas that integrate crops, forage and livestock, costs of increased cereal production will be much higher and prospects for success

much less. (See Technical Appendix 4, following, for a more complete development of this argument.)

Insofar as steps in the forestry area or range management area are steps which will make important contributions to the growth of cereals-production, they should be part of any cereals development strategy. (However, it does not necessarily follow that AID should be involved in all areas, so long as other activities are actually carried out.) And, even if strong causal relations are found there is also the question of prioritization of efforts within sharp resource constraints.

With the issue so understood, it is concluded that there may be important, but selected efforts involving forestry as well as range management which should be part of a cereals strategy.

7. Integrated Use of U.S. Resources

It is quite possible that over the long-term PL 480 resources will constitute a major portion of the resources potentially available for net increments in investment in rainfed agriculture. Some ESF may become available. To date, the mission has not been particularly successful in its efforts to insure that PL 480 counterpart funds are so utilized. In part the problem lies in the absence of a long-term plan for their use, in part it lies in different views within the GOM as to how such resources should be used, and in part it lies in lack of consensus within the U.S. Government with respect to the importance of the utilization of such resources for the development of Morocco's cereal potential. The strategy advocated herein calls for steps to be taken to deal with these varying obstacles to use of PL 480 funds. In particular, it is recommended that:

(a) The specific AID projects that are designed in such a way that PL 480 or ESF resources can be used to promote project objectives. The project design, wherever possible, should permit flexibility to use alternative sources of funds and alternative levels of program intensity.

(b) Within the process of project design, and as a covenant in the project agreement, an understanding with the GOM should be sought which would call for the use of PL 480 resources in the project framework should such PL 480 resources become available during the life of the project. In negotiating this approach with the GOM, the mission should have prior agreement from AID/ W that the establishment of such an approach to long term programming of PL 480 resources will be

an important criterion in determining how PL 480 resources are allocated. It should be made clear to the GOM, that such an agreement is still a step short of a multi-year PL 480 agreement.

(c) That in Washington, and in the field, efforts are made to establish within the U.S. government a consensus with respect to the political and economic significance of using PL 480 resources to make an effective contribution to developing Morocco's cereal potential.

8. Agricultural Labor/Mechanization

About 25 percent of the agricultural labor force is landless. At the same time the general labor force continues to grow rapidly and can be expected to expand at a very fast rate in the medium term. There is already considerable unemployment and underemployment. Within this context, it is important that efforts at agricultural development do not result in unwise displacement of agricultural labor. The strategy advocates that in the introduction of machinery, emphasis be on early and better tillage methods and higher yields, not on cost reduction by labor displacement. Any labor displacement should be heavily weighted in determination of costs.

9. Local Participation

Past efforts to change farming practices have often failed because, from the perspective of the small subsistence farmer, practices may include numerous considerations rationalizing his behavior patterns that go undetected by consultants and government planners. Such matters may involve issues or risk avoidance, fear of being caught up in judicial institutions (over failure to repay loans), complexity of loan applications, issues of title to land or how yield increases are divided between sharecropper and tenant. Our belief is that these issues may be numerous in the Moroccan context, and that even with strong involvement by sociologists in project design, it may not be possible to anticipate all of the significant features of the situation. The additional approach advocated is involvement, wherever possible, of the elected village leaders, in the process of design and implementation. The use of such local officials will not only be helpful in overcoming design problems, but will also help to increase interest and legitimize the behavioral changes required by the development process.

10. Women

The consultant team was not able to make any study of the specific roles that women play in Moroccan agricultural production. However, it is recognized that women do play important economic roles and that an adequate strategy for agricultural development needs to be informed with respect to these roles and the specific approaches that need to be adopted in the design of the projects so as to insure that production efforts are successful. As the strategic thinking on agricultural development progresses, and as we move into new project design, a deeper understanding of women's role and how it relates to potential change needs to be developed. Specific areas for investigation include:

- The extent to which women are engaged in production efforts.

- The specific roles they play.

- What role they play within the family's decision to modify long standing behavioral patterns (e.g., shifting crops, using credit, storing seeds, penning animals, responding to radio programs on new techniques, etc.).

- How the introduction of new economic roles affects decisions on family size.

12. Dependence vs. non-dependence on GOM resources

In laying out the strategy for AID development efforts in the drylands it is important to gauge the extent to which these efforts should be dependent upon GOM resource availabilities. This issue has several components.

- What should we be assuming about the levels of future GOM investment in rainfed agriculture?

- What will the GOM ability be to meet recurrent costs of new operations (e.g., salaries of a much expanded extension service)?

  Can we assume that the GOM will be able to meet its commitments of host country contributions to AID projects even if there is an ambitious portfolio?

  Would it make sense to engage in non-projectized sector support activities premised on predetermined GOM budget allocations over the life of a given planning period?

The general conclusions we have reached are that 1) the GOM has been quite reliable in meeting its project commitments, and there is no reason to believe that this will change even within the context of an expanded program; 2) there is considerable uncertainty with respect to future overall GOM budget allocations, and the budget expenditure process is part of how the government fine tunes its management of the economy; 3) there is significant need for technical support, and therefore projectized sector support would not seem appropriate; and 4) in designing future projects, it will be quite important to consider ways of reducing the recurrent cost burden. The GOM is quite sensitive to the lasting costs they face from efforts which donors have started. Projects should be designed so as to make full use of those with the lowest levels of training that can do the job adequately. In particular, in developing extension expansion, design team should consider use of local youths operating under supervision of more highly trained agents.

D. Reasons for Supporting a Cereals-Fallow/Livestock Farming System

It may be argued that since the main thrust of USAID's strategy is to be on equity and cereals and, to a lesser extent, oilseeds production, livestock development should receive interest in that strategy only if there is a complementary relationship between animal husbandry and cereals production. The purpose of this note is to argue the case for such complementarity and to define what seem to be its practical limits.

There are two major livestock production systems in Moroccan agriculture: (1) Sedentary production on farms in conjunction with crop (mainly cereals) farming and (2) Nomadic or semi-nomadic grazing of government-owned and tribal lands. Setting aside question of appropriate sector-wide land use,[1/] there appears to be little direct complementarity between nomadic grazing and cereals production. As would be expected and as it recognized in USAID's Range Management Improvement Project (608-0145), nomadic and semi-nomadic herding are located in areas largely unsuited, for reasons of soil, topography and climate, to crop production. In addition to the land use question, further caveats to this assertion are:

1. Forage species introduced for ranges may well be suited for introduction into cereals rotations.

2. Market forces, in the long run, may shift resources between the range lands and crop farms.

3. Also in the long run, a market relationship, in which young livestock are sold by herders to farmers for fattening, may become important.

In sedentary agriculture, the classic case of complementarity between crops and livestock occurs as animal production is enhanced through the production of feedstuffs from cultivated crops, and crop production is supported through the use of animal manures as fertilizer on crops. This symbiosis is operative on cereals farms in Morocco:

1. Barley which is produced on most farms, is a commonly used livestock feed, as is the straw from both wheat and barley.

1/ This is an important question. The Strategy Team observed some forests on land which would be more productive in crops and cereals planted on land which would be more productive in forests or well-managed ranges.

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2. Barley fields are often grazed during the early vegetative stage before the development of the seed head.

3. Both wheat and barley are turned completely to grazing if, in the farmer's judgement, a harvestable cereals crop will not be obtained.

4. Cereals stubble is grazed after harvest, and more important, so is the weed growth which springs up after the first autumn rains on the land left fallow.

5. On the other side, animal droppings help fertilize the farm's land.

The first three of these would continue to obtain even if the development program excluded any attention to livestock. The fourth item, the grazing of weed fallow, would be detrimentally affected by such a program. Sooner or later weeds will become an increasingly limiting factor to major increases in cereals yields.

At that time, effective control of weeds in the cereals crop will be adopted and reduce their growth as forage in the succeeeding fallow. At that point, more systematic cereal-forage rotations will need to be employed.

As a matter of prediction, if not of prescription, the predominant farming system in the rainfed areas will continue to be based on cereals and livestock combinations. Specialized crop farms and specialized livestock farms are not foreseen as major elements in Moroccan agriculture, especially on smaller farms. Livestock provide an important portion, if not the major portion, of the income on small crop farms. It is the major avenue for farmers' capital accumulation. The bulk of the cost of animal production is feed, since much family labor on farms is otherwise idle during the long slack periods between tillage, seeding and harvest.

More easily imagined as cereals production increases, but still unlikely over any reasonable planning horizon, is the massive replacement of fallow with cereals, and some cultivated forage, with grazing mainly on the young barley crop and on cereals stubble, and the animals otherwise fed in confinement with stored grain and forages (including straw).

Enhancing the animal-carrying capacity of that portion of the small farmers' land which is now in weed fallow makes excellent sense in the framework of a cereals development program. It fits within the existing farming-system in that it is consistent with this current use of resources and

current sources of income and investment. It supports the cereals program by reducing the value of weeds as forage, thereby providing an incentive for weed control in the cereals crop. Technically, a research and extension program to develop and disseminate forage technologies is not greatly different from that to be undertaken for cereals. Supporting infrastructures (credit, input supplies, etc.) would be similar or identical.

E. MOROCCAN RESOURCES TO SUPPORT THE STRATEGY

I. Inputs

Inputs, broadly defined, include everything that goes into the production of a commodity for home consumption or sale: that is land, labor, water, seeds, soil additives, pesticides, tools, machinery, livestock, capital. In the most primitive farms, and they exist in large numbers in Morocco, production is carried out by applying labor and a simple tool to land with seed saved from the last crop. Capital is restricted to land and simple tools and carry-over seed. The tiller may rent the land and have the seed supplied by the landlord, in which case the capital to his enterprise is limited to simple tools, some of which he may make.

At the other extreme, the modern farm, and these also exist in large numbers in Morocco, is heavily dependent on off-farm supply for everything but land. Irrigation water (if needed), tools, improved seed, fertilizer and other soil additives, pesticides, heavy machinery and equipment, fuel, skilled labor, production services, animals to finish, a wide variety of marketing services, a flow of technical information and, to finance this, a large supply of capital that can be borrowed on flexible terms. Flexibility and easy access are critical for all these.

This section is mainly concerned with the adequacy and terms of supply for these various "modernizing" inputs to individual farms in Morocco.

A. Irrigation Water

The major part (over 50 percent) of Moroccan public investment in recent years has gone into development of irrigation. Irrigation water now is supplied to about 2 percent of the total arable area of nearly 8 million ha. It is estimated that this could be increased by at least 50 percent more. Because of special Government arrangements in the irrigation perimeters, farmers with irrigation generally also have preferential access to most other inputs (other than labor). IBRD in its recent project analysis concludes that returns to principal irrigation investments are likely to be 7-12 percent. In contrast rainfed project returns have been projected at 20 percent or more, the "integrated intensive rural development" projects at 21-24 percent, credit at 20 percent and the poverty oriented projects devoted to the poorest regions (of agriculture-forestry-livestock) are

expected to have returns of 10-15 percent 1/. Based on the above and on our analyses, we think that about as much has gone into irrigation investment as can be justified, given the overall resource constraints.

This is not to suggest that the irrigation areas should be totally ignored. Research supported by AID in several countries with gravity/flow systems where only nominal water charges are assessed, has consistently uncovered very high water applications rates relative to crop production (low efficiency of water use). It would be desirable to include scientific investigation of water use efficiency as a part of the physical research activity possibly under the Hassan II INAV-Un. of Minn. project. Another issue for irrigation is whether enough has been done to develop more optimal crop-livestock systems. Many agriculturalists believe a major contribution could be made to cereal production in the irrigated perimeters without reducing production of high value crops such as fruits, vegetables and sugar beets. This again may be an area indicated for some analytical attention under the AID-supported activities.

B. Labor

Considerable analysis has gone into the question of labor supply. While farmers may complain of labor shortages, the general conclusion is that unemployment and underemployment are serious for most of rural Morocco. During harvest time labor is most heavily occupied, but it has not been established that labor is a general constraint on farm enterprises under rainfed conditions. Where combines, for example, have been found to be economic to harvest larger farms, it has been more related to management problems with labor and relative cost of machines and labor, not that no labor can be found. The 1971 census showed about a 10 percent unemployment rate nationally. Low wages and limited employment opportunities in rural areas have led to high rates of out-migration.

C. Machinery

Two levels of mechanization were reviewed: (a) tractor mechanization with quite limited selection of implements and combines; (b) animal mechanization. Tractor and heavy equipment mechanization was widely introduced and widely used during the French period, but recently has stagnated. The reason is not totally clear. Apparently most of the farms which are well suited to large scale mechanization and where

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1/ IBRD Memorandum on Morocco's Agriculture Sector, May 2, 1980, pp 6-7.

characterized as a lack of respect for the extensionist, is likely to be more a function of extension methods used and an expectation that the extensionist should also be a source of credit and input supplies than it is of a lack of a body of knowledge about improved technologies.

Credit and input supplies are outside the administrative and functional mission of the Extension Directorate. Within its own mission, and recognizing the absolute necessity for adequate financial resources, the most promising avenue for improved extension performance is likely to lie in close coordination of extension with research. Mention of the recognition of the value of this was made above, and it appears to be an important candidate for USAID assistance.

Other, specific areas of possible assistance were listed for the team by the Director of Extension. These are:

1. Evaluation of extension methods in the framework of a planned program of experimentation with different extension methods.

2. In-service training of extension personnel.

3. Production of audio-visual materials.6/

All of these are consistent with the development of close research-extension relationships.

C. Production Campaigns

Responsibility for coordination of input supplies lies with the Ministry's Direction de la Production Vegetale (DPV). DPV directly operates Centres des Travaux from which tractor and other machine services can be hired by farmers. DPV has only limited direct control over the distribution of fertilizer and other inputs, but it serves as the Ministry's planning agency in estimating requirements and in facilitating distribution.

6/ As an example of potentially beneficial efforts in this area, one of the MIAC/Nebraska team members has mentioned the existence of a radio "soap opera", produced in Turkey, which features a traditional farm family and which, in addition to having a general-interest story line, contains extension material on production methods, family planning and the role of women in the economy.

DPV recognizes that the distribution system for input goods and services is not adequate for needs, particularly in the drier regions.7/ Its director pointed out to the team that, for many farmers, the constraint is not one of the lack of technical knowledge but of the lack of credit, fertilizer, improved seeds, and other inputs at the time they are required. He indicated that USAID assistance would be valuable in expanding the number of distribution points in the villages.

D. Economic and Social Science Analysis

Work in statistics and agricultural economics is sited in the Ministry's Direction de la Planification et des Affaires Economique (DPAE). Most attention is given to agricultural statistics. Work in agricultural economics in DPAE is confined largely to assisting the statistics operation and to benefit-cost analyses of agricultural projects. Some farm management work is underway in DPV and in the Offices Regionaux de Mise en Valeur Agricole which are responsible for irrigation development. At INAV Hassan II social science research is primarily in rural sociology, with much fewer resources devoted to agricultural economics. Much of the sociology research provides information of a qaisi-farm management nature. Nowhere is there an institutional capacity for sector-wide, empirical analysis of demand and the economics of production, which would be of great benefit in policy formulation and sector development planning. USAID assistance in soil mapping and the accelerated development of Morocco's area sampling frame, recommended elsewhere in this report, will greatly improve the data base for economic analysis. Data and information are not the same thing, however. Data become information only through interpretation and analysis. Assistance in developing that analytical capability would enhance the planning and policy making process.

Data supply and data analysis (transformation into information) are two of the three major functional components of an agricultural information system. The third component, equally essential, is the set of information users (public and private decision makers). A great danger, both in terms of its likelihood of occurrence and the seriousness of its effect, is that

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7/ Distribution points for seeds and fertilizer have been set up within the network of Centres des Travaux and irrigation perimeters (263 altogether) to implement the network of the parastatal seed and fertilizer companies and private retailers. These points handle about 10 percent of the total.

data are generated and analyses are carried out in a communications vacuum.

In an ideal information system, management and control rest with the user group. In practice, however, the most that can be achieved is open and free communications among the three elements so that the service of users' purposes is paramount.

F. ON-FARM BENEFITS AND COSTS AND DISTRIBUTION OF BENEFITS FROM PROPOSED STRATEGY

I. Benefit-Cost Analysis

Analysis of hypothetical budgets of farms typical of the rainfed, cereals producing regions of Morocco is a useful tool in making judgements about the financial and economic impact of the proposed strategy. Two sets of budgets are examined. The first is of a somewhat larger than average farm in Meknes Province in the higher rainfall (450-600mm) region of Morocco. This is the region in which agronomic research conducted to date indicates considerable potential pay-off from vigorous extension of variety, fertilizer, and weed-control technologies, and the second is based on the prospective farm budget shown in text Table 8 for a typical small farm in Settat Province, a lower rainfall zone (250-400mm). Less agronomic research has been carried out in this region, and large gains from improved technology lie further down the road. Tillage to conserve moisture and weed control are the extendable technologies currently available. For both rainfall zones, however, there is considerable scope for improving forage production to support the flock of sheep and one or two milk cows which are an inevitable part of the rainfed crop farm in Morocco. In the higher rainfall areas forage systems using cereals-legume mixtures could easily replace low yielding maize and weed fallow. In the drier areas barley for grazing would serve the purpose at current levels of knowledge.

A. Development of a 24 ha farm in Meknes Province

The size of the farm is somewhat larger than the average for the Province. For simplicity it is assumed to be fully owner-operated, through this would be somewhat atypical. The crop mix with current practices (Table F.1) reflects the relative statistical distribution of these crops and fallow in the Province in 1979/80, and yields are the Province-wide averages for that season. Livestock holdings are very similar to those of the several operators of farms of about this size who were interviewed by Team members.

Custom hire of tractor-drawn tillage equipment and of combines for cereals harvest, simplifiying assumptions, are fairly common in Morocco for farms of this size, though Ministry of Agriculture and Agrarian Reform technicians estimate that there are only enough tractors in the country for 1/3 the cultivated land. An owner-operator of a farm this size has access to credit from the CRCA. The interest rate is 8.5 percent on seasonal loans, but placement fees bring that to about 10 percent.

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Table F.1 FINANCIAL ANALYSIS: INDICATIVE FARM BUDGET WITH CURRENT PRACTICES, MEKNES PROVINCE, 1980

(Family of six cultivating 24 ha and owning 1 cow, 30 sheep and 1 mule)

Value of Production

Crop	Area (ha)	Yield (qx/ha)	Production (qx)	Price (DH/qx)	Total Value of Production (DH)
Hard Wheat	8.0	6.3	50.4	125	6,300.0
Soft Wheat	2.5	15.0	37.5	145	5,437.5
Barley	4.0	13.9	55.6	90	5,004.0
Maize	0.5	8.5	4.2	102	428.4
Feve	1.0	6.3	6.3	157	989.1
Fallow	8.0	-	-	-	-
	24.0			Subtotal	18,159.0
Milk production, 300 liters x 1.2DH					360.0
Lamb sales, 20 x 125DH					2,500.0
Wool sales, 26 sheep sheared x 1.25 kg/head x 8DH/kg					260.0
				Subtotal	3,120.0
				Total value of production	21,279.0

Production Cost

Custom tillage on wheat and barley with cover crop x 80DH/ha	1,160.0
Work ration for mule, 30 days x 1 kg/day barley	27.0
Seed: Durum, 100 kg/ha; soft wheat, 80 kg/ha; barley, 100 kg/ha; maize, 30 kg/ha; feve, 30 kg/ha	1,712.4
Fertilizer: 150 kg 14-28-14/ha on cereals x 0.90DH/ha	2,025.0
Custom Harvest of Wheat and barley, 100DH/ha	1,450.0
Harvest labor for feve, 10 man-day, 20DH/day	200.0
Interest on cash expenses, 10%/yr, six months	327.4
Total Production cost	6,901.8
Total financial return to land, management and family labor	14,377.2

Notes to Table F.1

Crop mix reflects areas devoted to major crops as reported for Meknes province in 1979/80 and reported in MARA, Direction de la Planification et des Affaires Economiques. Enquete Agricole, Principales Productions Vegetales, Compagne Agricole, 1979-80, January 1980.

Yields are as reported for the rainfed area of the province in 1980 (Enquete Agricole).

Prices are as reported for the province in 1980 in MARA, Division des Affaires Economiques, Prix Payes aux Producteurs de 1974-75 a 1979-80, April 1981.

Lamb and wool sales. Flock has 28 ewes and has a lambing rate of 70 percent. This is a bit less than the average rate of 80 percent reported in Direction de l'Elevage, Enquete 1975. The Direction de l'Elevage also estimates that 86 percent of the sheep are sheared at 1.25 kg per head.

Cultivation and Harvesting. On a farm of this size tillage of cereals land is typically by custom hire tractor and tandem disk. Seed is broadcast by hand and covered in a light disk. Land for maize and feve is prepared with an animal drawn plow and seeded by hand. Cereals are harvested with a custom-hire combine. Feve is harvested by hand at 0.1 hectare per man-day (hired labor assumed). Maize is harvested with family labor.

Financial Picture

The budgeted net return to land and family labor and management of 14.4 thousand Dirhams is well above the country's median family income of about 6.8 thousand Dirhams[1/] (Table F.1). The gross value of production (sales and home consumption) is estimated at 21.3 thousand Dirhams, of which 85 percent is from crops and 15 percent is from livestock. Cash expenses of 6.9 thousand Dirhams are most directly allocable to the crop enterprises, though this overstates the case since cereals straw and stubble are major feed inputs. The livestock enterprises are important to the family's resource allocation since, other than feed, the major input is family labor which would be otherwise idle during the long slack periods on cereals farms.

The changes in farm land use, inputs, and production, as a result of a vigorous extension and production program, are shown in Table F.2. Prices for inputs and outputs are held constant to show the projected impact of such efforts in quantity terms.

In terms of land use, the major changes are reductions in the areas devoted to durum and to barley for grain. With higher yields, production of these two commodities can be maintained on less land. Bread wheat area expands significantly, consistent with the Government's price policies favoring bread wheat. Maize disappears from the cropping pattern due to its relatively low yield. Equally important is the conversion of part of the farm's fallow land to a cereals-legume forage which, along with a more than 50 percent increase in straw production, greatly increases the farm's feed resources.

1/ Estimated from data presented in T. H. Eighung, "A Statistical Description of Morocco's Poor," USAID/Rabat, May 1979.

Table F.2 -- FINANCIAL ANALYSIS: INDICATIVE FARM BUDGET WITH IMPROVED PRACTICES, MEKNES PROVINCE

(Family of six cultivating 24 ha and owning 1 cow, 30 sheep, and 1 mule)

Value of Production

Crop	Area (ha)	Yield (qx/ha)	Production (qx)	Price (DH/qx)	Total Value of Production (DH)
Hard wheat	5.0	11.0	55.0	125	6,875.0
Soft wheat	6.0	18.4	110.4	145	16,008.0
Barley	4.0	16.6	66.4	90	5,976.0
Feve	1.0	8.4	8.4	157	1,318.8
Forage	4.0	40.0 (dry matter)	160.0	-	-
Fallow	4.0	-	-	-	-
				Sub Total	30,177.8

Milk Production, 600 liters x 1.2 DH	720.0
Lamb sales, 25 x 200DH	5,000.0
Wool sales, 26 sheep sheared x 1.25 kg/head x 8DH/kg	260.0
Sub Total	5,980.0
Total value of production	36,157.8

Production Cost

Custom tillage of wheat, barley and forage with cover crop, 80 DH/ha	1,520.0
Work ration for mule, 30 days x 1 kg barley/day	27.0
Seed: Durum, 100kg/ha; bread wheat, 80kg/ha; feve, 30kg/ha; forage (barley-legume mixture), 100kg/ha	1,994.0
Fertilizer: 80kg/ha on cereals x 1.82DH/kg	2,184.0
40kgP_2O_5/ha on all crops x 1.30DH/kg	1,040.0
Herbicide on cereals, 2 l/ha x 70DH/l	2,100.0
Herbicide application with back-pack sprayer, 5 days x 40DH/day	200.0
Custom harvest of all cereals, 100DH/ha	1,500.0
Harvest labor for feve, 10 man-days x 20DH/days	200.0
Interest on cash expenses, 10%/year, six months	536.9
Total production cost	11,301.9
Total financial return to land, management and family labor	24,855.9

Notes to Table F.2

Crop Yields: Assumed to be 3/4 of those reported from recent varietal and fertilizer trials. Forage yield assumed at 2/3 the yield judged possible for this rainfall zone.

Crop Mix: Durum and barley areas assumed to be such as to produce approximately the same quantity of those commodities as was produced with former practices. Maize was removed from the crop mix due to its relatively low yield. One-half the area normally in fallow was planted to a barley-legume forage.

Cropping practices assumed: HYVs of cereals, fertilizer, and weed control.

Animal Production: Milk production and value of lambs sold judged to double with increased feed available. Increase in value of lambs due to higher lambing rates and sales at heavier weights.

Cost of Herbicide: 2 liters, 2,4-D preparation, conservatively priced at 70 DH/liter.

Herbicide Application: Back-pack sprayer, 3 ha per day. 20 DH per day for the applicator and 20 DH per day for the sprayer.

Increased crop yields result from the use of HYVs of wheat and barley, higher levels of nitrogen and phosphorus fertilization, and weed control.2/ The adoption of cultivated forage is, in part, necessitated by the control of weeds in cereals which reduces their availability as forage on succeeding years' fallow. Yields are estimated at 75 percent of those obtained in experimental variety and fertilizer trials in the same rainfall zone. With increased feed resources, meat and milk production are estimated to double from current low levels.

The net return to land and family labor and management is increased by 73 percent to 24.9 thousand Dirhams. Gross production of 36.2 thousand Dirhams is divided 83 percent from crops and 17 percent from livestock. Due to the use of cultivated forages, more of the cash costs are directly allocable to the livestock enterprise.

Further development potential for this farm exists. Cereals yields could be higher still with the use of improved tillage and seeding methods. The farm could profitably support more sheep with the conversion of additional fallow to forage production and with the use of caustic soda to increase the nutritional value of cereals straw.

Benefit-cost calculations for the development of this farm are shown in Table F.3. In financial terms, an increase in the value of production of 14.9 thousand Dirhams is associated with increased costs of 4.4 thousand, for a financial benefit-cost ratio of 3.4. In economic terms, in which benefits and costs are valued at prices estimated to reflect the economic alternatives available to the Moroccan economy, the benefit-cost ratio is 4.5.

2/ Chemical weed control was assumed in constructing the budget, but the net benefits of this method over others have not been determined for Moroccan conditions.

Table F.3 -- ECONOMIC ANALYSIS: CHANGES IN FARM PRODUCTION AND COSTS AS A RESULT OF IMPROVED PRACTICES AND VALUED AT ECONOMIC PRICES, 24 HA FARM IN MEKNES PROVINCE

Item	Change (DH)	Ratio-Economic Price to Market Price	Economic Value of Change (DH)
Production			
Hard Wheat	575.0	0.77 3/	442.8
Bread Wheat	10,570.5	0.74 3/	7,822.2
Barley	972.0	1.02 3/	991.4
Maize	-428.4	0.87 3/	-372.7
Feve	329.7	1.08	356.1
Milk	360.0	0.71	255.6
Lambs	2,500.0	0.84	2,100.0
Total Change in Production	14,878.8		11,595.4
Cost			
Custom tillage	360.0	0.51	183.6
Seed	281.6	0.80 4/	225.3
Seed			
Fertilizer:			
14-28-14	-2,025.0	1.47 5/	-2,976.8
N	2,184.0	1.25 5/	2,730.0
P_2O_5	1,040.0	1.76 5/	1,830.4
Herbicide	2,100.0	0.62	1,302.0
Herbicide Application	200.0	0.52 6/	104.0
Custom Harvest	50.0	0.51	25.5
Interest	209.5	2.00 7/	419.0
Total Change in Cost	4,400.1		2,554.2
Net change in Production	10,478.7		9,041.2
Benefit cost ratios	3.4		4.5

Notes to Table F.3

1/ Value of item with improved practices less the value of the item with current practices.

2/ Except as noted, these ratios are as estimated by IBRD staff and consultants.

3/ Based on village market prices in Meknes Province, rather than government support prices.

4/ Average of all seeds which are assumed to be produced on the farm.

5/ Re-estimated from 1980 import (N) and cost price (P_2O_5) information.

6/ Average of unskilled labor and machinery services ratios.

7/ Shadow interest rate twice that of the CNCA assumed.

B. Development of a 7 ha farm in Settat Province

The budgets for this farm are based on that shown in text Table 8. Certain simplifying assumptions were made to facilitate the benefit-cost analysis. The most important of these is that the farm is fully owner-operated, resulting in crop yields and total production higher than that shown in the text table.

Financial Picture

The budgeted net return to land, management, and farm family labor, 5.8 thousand Dirhams, is below the median family income in Morocco, and gross value of production, 7.4 thousand Dirhams, is divided 82 percent for crops and 18 percent for livestock (Table F.4).

A vigorous extension and production program in this region is projected to result in a modest increase in crop yields and significant changes in land use (Table F.5). Low yielding maize is no longer planted. That area is assumed to be divided between the planting of an annual forage crop (barley) and durum which, due to significantly higher prices, is somewhat more profitable than barley for grain.

Technologies currently recommended for yield improvement in this rainfall zone are tillage to conserve moisture and weed control (Chemical control was assumed).

Table F.4 -- FINANCIAL ANALYSIS: INDICATIVE FARM BUDGET WITH CURRENT PRACTICES, SETTAT PROVINCE, 1980

(Family of six cultivating 7.0 ha owning 1 cow, 10 sheep and 1 mule)

Value of Production

Crop	Area (ha)	Yields (qx/ha)	Total Production (qx)	Av. Producer Prices, Settat Province, 1980 (DH/qx)	Total Value Production (DH)
Hard Wheat	1.33	10.0	13.3	122	1,622.6
Soft Wheat	0.67	9.5	6.4	109	697.6
Barley	2.40	12.6	30.2	89	2,687.8
Maize	2.03	5.3	10.8	78	842.4
Feve	0.22	8.0	1.8	114	205.2
Fallow	0.33	-	-	-	-
	6.98			Sub total	6,055.6

Milk sales:	(during March/April/May) 300 litres x 1.2 DH	360.0
Lamb sales:	7 lambs at 125 DH/head	875.0
Wool sales:	9 sheep sheared at 1.25 DH/head x 8 DH/kg	90.0
	Sub total	1,325.0
	Total value of production	7,380.6

Production Costs

Custom disking on all wheat @ 50 DH/ha	100.0
Work ration for mule: 60 days x 1 kg barley	53.4
August/November ration for cow: 120 days x 1 kg barley	106.8

Seeding Rates

Hard wheat 100 kg/ha; soft wheat 80 kg/ha; barley 100 kg/ha; maize 30 kg/ha; feve 30 kg/ha	489.3
Fertilizer: 14-28-14 for wheat: 200 kg/ha x 0.90 DH/kg	360.0
Harvest labor for all wheat: 5 men x 20 DH/day x 5 days	500.0
Total production costs	1,609.5
Net return to land, management and family labor	5,771.1

Notes to Table F.4

The budget was modified somewhat from that shown in text Table 8 for simplicity and consistency. It is assumed that all land is owned by the farmer, with the crop mix for the total farm remaining unchanged. Changes resulting from this assumption are:

1) Yields for entire farm equal to those shown formerly only for the owned portion.

2) Seeding and fertilizer use rates are also increased by the same factor.

The type of fertilizer used was changed to 14-28-14, the most common in use on Moroccan farms.

Lambs sales and numbers of sheep sold were adjusted to eliminate fractions of animals.

Milk sales were increased to recognize the value of home consumption.

Table F.5 -- FINANCIAL ANALYSIS: INDICATIVE FARM BUDGET WITH IMPROVED PRACTICES, SETTAT PROVINCES, 1980

(Family of six cultivating 7.0 ha owning 1 cow, 10 sheep and 1 mule)

Value of Production

Crop	Area (ha)	Yield (qx/ha)	Production (qx)	Price (DH/qx)	Total Value of Production (DH)
Hard Wheat	2.53	13.3	33.6	122	4,099.2
Soft Wheat	0.67	12.7	8.5	109	926.5
Barley	2.40	16.8	40.3	89	3,586.6
Feve	0.22	10.9	2.4	114	273.6
Forage	0.83	34.0 (dry matter)	28.2		
Fallow	0.33	-	-	-	-
	6.98			Sub total	8,886.0

Milk production, 600 liters x 1.2 Dh	720.0
Lamb sales, 8 lambs @ 200 Dh/head	1,600.0
Wool sales, 9 sheep sheared @ 1.25 kg/head x 8 Dh/kg	90.0
Sub total	2,410.0
Total value of production	11,296.0

Production Cost

Custom tillage of wheat and barley with sweep; cover crop after broadcast seeding @ 80 Dh/ha	448.0
Work ration for mule: 30 days x 1 kg barley/day	26.7
Ration for cow, 120 days x 1 kg barley/day	106.8
Seed: Durum, 100 kg/ha soft wheat; 80 kg/ha; barley and barley forage, 100 kg/ha; feve, 30 kg/ha	662.1
Fertilizer: 30 kgN/ha on cereals and barley forage @ 1.82 Dh/kg	351.1
20 kg P_2O_5/ha on all crops @ 1.30 Dh/kg	172.9
Herbicides on cereals and forage, 2 l/ha @ 70 Dh/l	900.2
Herbicide application with back pack sprayer, 2 days @ 40 Dh/day	80.0
Harvest labor, 58 men/day @ 20 Dh/day	1,160.0
Total production costs	3,907.8
Net return to land, management and family labor	7,388.2

Notes to Table F.5

Crops yields are judged to increase by 1/3 as a result of improved practices. Forage yield (barley) set at twice the grain yield of that portion harvested as grain.

Crops mix: Maize was removed from crop mix due to its low productivity. Soft wheat, barley, feve, and fallow areas assumed unchanged. The 2.03 ha in maize were allocated to hard wheat (1.2 ha) and forage (0.83 ha). Cropping practices assumed: Reduced tillage to conserve moisture and weed control with a herbicide.

Animal production: Milk production and value of lambs produced were judged to almost double as a result of increased feed availability. Increase in the value of lambs is due to a slightly higher lambing rate and lambs sold at heavier weights.

Herbicide: 2 liters of 2,4-D preparation, conservatively priced at 70 DH/l. Application with a back-pack sprayer at the rate of 3 ha/da. Cost is 20 DH/day for the application and 20 DH/day for the sprayer.

Research on HYVs and fertilizer use for this region is recommended as part of the strategy and is, in fact, already underway.

With the higher level of production of forages as a result of the change, livestock production, milk and lambs, almost doubles.

The gross value of production on this farm is judged to increase to 11.3 thousand Dirhams (79 percent from crops and 21 percent from livestock). Net return rises to 7.4 thousand Dirhams, with more of the direct cost allowable to livestock.

The benefit-cost summary is shown in Table F.6. Increased costs of 2.3 thousand Dirhams give an increased value of production of 3.9 thousand for a financial benefit cost ratio of 1.7. When benefits and costs are valued at their estimated economic prices, the ratio rises to 2.1.

These ratios for the small farm in Settat Province are about 1/2 those for the larger farm in Meknes. The difference, for the most part, results from the higher average rainfall in Meknes Province, permitting greater opportunity for the use of new technology. Little of the difference can be attributed disparities in farm size. Only one cost element is affected by size: The larger farm was judged to be more susceptible to combine harvesting of cereals than was the smaller and, at 100 DH/ha, this is about half the rate of hand harvest.

Table F.6 -- ECONOMIC ANALYSIS: CHANGES IN FARM PRODUCTION AND COSTS IS A RESULT OF IMPROVED PRACTICES AND VALUED AT ECONOMIC PRICES, 7.0 HA FARM IN SETTAT PROVINCE*

Item	Change (Dh)	Ratio: Economic Prices to Market Prices	Economic Value of Change (Dh)
Production:			
Hard Wheat	2,476.6	0.77	1,907.0
Bread Wheat	228.9	0.74	169.4
Barley	898.0	1.02	916.9
Maize	-842.4	0.87	-841.5
Feve	68.4	1.08	73.9
Milk	360.0	0.71	255.6
Lambs	725.0	0.84	609.0
Total Change in Production	3,915.4		3,090.3
Cost:			
Custom tillage	348.0	0.51	177.5
Work ratio for mule	-26.7	1.02	-17.1
Seed	172.9	0.80	138.3
Fertilizer:			
14-28-14	-360.0	1.47	-529.2
N	351.1	1.25	438.9
P_2O_5	172.8	1.76	304.1
Herbicide	900.2	0.62	558.1
Herbicide Application	80.0	0.52	41.6
Harvest Labor	660.0	0.51	336.6
Total Change in Cost:	2,298.3		1,448.8
Net Change in Production:	1,617.1		1,641.5
Benefit - Cost Ratios:	1.7		2.1

*See notes to Table 3.

II. DISTRIBUTION OF PROGRAM BENEFIT

In general, the cereals development strategy outlined in this report recommends both a greatly expanded crop, forage and livestock research program and a cereals and forage production program to the extent one is supportable by existing research results. Initially greater emphasis is to be given to production programs in areas where the annual rainfall averages 400 mm and above, and greater emphasis is to be given to research in areas of annual rainfall below 400 mm. It is this latter rainfall zone in which availability of research results most severely limits the production program.

Over the early life (3-5 years) of the cereals development program, the distribution of program benefits will favor farmers in the higher rainfall areas. There is no way of knowing whether or not later years' benefits will be weighted in favor of farmers in the drier areas, but discounting future benefits at any reasonable rate of interest reduced the likelihood of an equal distribution of benefits between these two sets of farmers.

Data available to the team on farm sizes or farm income by rainfall zone is sparse. Table F.7 shows the rural population density per km^2 of arable land for six major rainfed cereals producing provinces in three average rainfall zones. Assuming farm size is correlated with population density, there is a direct relationship between farm size and rainfall. But this is believed to be largely associated with the concentration of large farms in the higher rainfall plains areas best suited to cereals, not necessarily to the distribution of farms below 10 ha. It is true that similar soils in higher rainfall areas are more productive than in drier areas.

Information by province on rates of illiteracy, persons per medical doctor and infant mortality are all skewed against the drier cereals producing regions,[3/] further indicating that initial program benefits will tend to favor the better off of the low income small farmer category.

The strategy team does not regard these considerations as weightly arguments against the recommended program. There does not appear to be any way absolute levels of income will fall as a result of this strategy. Production by low income farmers will not decline. Price impacts will be negligible, since sector-wide output is not likely to grow at rates much beyond those of demand growth, and in so far as they do, the major impact will be that of import substitution.

3/ T. H. Eighmy, "A Statistical Description of Morocco's Poor" USAID/Rabat, May 1975

Table F.7 -- RURAL POPULATION DENSITY IN SIX MAJOR RAINFED CEREALS PRODUCING PROVINCES GROUPED BY RAINFALL ZONE

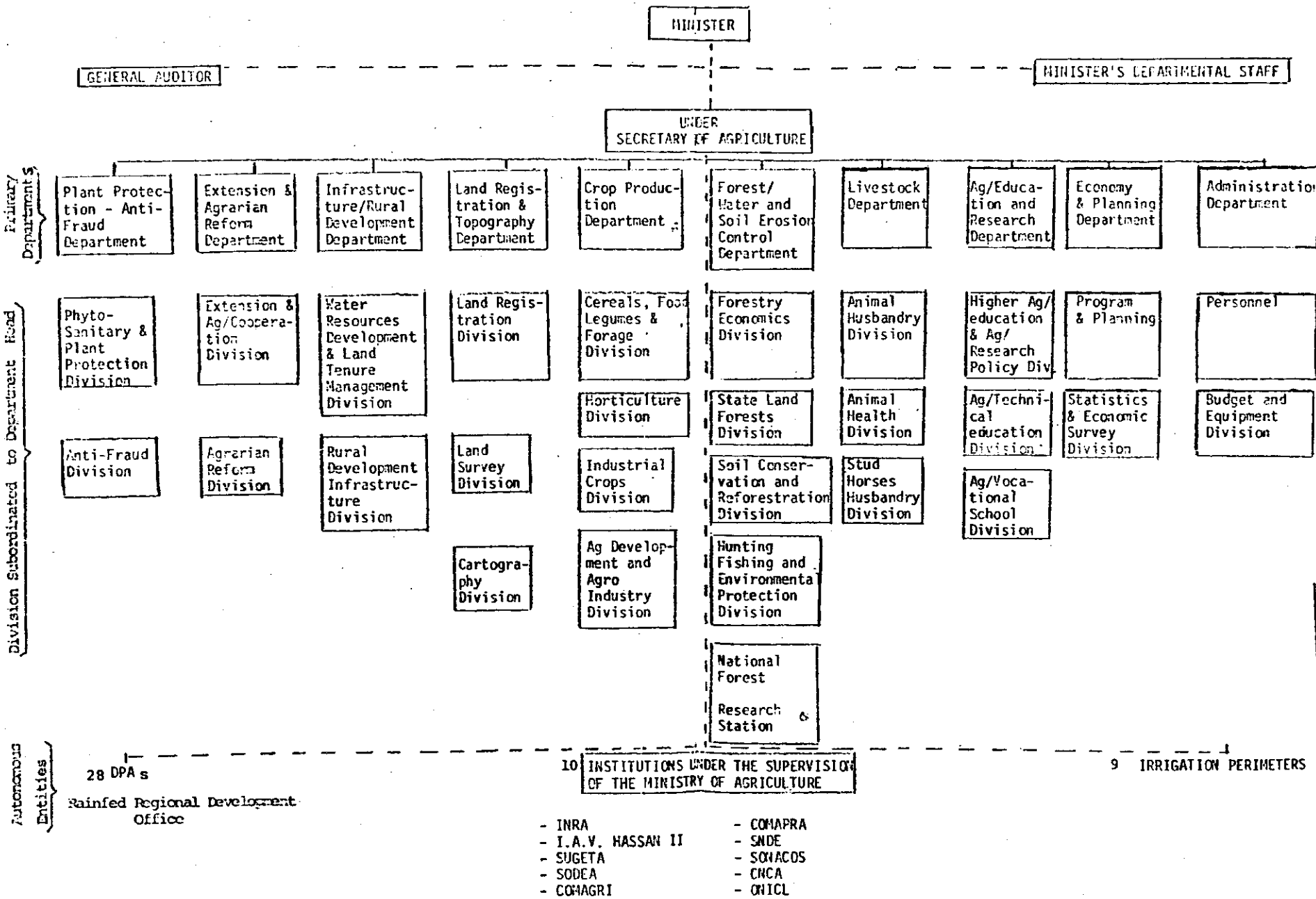
Rainfall Zone Province	Area of Arable land (km2)	Rural Population (1000 persons)	Rural Population Density** (persons/km2)
High Average Rainfall (450 mm), Khemisset, Meknes	6,864	664.7	96.8
Medium Average Rainfall (300-400 mm) Settat, Essaouira	9,079	931.6	102.6
Low Average Rainfall (250-300 mm) El Kelaa, Marrakech	10,903	1,206.4	110.6

** Rural population per km2 of arable land.

Sources: Arable land and rural population are 1979 estimates by the Ministry of the Plan. Average rainfall estimates were judgments made from a rainfall map of Morocco.

Further, it is unlikely that initially productivity in the drier areas can be increased significantly more rapidly than is implied by the proposed strategy. The major problem is that of the lack of a set of readily adoptable technologies for those regions. It is not probable that the Moroccan institutions concerned can absorb the necessary technology generating resources at a rate greater than the strategy suggests.

MINISTRY OF AGRICULTURE AND AGRARIAN REFORM (M.A.R.A.)



APPENDIX G

farmers could afford it have been mechanized. This has been estimated to cover about 1/3 of the total crop area. The IBRD, in reviewing proposed mechanization financing, concluded that farmers could get an average of 300 kg more grain per ha (other things being equal) if they had tractor power and plowed and planted before the rains came (or very soon after the first rains). Based on this and labor savings, mechanization was found to exceed the economic threshold on larger farms.

Little interest is encountered in animal mechanization. The reason given is that it could not overcome the problem of delayed planting. That is, that it could not realize the gains possible with planting before or soon after the first rains. The team believes this is, at most, only partially true. Considerable returns from earlier planting appear possible with lower energy-using tillage systems based on animal power. Further, evidence indicates that considerable yield gains can be achieved by better seed and fertilizer placement with some savings on seed.

Just how far this can go must be determined by on-farm trials. Small scale mechanization will require development and testing of better systems and equipment and then work with small scale manufacturers to produce and market simple equipment.

Some research work is planned under the Dryland Research Project. This needs to be much expanded, and the phases of introduction and testing of simple equipment and its manufacture and distribution provided for. This will require animal or small tractor mechanization.

Even for large tractor mechanization, production scientists with experience in other similar areas, consider the implements and methods used - deep plowing and use of the "cover crop" not well suited to the moisture conservation needs of the lower rainfall areas of Morocco.

In summary, considerably more work is needed in testing, adaptation and then manufacture and distribution of better suited tillage equipment and systems, especially for small scale operations. Ultimately, to make a major impact, this will require manufacture and distribution on a large scale. Hopefully, much of the distribution could be managed by existing private enterprises supplying rural families with other goods and the integrated rural development program credit used to finance farmer purchases.

As small an investment in small scale equipment as $100/ha spread over 2 million has. would total $200 million.

D. Fertilizer, Seeds and Pesticides

The key inputs in the higher yield packages generally are considered to be technical know-how, high yielding seeds, fertilizer and pest management. A major part of the last item includes use of pesticides. Technical know-how (research and extension) are covered in the next section. Improved tillage tools to conserve and better use moisture were briefly covered earlier.

Fertilizer, pesticides and high yielding seeds have much in common in the nature of their supply and distribution. In Morocco they are inadequate in supply, and the distribution system is inadequate to make them conveniently available to farmers where and as needed.

By far the largest in volume and cost of these inputs is fertilizer which currently totals 500-600,000 mt/year or 170-190,000 mt of N, P_2O_5 and K_2O (Table 1) 2/. This is generally believed to be only about one-fourth of the amount needed for optimal crop production under currently known technology. Improved cereal seed moving through commercial channels currently is 30,000-50,000 tons, about 1/2 that required for seed replacement every five years. Pesticide use on cereals is extremely low.

1. Fertilizer

Morocco has over half of the world's phosphate reserves and is the world's largest exporter of this commodity. Morocco is able to supply all of its phosphate requirements, but it still must import most nitrogen and potassium fertilizers. Morocco produces a large part of the mixed fertilizer used in the country.

2/ Ministry of Agriculture technicians estimate that fertilizer use is distributed as (1) irrigated areas 33%, (2) rainfed land with over 400 mm rainfall annually 44%, (3) rainfed land with 250-400 mm rainfall annually 23%, and nationwide at about 27 nutrient kg per hectare.

Table E.1 -- TOTAL CONSUMPTION OF FERTILIZER

Year	Nutrients (N-P-K)	Product
	(.....1000 tons.....)	
1965	56.5	NA
1966	67.6	NA
1967	79.9	NA
1968	95.9	NA
1969	87.0	NA
1970	NA	272.5
1971	NA	274.5
1972	NA	320.1
1973	NA	375.5
1974	NA	427.9
1975	NA	494.2
1976	NA	450.0
1977	162.0	459.0
1978	164.0	492.0
1979	199.0	563.0
1980	192.0	548.0
1981	194.0*	553.0*

NA - Not available.

*Preliminary data

Source: BMCE

For the last few years, phosphate rock production reached about 20,000,000 mt/yr of which 85 percent is exported and the remaining is processed in the country (Table 2). Until 1965, Morocco used to export all its phosphate production as a raw material.

Table 2 -- PHOSPHATE ROCK PRODUCTION AND DISTRIBUTION
(1,000 tons)

Year	Production	Exports	Domestic Sales
1970	10,711	11,537	360
1971	12,493	11,868	550
1972	16,520	13,559	600
1973	18,389	16,109	670
1974	19,749	18,700	620
1975	14,119	13,011	510
1976	15,656	14,651	790
1977	17,572	15,791	1,580
1978	19,272	17,264	1,850
1979	19,999	17,960	2,230
1980	20,800	16,527	2,400

Source: Information assembled by the Office of the US Agricultural Attache, Rabat.

With the installation of the four industrial chemical plants in Safi areas, Morocco starts to process a part of its production to be used either for local consumption or export.

The processing capacities and products of these four industrial plants which are under the Office Cherifienne des Phosphates (OCP), are:

OCP Group	Yearly processing capacity	Products TSP, ASP
Maroc Chimie I	180,000 mt P_2O_5	14-28-14
Maroc Chimie II	165,000 mt P_2O_5	MAP, acid
Maroc Phosphore I	495,000 mt P_2O_5	MAP, acid
Maroc Phosphore II	495,000 mt P_2O_5	MAP, acid

Fertilizer imports (N and K) are monopolized by the parastatal company FERTIMA. The quantities and values of nitrogen and potassium fertilizer in recent years is shown in Table 3, FERTIMA and the OCP supply primary materials (Urea, TSP, potassium sulfate, etc.) to private mixers mostly located in Casablanca who produce blends such as 14-28-14. Blends commonly are used on cereals, although there is little evidence that potassium is needed except in rare cases, and there are serious doubts on the need of phosphate in most cases. One of the rationales for the 14-28-14 blend is that it is part of a process of converting farmers to use more N. Until recently farmers used little except phosphate. The evidence points to general need for more N on grain, except possibly for low yield targets where grain follows grain-legumes or fallow with heavy natural forage legume growth. Amounts and methods of using nitrogen in the lowest rainfall crop areas still require much more research. Inadequate supply and distribution of fertilizer and suitable seeds has been identified by Moroccan and foreign plant and social scientists as a major constraint - usually too little, too late and too far away.

Table 3 -- FERTILIZER IMPORTS: QUANTITES COSTS, UNIT VALUES

Item	1979 Quantity (1000 t)	1979 Total Value (Dh 1000)	1979 Unit Value (Dh/t)	1980 Quantity (1000 t)	1980 Total Value (Dh 1000)	1980 Unit Value (Dh/t)	1981 (11 months) Quantity (1000 t)	1981 (11 months) Total Value (Dh 1000)	1981 (11 months) Unit Value (Dh/t)
Urea (46-0-0)	86	58800	684	103	88700	861	34	40100	1179
Ammonium Nitrate (33.5-0-0)	71	44100	621	76	63000	829	44	52200	1186
Ammonium Sulfate (21-0-0)	94	33400	355	75	30300	404	84	53700	639
Potash Sulfate (0-0-50)	47	26700	568	37	25900	700	35	37700	1077
NPK mix (14-28-14)	27	19600	726	*	200	-	*	300	-
Muriate of Potash (0-0-61)	36	11600	322	42	17200	410	31	22200	716
Miscellaneous	3	2300	767	5	4900	980	1	2500	2500
TOTALS	364	196500		338	230200		229	208700	

*Less than 500 tons

Source: Information supplied by the Office of the U.S. Agricultural Attache, Rabat.

Retail fertilizer prices (Table E.4) have been maintained below import prices and phosphate production prices by subsidies paid to FERTIMA by the Caisse de Compensation. These range from about 20 percent for uses to about 43 percent for TSP.

Table E.4 -- FERTILIZER PRICES (DH/MT)

Imported Fertilizer	Retail Prices to Farmers, bagged/loaded (Casablanca Port)	
	1978/79	1979/80 and 1980/81
Urea	659.10	790.90
Ammonium Nitrate (33.5-0-0)	590.50	708.60
Ammonium Nitrate (34.8-0-0)	619.80	743.80
Ammonium Sulphate (21-0-0)	379.90	455.90
Potassium Chloride, granular (0-0-61)	447.30	536.80
Potassium Chloride, pulverized (0-0-61)	404.90	485.90
Local Mixes	(Safi)	
ASP (19-38-0)	641.50	735.70
TSP (0-46-0)	473.50	533.40
14-28-14 granular	710.30	818.30

Source: Caisse de Compensation

The principal official channel for distribution of fertilizer is from warehouses of FERTIMA and the blending companies located in principal cities, to large farmers or private retailers at a uniform price for the district and virtually the same price nationally. Private dealers take it back to more remote points for sale at prices sufficient to cover their costs and some profit (they hope). Small amounts (about 10

percent of the total) are distributed by the Ministry of Agriculture through 263 distribution points located at irrigation perimeters and, in the rainfed areas, at the Centres des Traveaux (CT). Given the very small CT network (one for each 5,000-6,000 crop producers) the current system must depend heavily on private initiation to move fertilizer closer to farms. (Some efforts are being made to move inputs through cooperatives and small farmer groups.) Since there is no explicit provision for margins for private distributors, the manner of ex-warehouse pricing would effectively preclude dealers from most large volume sales to larger farmers. The pricing structure is such that aggressive private sale and stocking for that purpose is unlikely. It was pointed out that private dealers do not carry significant stocks. This is partly because of the margin problem and partly that demand currently varies widely from year to year and between areas in a given year, depending on amount and timing of rainfall. This variation in demand is related to farmers' perception of the fertilizer-rainfall-crop yield relationships. In the long run there may be considerable shift in these perceptions with more experience and better tillage system, but now it exists as a major factor and must be dealt with initially by creating necessary flexibility in the distribution system.

If no other alternative exists, public warehouses will need to carry sufficient stocks to meet needs in years of good rainfall and be prepared to deal with excess stocks in less satisfactory years. The system must provide adequate stocks in hand early enough to fully supply farmers directly and indirectly through dealers when abundant rains arrive early. In a shortage situation, which has frequently existed, favorably situated farmers with transport undoubtedly have had first call, while small farmers dependent on dealers were in a much less favored position to obtain any. They were thus probably subjected to higher prices when conditions were considered favorable and demand increased. One would expect supplies through dealers to be small and to arrive late. In contrast, in a year perceived to be unfavorable, dealers and small farmers probably had little difficulty obtaining supplies. Small farmers are in the poorest position to bear the risks of early purchase and carry-over or the use of fertilizer in less favorable situations.

A large program is under consideration by the Ministry of Agriculture's Direction de la Production Vegetale which would vastly increase the network of fertilizer storage and mixing facilities and outlets. As conceived, this $120 million program would be largely in the public sector. U.S. assistance in alleviating these problems of inadequate and late supply and too limited distribution should be accorded high priority. It would be an excellent candidate for future U.S.

funding from DA, PL 480 and ESF. Most of the costs, other than import of additional fertilizer, small amounts of T.A. and equipment, would be local costs.

It would require considerable study, focusing especially on reconciliation and definition of private and public roles and margins and how to manage stocks in situations of varying year to year rains and demand.

At present nitrogen use on cereals in the above 300 mm rainfall area is probably 12-14 kg/ha. Raising this to 30 kg (75 percent of the minimum indication) would require 50-60,000 mt of additional N per year which would cost (CIF) $30-40 million per year. This should produce 600,000-700,000 mt of additional cereals per year valued at $90-120 million/year (CIF).

A major part of the needed expansion or the input distribution system for inputs might be achieved by some increase in fertilizer and seed prices and providing dealers with a formal and better margin. Financing might be provided to help them build and carry stocks. The greatly increased fertilizer application rates probably would also require some increase in storage and transport capacity and scheduling and stock management. Costs of improved planning and management would be items particularly suitable for DA along with some systems improvements.

The major objectives of the program would be: (a) to increase greatly the use of fertilizer, especially nitrogen on cereals; and (b) to reduce the sharp disparities in access of large vs. small farmers, rich vs. poor, and favorably located vs. remotely located farmers. The purpose would be to make the right kind of fertilizer available in unrestricted quantities in every village and souk throughout the crop areas. This probably would require 10,000 or more outlets.

U.S. resources might be used to help finance:

1. Expanded public and private storage and mixing.

2. Expanded truck capacity to permit more rapid resupply of warehouses.

3. Carry-over costs of excess stocks in a poor off-take year (funds at concessional interest but not to cover stock risk per se).

4. Financing of private dealer stock accumulation prior to application times.

5. Special arrangements for short-term credit to small farmers to buy fertilizer, e.g. through CLCA.

6. Methods for channeling inputs through small farmer groups.

7. Early scheduling and import of sufficient nitrogen fertilizer to alleviate the problem of supplies arriving late.

8. Analysis of supply, demand, scheduling and means for creating a better system for supply management. This might include study of the impact of subsidies and input pricing.

9. Cooperation between government agencies (e.g., DPV, Extension, INRA) and fertilizer dealers to supply the latter with information to pass to farmers on better use of fertilizer.

10. Use of private dealers to channel soil samples to laboratories and test results to farmers.

2. Seed and Pesticides

Most of the problems for fertilizer apply equally to seeds and fertilizer. In Morocco the high-yielding varieties of wheat and barley are produced by the National Agronomic Institute (INRA) on its experiment stations and/or through contracts with highly modern farmers.

This seed from INRA is purchased by a government company, Societe Nationale de Commercialisation des Semences (SONACOS). SONACOS was established a few years ago with the main duty of assuring an adequate distribution of seed of the high-yield varieties (HYVs) and to import any kind of seed not available in the country. Improved seed is obtained by farmers from about 200 distribution outlets throughout Morocco which are overseen by SONACOS. The storage capacity of SONACOS is at least 240,000 mt with most of it in the north of the Country:

Location	Capacity	Rainfall
Fes	70,000 mt	Over 400 mm
Kenitra	50,000	"
Casablanca	20,000	"
Rommani	20,000	Irrigated zone
Fkih Ben Salah	20,000	"
Sidi Bennour	10,000	"
Marrakech	NA	
Agadir	NA	
Settat	NA	
Meknes	50,000	Over 400 mm

SONACOS distributes about fifteen varieties of cereals:

- Durum Wheat: 2777, 2909, 1658, COCORIT and JORI.
- Bread Wheat: NASAM 149, 2306, POTAM and SIETE CERROS.
- Barley: 071, 905 and 895.

They are sold at prices fixed by the Government. Prices of COCORIT and NASMA 149, at DH 235/qx and DH 170/qx, respectively, contain a subsidy of about 20 percent.

According to the Ministry of Agriculture, for the last two years the availability of selected seed was

1980	52,000 mt
1981	71,700
1982 (estimation)	50,000

In 1980, only 33,400 mt of high-yielding varieties seed or 60 percent of the total selected seed available was used by farmers, and this is estimated to be about 12 percent of all cereals seed used.

The lack of a network of seed outlets reaching near farms has been identified as one problem. At present for this reason, and doubts about quality and suitability, HYVs are not widely used despite subsidies.

Pesticide use (weedicides, insecticides and fungicides) are not widely used, especially by small farmers. Again supply, distribution, technical information and application equipment are all problems.

Both improved seeds and pesticides supply and distribution problems might be addressed in part in conjunction with the fertilizer supply and distribution program activities listed above. The additional cost would probably not be large compared with requirements for adequate supply and distribution of fertilizer, but the network of retailers would need to be about equally large if small farmers are to be served adequately.

The efforts to remove the current serious development constraints imposed by poor scheduling and an inadequate supply and distribution network for inputs should be a major focus of U.S. assistance drawing on available DA, PL 480 and ESF resources. Major increases in imports of nitrogen might be financed, for example, by supplying PL 480 funds to finance

wheat and vegetable oil imports which would free GOM foreign exchange to import nitrogen fertilizer.

II. Agricultural Credit

Agricultural credit is the responsibility of the Caisse Nationale de Credit Agricole (CNCA) which was created in 1962 as a government institution to serve commercial agriculture. It operates through about 100 regional branches called "Caisse Regionale de Credit Agricole" (CRCA) and "Caisse Locale de Credit Agricole: (CLCA).

Until 1973, there also existed a network of local credit and welfare organizations called "Credit Assistance Organization" (CAO), created during the French protectorate, but they were absorbed into the CRCA organization.

During the past twelve years, CNCA, reflecting government policy, extended credit primarily to large and medium farmers and to cooperatives grouping small farmers. The CRCA used to serve the large and the medium farmers, the CLCA the small farmers only, but from March 1981, the Agricultural Credit Bank CNCA: (CRCA + CLCA) has been directed to refocus all activities to small and medium farmers. Farmers with large holdings, who previously drew heavily on CNCA, will now have to turn to commercial sources of credit. The CNCA (CRCA + CLCA) now will provide credit at subsidized rates of about 8 1/2 percent to small and medium farmers only. This rate is much below the one used by higher income farmers from banks and other sources in Morocco.

The CNCA credit to farmers is divided into three parts:

Long-term	:	6 to 25 years
Medium-term	:	2 to 5 years
Short-term	:	3 months to 1 year

Since the CNCA requires a heavy guaranty from farmers for long-term credit, the medium- and the short-term credit are the only ones used by farmers. Long-term credit has been used only in special cases. Due to the new GOM policy promoting farm machinery and to the high prices of farm equipment, early in 1982 the CNCA was directed to shift many items under medium-term to long-term. This will also be applied to provide added capital to small and medium farms for such items as high producing cows.

By 1980 the CNCA has reached only about 400,000 of about 2,200,000 farmers in Morocco. The total lending of DH 745 million has been distributed as follows:

Short-term :	DH	430 million
Medium-term :		315 million
	DH	745 million

In 1980, loans for the 1981 and 1982 crop seasons were predicted as follows:

1981		1982	
Short-term :	DH 735 million	Short-term :	DH 945 million
Medium-term :	600 million	Medium-term :	800 million
	DH 1335 million		DH 1645 million

Because of the drought in 1985 and during early land preparation for 1981-1982 crop, the volume of lending probably was much larger. No information has yet been released on this subject by the CNCA.

A major effort has been made by the credit bank to reach more small and medium size farmers. Lengthy and complex lending procedures have been simplified, and the minimum income required to qualify for a loan has been set at a lower level. Thus, all farmers with income of at least DH 1,000 per year were eligible for credit.

However, more effort will have to be made on the decentralization of the CNCA credit centers. A continuous survey, of farm credit usage is needed to permit the GOM to identify the reasons why a majority of the Moroccan small- and medium-size farmers do not benefit from subsidized credit.

Aside from the CNCA facilities, credit from other farmers, merchants and dealers exists in the rainfed zones. This kind of credit plays a large role, especially after a bad harvest. Farmers borrow either money or kind, such as seed from a neighbor, that is paid for in money or a share of the crop at harvest time. Little is known of the amount, terms or adequacy of credit from these sources.

III. Institutional Issues

The program outlined in this strategy contains few surprises. Its core elements relate to the development of improved production technologies and their adoption by farmers. For the higher rainfall areas, there appear to be suitable technologies (HYVs, soil fertilility, weed control, etc.) which are beyond the development stage. For the lower rainfall areas (below 300 mm annual average rainfall), much development work remains.

The Moroccan agencies with which USAID must work in implementing this core strategy are those concerned with

agricultural research, extension, production campaigns, and social science analysis for policy formulation. These agencies are:

1. Ministere de l'Agriculture et de la Reforme Agraire

   - Institut National de la Recherche Agronomique (INRA)
     (Crop and livestock research)

   - Direction de la Vulgarisation
     (Agricultural extension)

   - Direction de la Production Vegetale
     (Production campaigns)

   - Direction de la Planification et des Affaires Economiques
     (Agricultural statistics and economic analysis)

   - Institut National Agronomique et Veterinaire, Hassan II (INAV)

     (Agricultural and Social Science Research and Instruction)

The following comments are based largely on all-too-brief visits with persons in leadership positions in these agencies, on limited field visits to INRA research work in progress, and on observations of others familiar with their activities.

A. Research

Research topics the team believes to be critical to Morocco's cereals development program are listed elsewhere in this report. To a great degree these have been recognized by the INRA staff in its own research planning. An overall set of research objectives, commodity group, has been determined through a complex ranking process.3/ Cereals, red meat and

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3/ MARA, INRA. Plan Directeur: Essai de Hierarchisation des Objectifs de Recherche. Undated (1981). Ranking criteria were:

- Contribution to agricultural gross domestic product
- Contribution to household consumption budgets
- Contribution as input to industrial sector
- Contribution to exports
- Percent of self-sufficiency, current and projected
- Susceptibility to vigorous extension efforts

vegetable oils are seen from this exercise as requiring major research and extension efforts. Forages, the critical input group restraining meat production, are ranked low on the list of priorities. This, though unfortunate, is not surprising. Since the bulk of forage production is transformed through livestock within the agricultural sector, there is no way the ranking criteria could capture its importance. For our purposes, an important significance of this exercise is its indication that the agency is attempting, formally, to look beyond itself in the identification of research priorities.

INRA staff have listed 32 research projects for winter cereals and 19 for spring cereals (maize, sorghum, and rice) as priority topics for that subsector over the next few years.4/ Although one could easily question some of the projects as being only of minor importance to the primary objective of increasing overall cereals production (e.g., breeding research for triticales and malting barley), in the main they cover the major topics recommended for cereals in this report. Unfortunately, the team did not see material on INRA's research plans for forages and livestock.

Of equal importance to the research topics to be treated is the mode in which they are carried out. Limited observation and discussion with persons familiar with research operations in Morocco suggests that attention be given to several issues:

1. Basing current and future research on the results of past work. Some review of past work was presented in a recent research seminar held in Settat.5/ The team also understands that an INRA staff member has been assigned the task of synthesizing past cereals research results as a basis for further work and extension programs. This should be accelerated.

2. Research appears to be too closely confined to experiment stations, with the result that resources are devoted to fine-tuning particular technologies and further confirmation of established results.

   The impact of research on production would be enhanced if resources were shifted to on-farm tests and trials in which, at some stage, the farmer is

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4/ MARA, INRA. Plan Directeur: Secteur Cerealier, August 1981.

5/ MARA, INRA. Seminaire sur l'Arideculture, Decembere 1980.

an active participant. Research proposals should specify the on-farm component and demonstrate, ex ante, the relationship between experiment station and on-farm experiments. Any expansion of the research station network should seriously consider the use of rented farm land (under leases of terms coinciding with the duration of the particular research project) as an alternative to the acquisition of permanent research plots.

3. A close liaison with extension, in which staff of the two agencies jointly identify research priorities and execute research and demonstration projects, would contribute to the on-farm relevance of research and enhance the extension mission. The 1981-85 Development Plan calls for the formation of integrated research-extension teams for this purpose, and three such teams have begun their work.

4. The close integration of livestock and crops on farms in the rainfall areas suggests that a "systems" approach to experimental work be a part of the overall research program. A possible example of such an approach was suggested to the team by the Director of INRA: Integrated experimentation in both crop agronomy and animal science could be carried out on experimental units which simulate the crop-livestock relationship on farms.

5. Of the list of 51 research projects referred to above, 19 indicate cooperation with the Institut National Agronomique et Veterinaire Hassan II (INAV), and many list cooperation with international and foreign national research agencies. Such cooperation, especially that with INAV, should be strengthened. INAV posseses a body of scientific expertise in its faculty and graduate students which should be fully exploited in planning and implementing research programs.

B. Extension

Extension coverage in Morocco is clearly inadequate to the needs of the country. In a limited number of interviews with farmers, the team found none of them to have ever been visited by an extension agent, and this is reported to be the case for most farmers in the rainfed areas. Problems appear to focus on the lack of resources, particularly vehicles and fuel, for making contacts and the lack of anything to extend. The former is a real budgetary problem. The latter, sometimes