IRRIGATION PRICING AND MANAGEMENT

ANNEX 3

Morocco

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Morocco

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LIST OF ACRONYMS AND ABBREVIATIONS

DER	Directorate of Rural Equipment
DPA	Provincial Directorate of Agriculture
GDP	Gross Domestic Product
LSI	Large-scale irrigation
MARA	Ministry of Agriculture and Agrarian Reform
M	Million
O and M	Operations and Maintenance
ORMVA	Regional Office of Agricultural Development
ORMVAD	Regional Office for Development of Doukkoua
SMSI	Small and Medium Scale Irrigation
WUA	Water User Association

CURRENCY EQUIVALENTS

US$ 1.00 = DH (Moroccan Dirhams) 9.84

WEIGHTS AND MEASURES

1 hectare (ha)	=	10,000 m^2
	=	2.471 acres
100 hectares (ha)	=	1 km^2
1 kilogram (kg)	=	2.204 pounds
1 metric ton (MT)	=	1,000 kg
	=	2,204 pounds
1 kilometer (km)	=	0.621 miles
1 square kilometer (km^2)	=	100 ha
1 millimeter (mm)	=	0.04 inch
1 cubic meter (m^3)	=	1,000 liters
1 liter (l)	=	1.066 quarts
1 liter per second (l/s)	=	1.066 quarts per second

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Annex 3

Morocco

A. Background

1. Economic background

a. Macroeconomic conditions and policy

In the decade of the 1970s, Morocco pursued a dynamic growth strategy that resulted in a relatively high growth rate of 7.3 percent between 1973-77. Average annual per capita income grew at a rate of 3 percent in these years and in 1978 per capita GNP was DH 2,714 or US$ 670. The development effort of the decade saw large investments, especially in the service sector (education and training) which comprised almost half the total GDP. (See Table 3-1.) However, savings and exports did not keep pace with investment and import growth. This has resulted in a deepening financial crisis.

Table 3-2 shows the government's current account deficits as well as the large gap in the balance of payments. The overall effect has been to compel the government to resort to heavy reliance on external borrowing. Structural factors contributing to the financial disequilibrium include a sectoral development strategy that emphasized across-the-board consumer subsidies such as in education and health which were provided at all income levels. This proved to be a considerable strain on the budget. The large expenditures on modernizing the Royal Armed Forces since 1975 imposed an additional burden.[1]

Other contributing factors are the government's price policies, the effects of protectionism and over evaluation of the currency. The government intervenes in both product and factor markets through subsidies and price controls, often with conflicting objectives. The unsurprising effect of these policies is contradictory and negative results. The pricing policies pursued frequently act as disincentives to domestic production while an overvalued currency and lower world market prices for essential foodstuffs prove to be an incentive for continued high import levels.

The accelerated public investment program in the past decade was instituted in an environment in which the sudden rise in phosphate prices brought in unexpectedly huge receipts from phosphate exports. The subsequent slowdown in phosphates has negatively affected export earnings and this has not been compensated for by expansion in other export-oriented production. One of the factors responsible is the

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[1]The World Bank, Morocco: Economic and Social Development Report, (Washington, DC: The World Bank, October 1981), p. i-ii.

Table 3-1: Sectoral Gross Domestic Product, 1978

	1978[a] (M DH)	Share in GDP (Percent)
Gross Domestic product	50,325	100
Agriculture	9,104	18.1
Industry	16,241	32.3
Services	6,168	49.6
GNP Per Capita	2,714	

[a]At market prices.
[b]NFS = Non-factor services.

Source: The World Bank, Morocco: Economic and Social Development Report (Washington, DC: The World Bank, October 1981).

Table 3-2: National Accounts Summary and Balance of Payments, 1977-82
(M DH)

	1977	1978	1979	1980	1981	1982
Government Finance						
Current Revenues	11,669	10,954	14,820			
Current Expenditures	11,925	12,940	14,393			
Current surplus/deficit	-256	-1,966	-427			
Balance of Payments						
Exports of goods and NFS[a]	8,281	8,910	10,418	12,717	15,941	17,882
Imports of goods and NFS	18,292	16,282	18,282	20,357	27,465	31,314
Resource gap	-10,011	-7,343	-7,864	-7,640	11,524	13,432
External Debt	18,636	20,813	NA[b]	NA	NA	NA

[a]NFS = Non-factor services.
[b]NA = Not available.

Source: The World Bank, Morocco: Economic and Social Development Report (Washington, DC: The World Bank, October 1981).

government's large role in investment which has dampened private sector investment.

Morocco's current financial difficulties have had their impact on irrigation development, as elsewhere. Most of the large-scale irrigation (LSI) development has taken place in the past fifteen years. During this period 65 percent of investment in the agricultural sector was applied to irrigation construction. The Investment Code of 1969 laid out a strategy for cost recovery from farmers of 40 percent of investment costs and 100 percent of operations and maintenance (O and M) expenses. In practice, the cost recovery goals have not been achieved and the government has subsidized more than its share of 60 percent of capital costs as well as O and M. However, the government's current straitened financial circumstances have given greater urgency to cost recovery issues which are now being paid more attention. This is the macroeconomic context in which the current study of irrigation pricing and management was undertaken in Morocco.

b. The rural and agricultural sector

In 1982, agriculture contributed 18 percent to Moroccan GDP at current prices, provided 40 percent of employment and a third of total exports. Although sixty percent of Morocco's population is dependent upon agriculture, the sector contributes a relatively small and declining proportion to GDP. For example, in the 1960s, agriculture contributed 25 percent to GDP growth but in the next decade its share was only three percent. However, while the share of agricultural employment in the overall labor market is declining, the absolute number of people employed in agriculture is still increasing. Furthermore, 45 percent of rural families live at or below the absolute poverty level estimated to be US$ 238 per capita in 1981. Overall GNP per capita was US$ 790 in 1979.

Total land area in Morocco amounts to 69 M ha of which only 7.7 M ha is suitable for cropping. Most of the cultivable land is located in the northern half of the country and along the Atlantic coast. Aridity increases towards the south and 20 M ha of semiarid and mountainous land are suitable only for grazing and forests. East and south of the Atlas mountains is desert. Total irrigated area amounts to 850,000 ha and this is where most industrial and forage crops, vegetables and citrus fruits are grown, as are almost 65 percent of agricultural exports.

Of the available cropping land, only 5.3 M ha are cultivated each year, the rest being under tree crops or remaining fallow (two M ha). The main crops are winter cereals (primarily hard and soft wheat, barley, and oats) which are planted on 4.3 M ha, pulses on 500,000 ha and the rest in vegetables, sugar beets, oilseeds, cotton and forage crops. Extensive livestock raising is practiced in the arid regions while intensive livestock production is becoming increasingly important in irrigated and high rainfall areas.

There is a marked contrast between performance in the irrigated and rainfed sectors with production in the more modernized irrigated sector contributing an increasing proportion of agricultural value added. This is generated by the progress in production of high income elastic high-value commodities such as sugar, vegetables and 60 percent of milk--a trend given additional impetus by demand growth resulting from increasing urbanization. About 45 percent of total agricultural value added is contributed by production on large irrigation schemes which cover only 10 percent of the cultivated land area. Irrigated production has, however, benefitted from subsidized irrigation water, guaranteed markets, government extension services to introduce modern farming techniques and inputs and attractive prices. Consequently, sugar beet production grew by 13 percent per annum between 1967/69 to 1976/78 while milk production increased 4.3 percent per annum from 1971 to 1977 and vegetable production at eight percent per annum.[2] The prevailing patterns of protection clearly favor the irrigated sector and provide tremendous incentives for capital and energy intensive irrigated cropping.[3]

Production in the rainfed sector accounts for the major portion of the country's basic food supply and supports the majority of the rural population.[4] Thus, 85 percent of Morocco's cereals as well as its pulses, oilseeds and red meat are produced under rainfed conditions. Most rainfed areas are characterized by traditional agricultural practices. As a result of limited use of agricultural inputs and farm machinery as well as unfavorable price policies, crop yields and livestock productivity are generally low. For example, production of pulses and olives show no long run improvement (See Table 3-3), while cereal yields have increased by only 0.12 tons/ha in 18 years.[5]

Over the past 20 years, the relative importance of agriculture in Morocco's economy has declined as has its contribution to overall value added, employment and exports. The weakness of Morocco's agricultural sector performance is clearly demonstrated by the widening food gap.

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[2]Increased vegetable production was primarily due to additional area brought under irrigation. The World Bank, Morocco: Economic and Social Development Report, p. 159.

[3]The issue is of significance because the deficits in cereals, vegetable oils and meat cannot be covered except by intensified production in rainfed areas. Ibid., p. 162-63.

[4]With the expansion of agricultural imports, the food supply is generally adequate as are nutritional levels. However, nutritional deficiencies persist among poor people and approximately 45 percent of Moroccan farm families live at or below the absolute poverty level estimated at US$ 200 per capita (1979 prices).

[5]The World Bank, Morocco: Economic and Social Development Report, p. 159.

Table 3-3: Volume of Selected Agricultural Production
(000s Quintals)

Product	1970-71	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77	1977-78	1978-79	1979-80
Winter Grains[a]	48,312	47,157	29,347	43,117	32,455	51,734	26,684	42,281	37,386	41,214
Spring Grain Crops[b]	5,138	4,410	2,890	4,915	4,746	5,297	1,890	4,265	3,349	3,843
Pulses[c]	3,367	4,143	3,537	7,048	4,508	4,963	1,583	2,749	3,428	2,310
Olives	1,160	5,060	1,950	2,547	2,009	3,043	1,630	3,040	1,630	4,400
Oilseeds[d]	175	402	269	299	352	297	275	298	677	418
Sugar Beets	15,839	16,770	12,927	19,436	17,919	23,616	14,737	23,954	21,745	21,890
Vegetables[e]	7,140	6,760	8,580	8,100	10,600	10,500	10,700	NA[f]	NA	NA
					(000s Tons)					
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Milk	505	524	523	521	570	600	650	NA	NA	NA

[a]Includes hard wheat, soft wheat, barley, oats and others.
[b]Includes maize, sorghum, rice and others.
[c]Includes beans, chick peas, green peas, lentils and others.
[d]Includes flanseed, sunflower seed and peanuts.
[e]Includes early crops, tomatoes, potatoes and fresh vegetables.
[f]NA = Not available.

Source: The World Bank, Memorandum on Morocco's Agricultural Sector: Identification of Issues and Bank Strategy (Washington, DC: The World Bank, May 1980).

Domestic food production has been unable to keep pace with demand which has been increasing as a consequence of high population growth (3.2 percent per annum) and rapid urbanization (4.8 percent per annum) and income growth. The result has been substantially increased food imports with Morocco becoming a net food importer in 1974. The average rate of growth in agricultural imports between 1977-81 was over 10 percent per annum amounting to US$ 600 M in 1981. Imports of agricultural commodities now comprise 25 percent of total imports, two-thirds of which are made up of soft wheat, sugar and edible oils. This increase in food imports has had a significant impact upon the agricultural trade balance which has swung from substantial surpluses in the early 1970s to major deficits in more recent years.

Factors contributing to the agricultural sector's weak performance are several successive years of drought as well as structural and policy-related causes. Of the structural constraints, the land tenure problem is most significant. Problems include unequal land distribution, extreme fragmentation (leading to inefficient holdings), lack of land titles, lack of security of land tenure and a high incidence of absentee land ownership. Table 3-4 shows the size and distribution of landholdings. Over 56 percent of the landholdings are less than 5 ha and these comprise about a quarter of the total cultivable land area. A series of reform measures have been considered by the government but, aside from the large irrigated areas, these measures have not been effectively pursued.

Other policy-related constraints include conflicting price policy objectives, protection patterns, public investment strategies, the weakness of agricultural support services including research and extension and marketing and input supply. In order simultaneously to ensure high producer prices to raise farm productivity, to keep food prices low for urban consumers and to insulate the economy from short-term international price fluctuations, the government employs a variety of price controls, subsidies, quotas, tariffs, export and import taxes, etc. The result of simultaneously pursuing such divergent goals is often contradictory.

Thus, for example, the effect of fixed producer prices and government support buying and imports of commodities such as soft wheat (for bread) is for substantially lower prices to prevail on the free market. (Producer prices for bread wheat often can be 35 percent lower than the official fixed price.) Other effects are reduced farmer incentives for production and increased imports. Additionally, subsidies for a number of food items (flour, sugar and edible oils) bring their retail prices below world market prices. (See Table 3-5.) The corresponding official domestic producer price is also lower while the subsidies impose a heavy burden on the national budget. Currency overvaluation has in the past contributed to increased imports of basic staples but the September 1983 depreciation should moderate this effect.

Table 3-4: Land Distribution Patterns

Size (ha)	Number of Farms	% of Total	Area (ha)	% of Total	Average Number of Parcels Per Family
< 5	1,090,500	56.5	1,776,200	24.5	5.5
5-10	220,000	11.4	1,508,000	20.8	6.8
10-20	113,900	5.9	1,529,700	21.1	7.7
20-50	44,300	2.3	1,218,000	16.8	8.8
50-100	7,700	0.4	514,000	7.1	8.8
> 100	2,000	0.1	703,000	9.7	9.7
Total	1,478,000	100.0	7,250,000	100.0	6.0

Source: International Commission on Irrigation and Drainage (ICID), Specificities of the Moroccan Hydro-Agricultural Equipment, 30th Executive Council, May 1979.

Table 3-5: Fixed Prices for Key Agricultural Commodities Relative to World Market Prices

Commodity	Official Producer Price (DH/t)	Official Producer Price (US$/t)	World Market Price[a] (US$/t) 1982	World Market Price[a] (US$/t) Mobile Average 1980-1982
Bread wheat	1,400	204	167	164
Sugarbeet	155	22.6	15	20
Milk	1,590-1,790	232-261	180	194
Paddy	2,180	318	293	344
Maize	1,000	146	109	115
Soyu	2,270	331	245	265

[a]Prices are CIF Casablanca.

Source: The World Bank, Morocco: Agricultural Strategy Paper (Washington, DC: The World Bank, 1985).

2. Irrigation development

a. Description of irrigation system

In Morocco, there are both large scale and small and medium scale irrigation (SMSI) systems. The LSI projects generally range from 10,000 - 20,000 ha and represent new investments in major civil works for water regulation and conveyance and have modern distribution systems. Their development is generally accompanied by land consolidation and agricultural support services that include recommended cropping patterns and improved technological methods and delivery of inputs to farmers in the service area. The large perimeters are developed and managed by well-organized regional irrigation administration and agricultural development offices. There are nine LSI perimeters in Morocco with an irrigation potential of 870,000 ha of which over 400,000 have been completed (Table 3-6).

The SMSI projects range from a few to several thousand ha (generally less than 5,000 ha) and can be divided into two subcategories. The first type are the new projects technically similar to the large modern schemes and differentiated from the latter only by size. The second type of SMSIs are traditional systems some of which have existed for centuries. They are based on simple technologies and water distribution is defined by traditional rights. There are approximately 400,000 ha under irrigation in traditional SMSIs, about 100,000 ha of which have been partially rehabilitated by the government.[6] In addition, it is estimated that there is potential for the development of 100,000 ha of rainfed areas as modern SMSI perimeters.[7]

Of the total irrigated area in Morocco, 59 percent is equipped with modern facilities, i.e., water distribution facilities to the farm level.[8] Water resources from rivers and replenishible groundwater is estimated at about 25 billion m^3 annually. About seven billion m^3 of water is undevelopable. Of the developable waters about four billion m^3 is in groundwater and 14 billion m^3 is surface water. About 50 percent of the available water resources are already developed with a growth rate of 5 percent during the last 20 years. However, with

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[6]Estimates from different sources vary. Some small and medium rehabilitations were done 30-40 years ago while others are relatively recent. Also, some of the earlier rehabilitated projects are currently under review for another rehabilitation.

[7]The World Bank, Kingdom of Morocco: Staff Appraisal Report of the Small and Medium Scale Irrigation Project (Washington, DC: The World Bank, February 10, 1983).

[8]The World Bank, Project Performance Audit Report, Morocco-Doukkala I Irrigation Project (Loan-1201-MOR), (Washington, DC: The World Bank, December 30, 1982), p. iii.

Table 3-6: Total Area Projected for Large and Small and Medium Scale Irrigation Development in Morocco by 2000 AD

Large Scale	Area (ha)
Area equipped by State (new or traditional perimeters assisted)	820,000
Private modern installations	50,000
Subtotal, Large Scale	870,000
Small and Medium Scale	
New equipped by State or traditional systems given assistance	150,000
Modern private installations	30,000
Traditional systems ameliorated by the State	100,000
Subtotal, Small and Medium Scale	280,000
TOTAL	1,150,000

Source: International Commission on Irrigation and Drainage (ICID), Specificities of the Moroccan Hydro-Agricultural Equipment, 30th Executive Council, May 1979.

pressure from hydroelectricity, urbanization and industrialization, increasing competition among claimants for available water is highly likely even though national policy gives priority to irrigation over hydroelectricity.[9] There are several thousand ha of privately developed high value garden irrigation serving the larger cities near the coast.[10]

Most of the irrigation lies in the four river basins draining into the Atlantic, the Loukkos, Seboo, Oued-oum-er-Rbia and Souss. The Mouloya flows into the Mediterranean from sources in the Atlas mountains and from two internally drained basins while the Tafilalet and Quarzazate are located in the southeast. All the LSI perimeters are in these basins as are a number of the SMSI perimeters. Some of the SMSI also originate in the Atlas piedmont and are scattered throughout the country. Gravity systems are the most common but there are also considerable areas under sprinklers and some tube well development, particularly in the Souss Basin[11]. Large diameter shallow dug wells provide limited sources of supplementary water in the residual soils overlying hard rock areas and the groundwater of the Atlas piedmont has been traditionally exploited by horizontal tunnels called qataras. Never a large source, qataras are being phased out because of high costs of maintenance and competition from tubewells. Surface systems range from traditional run-of-the-river without regular distribution facilities to the farm level to modern ones backed, in most LSI areas, by reservoir storage and equipped with modernized distribution facilities to farm level.

Eight major types of potential or existing SMSI perimeters can be distinguished on the basis of water source, of which five can support year round irrigation and three cannot. The first five types of SMSIs can be described as follows. First are the large perennial rivers upstream of dams where irrigation can be provided by diversions and resurgences. Approximately 124,000 ha of this type are being irrigated along the major rivers. Second are low-lying terraces downstream of existing or proposed dams which can be harnessed by pumping water released from the dam into the river. About 36,000 ha of such irrigation potential exists along the middle sections of the Seboo River. Thirdly, are the small traditional perimeters in the piedmont gravity-fed from perennial springs through concrete-lined

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[9]International Commission on Irrigation and Drainage (ICID), Specificities of the Moroccan Hydro-Agricultural Equipment, 30th Executive Council, Special Session, May, 1979.

[10]This may be as much as 50,000 ha based on our discussions but no documented estimate was found.

[11]One source suggested as much as 200,000 ha is under sprinklers but this estimate could not be documented.

channels or seguias.[12] About 100,000 ha of such perimeters can be found along the Middle and High Atlas Mountains. The team visited one such site at Chichaoua which is described in a later section. The fourth and fifth types of perennial irrigation are various types of pumped groundwater wells and tubewells in the Souss and Sub-Saharan regions comprising in total about 150,000 ha. The intermittent types of SMSI irrigation come from flood waters of Saharan streams, gravity diversions from intermittent springs and rainfall runoffs in the semiarid piedmont.

The modern SMSI perimeters have been developed mostly in rainfed areas where benefits are generally lower than in LSI projects because there are constraints to the introduction of highly profitable commercial crops. Benefits are, however, substantial enough in terms of improved farmer incomes to make these projects viable. The centuries old traditional SMSI systems are generally located in areas where farms are small (0.2-3 ha). Water losses are usually high because canals are unlined and farmer maintenance is erratic. Where some modernization was previously done, poor maintenance results in the need for rehabilitation which is being undertaken on some of these projects. The intent is to reduce water losses by 25-45 percent and to increase crop intensity or extend the area.

Irrigation development is viewed as providing the means by which Morocco will be able to meet its targets of food grain production, agricultural exports and industrial crops production (sugar, beet and cotton) as set forth by national policy. The policy and institutional arrangements are discussed in more detail in Section B. In general, large perimeters are developed and managed by nine semi-autonomous regional offices known as Offices régionales de mise en valeur (ORMVA) under the Ministry of Agriculture and Agrarian Reform, Development Directorate (Direction de l'équipment rural). There is an ORMVA for each of the drainage basins listed above, except that there are three in the Qued-oum-er-Rbia Basin. (See Table 3-7.)

Rehabilitation and construction of new small and medium perimeters is administered by the Development Directorate directly through its regional and local offices. Traditional water user organizations in some form or other exist on the traditional systems. These are being formalized by registration and adjudication of land and water holdings within perimeters as traditional systems become candidates for rehabilitation. For the large perimeters, landholdings are consolidated and regularized under a national program of land "Regrouping." This has been a significant factor in their effectiveness.

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[12] Seguias are earth canals.

Table 3-7: Potential and Actual (1975) Irrigated Areas in ORMVA Projects

ORMVA	River Basin	Potential (ha)	Present Equipped[a] (ha)	1975 Irrigated (ha)
Moulouya	Moulouya	61,000	61,000	38,300
Loukkos	Loukkos	36,000[b]	36,000	4,400
Gharb	Seboo	230,000	230,000	65,200
Haouz	Oued oum er Rbia	140,000	75,000[c]	54,000
Tadla	Oued oum er Rbia	117,000	87,000[c]	90,000[d]
Doukkala	Oued oum er Rbia	90,000	90,000	25,900
Souss	Souss	102,000	29,000	66,860[d]
Quarzazate	Quarzazate	28,000	25,000	24,400
Tafelalet	Tafelalet	41,000	24,000	33,300[d]
TOTAL		845,000	657,000	402,300

[a]Area of potential ha that is currently developed with canals, gates and equipment.

[b]Of which 6,000 ha is irrigated with water from the Idris Dam.

[c]Estimate.

[d]Includes pumping.

Source: International Commission on Irrigation and Drainage (ICID), Specificities of the Moroccan Hydro-Agricultural Equipment, 30th Executive Council, May 1979 and the World Bank, Morocco: Economic and Social Development Report (Washington, DC: The World Bank, October 1981).

b. Future irrigation development plans

According to the ICID report, Morocco's target for the year 2000 AD is to provide permanent irrigation to 1,150,000 ha.[13] The breakdown by size of system is shown in Table 3-6. In addition, 300,000 ha would receive temporary or winter irrigation.[14] About 300,000 ha would be under sprinkler.[15] Figure 3-1 shows the location of the nine ORMVAs and potential areas equipped in 1975 or intended to be equipped.

Until recently, the emphasis of Morocco's irrigation development was on the LSI perimeters, but the focus has now shifted towards SMSI projects and towards greater attention to improved O and M on both LSI and SMSI perimeters. The draft Development Plan for 1980-85 called for a large increase in per annum SMSI investment from an average of about DH 20-25 M in the previous two plan periods to an estimated DH 125 M.[16] Allocations to the SMSI sector are up from 5 to 9 percent of the rural equipment budget. It is intended that SMSI development will be accompanied by improvements in support services such as research and extension and changes in land ownership towards more rational and intensive land use.

From the point of view of policy and institutions (see Section B), emphasis is expected to be given to improving collections in LSI, formalizing user associations and collecting water charges (under a 1984 revision of the National Agricultural Development Code) on SMSI and giving greater attention to improved O and M on all systems.

B. National Irrigation Administration and Policy

1. Organization of irrigation administration

a. Organizational structure at national level

The study and exploitation of water resources in Morocco are the responsibilities of the Water Resources Directorate of

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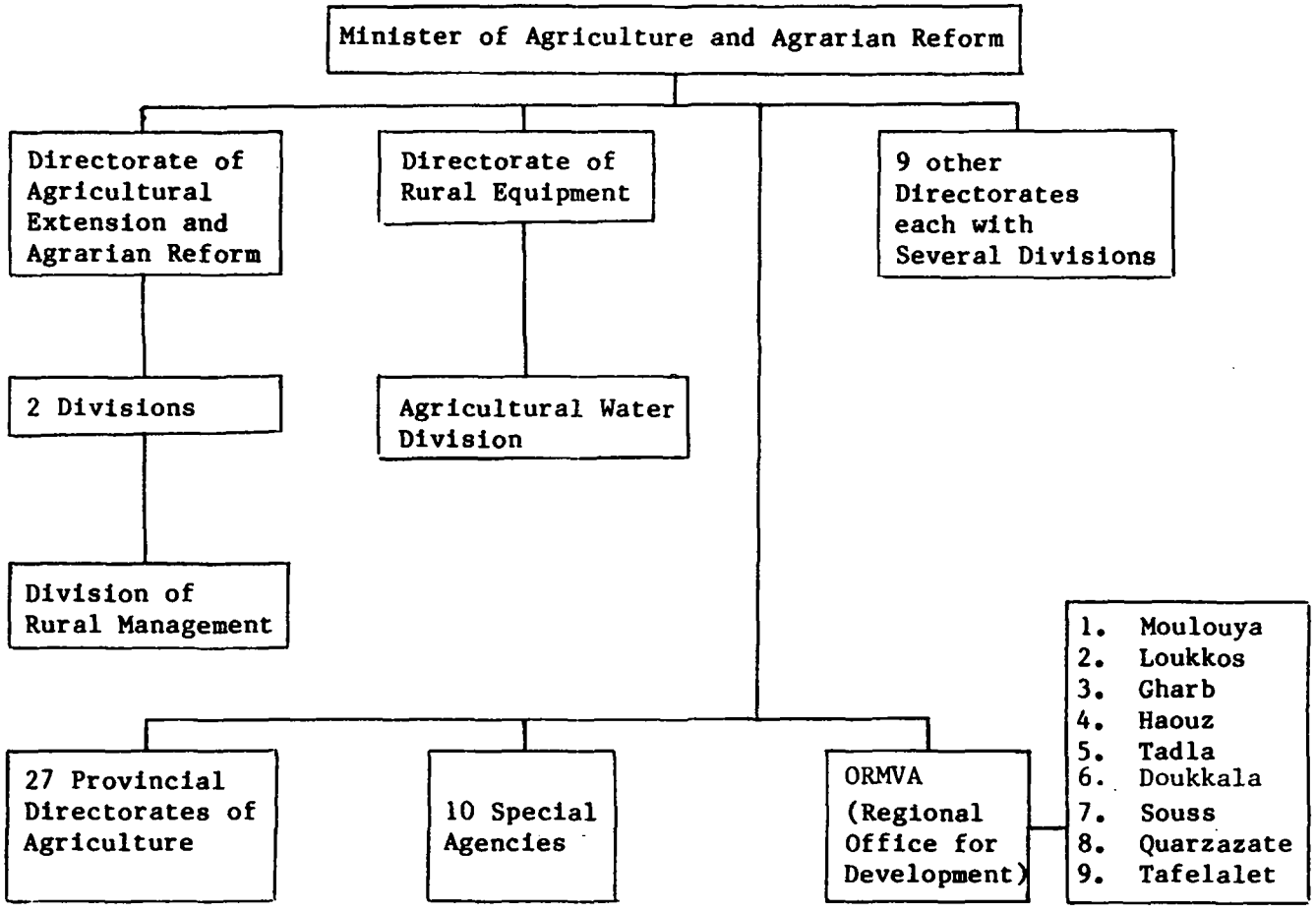
[13]ICID, 1979 and the World Bank, Morocco: Economic and Social Development Report, p. 198.

[14]These levels agree essentially with those mentioned orally by M. Oulad Charif, Directeur de l'équipement rural, MARA and by Professor M. Ait Kadi, Head of Agricultural Engineering, University of Rabat.

[15]Conversation with Professor Ait Kadi, Mrch 25, 1985.

[16]This amount is reported to have been cut by 40 percent because of the country's financial crunch. The World Bank, Morocco: Agricultural Strategy Paper, p. 21.



IRRIGATION PRICING AND MANAGEMENT: MOROCCO

Figure 3-1: Organization of the Irrigation Water Delivery Administration in MARA

the Ministry of Infrastructure[17] which is also responsible for maintenance and operation of most of the dams. Production and distribution are the responsibility of four ministries: Energy and Mines (hydropower); Infrastructure (drinking water), Interior (municipal authorities) and Agriculture (MARA) (irrigation water and scattered rural centers). Figure 3-1 shows the divisional organization of MARA for irrigation water administration. The Prime Minister controls capital investment through the Secretariat for Planning and the Ministry of Finance to monitor the investment program. Nine regional ORMVAs, under the Development Department of the Ministry of Agriculture have responsibility for developing and operating large-scale river-basin projects. Small scale projects are the responsibility of the Development Department.

b. ORMVAs

Beginning in 1943, the first large irrigation systems merely provided headworks and main canals serving primarily large colonial farms. After independence, from 1956-60 the Office of National Irrigation, an independent office, managed all irrigation and began to introduce specialized crops such as sugar beets. In 1965-66, this Office which became very powerful and quite centralized was dissolved in favor of a more decentralized approach, and formation of autonomous regional ORMVAs in the Ministry of Agriculture.

Each ORMVA has a separate budget within the national budget enacted each year. Separate budgets are appropriated for investment and for operations. Water charges for O and M, collected by the ORMVAs remain with the ORMVA. Loans to the Government of Morocco by international donors for development projects are processed through the Ministry of Finance and reappropriated to the ORMVAs through the annual budget.

c. Small-scale irrigation

Traditional SMSIs are administered by the local communities through the Water User Associations (WUAs) if the latter exist. At the provincial level the Provincial Directorate of Agriculture (DPA) is responsible, particularly if the government is involved in rehabilitating the project. For new SMSI project development the Directorate of Rural Equipment (DER) of MARA has the general authority for project implementation. At the provincial level the DPA is the responsible authority and overall coordination is in the hands of a Project Coordination Committee. This consists of a chairman (the Director of the DER) and members who are the Directors of Crop Production, Livestock Development, Extension and Agrarian Reform and

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[17]The World Bank, Morocco Economic and Social Development Report, p. 198.

other agencies. Day-to-day monitoring, coordination and project implementation are done by a Central Management Unit within DER's division of rural development.

2. Irrigation policies

a. General

A variety of laws determine irrigation policy in Morocco. Small-scale traditional systems are generally governed by traditional water rights as formally recognized by a law of 1914. The Agricultural Investment Code of 1969 governs cost recovery policy on the delimited LSI perimeters.[18] The formation of WUAs is provided for by the ASAP laws of 1924. Cost recovery policy has been the subject of discussion by policy makers over the past two years leading to changes made in 1984 that are applicable on both LSI and SMSI perimeters.

b. Water rights

The water rights of individuals and communities are based on traditions many centuries old. Such rights are clearly understood although they are maintained and transmitted orally. However, a 1914 law accorded recognition to traditional rights. It declared all water to be in the public domain except rights acquired prior to the passage of the law. A procedure also exists for formal recognition of water rights for specific groups of users but it is seldom used.

Water rights operate at two different levels, namely, that of the community to withdraw a certain amount of water flow from a river and the individual's right to a share of the community water right. The individual's water rights are usually defined in terms of a specific length of time during which the water supply in the seguia is available for the user. The intervals between turns for the individual are also specified.

Within each community there are a variety of types of water rights. Individual shares of community water rights may differ greatly depending upon customs and traditions and the distribution may be inequitable. Such rights are non-transferable but they may be leased. Another type of right is tied to the land, and therefore, only jointly transferable. Water rights may be defined as well in relation to crop cultivation patterns, as they are in the modern perimeters and in some traditional areas. Finally, water rights may be privately owned separately from the land and in such cases there is often a rental market for water. The number and complexity of traditional water rights and the fact that they are not well-known outside the

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[18]The term delimited refers to consolidation of landholdings in these perimeters.

local communities poses special problems for the irrigation administration in its attempts to modernize SMSI systems.

c. Cost recovery

(1) LSI perimeters

Three types of charges for irrigation cost recovery were established by the Investment Code of 1969 for the delimited modern perimeters where the LSI systems are located. Thus, farmers were expected to pay:

- Volumetric charges that were intended to cover 100 percent of O and M costs as well as up to 40 percent of original investment costs. MARA has the discretion to fix capital cost recovery somewhere between 0-40 percent;
- A fixed betterment levy which amounted to DH 1,500/ha. The first five ha of holdings of less than 20 ha were exempt from this charge; and
- A supplementary water charge to cover the costs of pumping, wherever applicable.

The Code also provided for the progressivity of charges during the early years of irrigation system operation, established principles for indexing and rules for the collection of water charges.

Despite the Code's comprehensive framework for cost recovery, actual collection until 1980 was well below the legally established minimum levels.[19] In practice the volumetric charges established at full system operation did not even cover O and M costs in the LSI perimeters while the rates for the supplementary charge were not specified until 1980. Recovery via the betterment levy was constrained by the vast number of landholdings (80 percent) that are less than five ha in size.

In June 1980 implementation of the Code was revised by Government decree. The volumetric water charge was to be increased 100 percent over three years, the pumping surcharge was required to be made operational to the full amount of energy cost and it was indexed to the cost of energy. These steps for the first time permitted a level of recovery that had been theoretically set up in the Code: 100 percent of O and M costs and a proportion of investment costs.

In 1982 further revisions were proposed in the form of an amendment to the Code in order to improve equity of cost recovery levels. The changes included a measure to make the volumetric charge

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[19]The World Bank, Staff Appraisal Report of the SMSI Project, p. 41.

cover 10 percent of irrigation investment costs rather than the prevailing discretionary 0-40 percent. Simultaneously, it was proposed that the land betterment levy would be set at 30 percent of total investment costs instead of the original fixed amount. The exemptions would be maintained for the first five ha of holdings less than 20 ha. (In 1984, the betterment levy was raised to DH 8,500/ha.) A formula was also proposed for automatic indexation of the volumetric charge.

The proposals represent improvements in cost recovery policy to the extent that the revised betterment levy would shift a relatively greater degree of investment cost recovery to large farms. It would also ensure a minimum contribution to investment cost by all water users and improve prospects for long-term cost recovery levels through indexing.

(2) SMSI perimeters

Despite the existence of varieties of water charges governed by established water rights in the traditional irrigation systems and the recognition accorded them by the 1912 law, there is no comprehensive national legal framework or policy governing cost recovery in the traditional SMSI and certain undelimited modern perimeters. This proved to be a stumbling block in the World Bank's efforts to implement its project to expand and rehabilitate SMSI systems.[20] Therefore, a system was devised whereby MARA with the appropriate DPAs and ORMVAs would enter into agreements with the local water user associations at each selected sub-project location.

MARA was required to propose cost recovery charges and incorporate the agreed-upon rates into agreements with the user associations. The principles guiding rate establishment included fixing volumetric charges so that they would permit recovery of all O and M costs plus a share of investment costs (approximately in line with capital cost recovery in LSI perimeters). In addition, adjustments could be made for exemptions that would take account of the limited small farmer capacity to pay.[21]

Some of these measures were incorporated into a law in 1984 that provided for the organization of WUAs that would enter into agreements with MARA for irrigation cost recovery and management on mutually acceptable terms. It is too early to assess the effects of these changes.

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[20]Details of the SMSI project are to be found in the World Bank, Staff Appraisal Report of the SMSI Project, 1983.

[21]The World Bank, Staff Appraisal Report of the SMSI Project, p. 44.

d. Irrigation management

The policy governing irrigation management is that O and M should be the responsibility of water users to the maximum extent possible. In practice, the establishment of WUAs that would formally undertake these duties at the LSI perimeters has been slow and is really in the initial stages. The primary responsibility for O and M, therefore, rests in effect with the project ORMVA officials.

In general, O and M has been a neglected aspect of irrigation development until quite recently. When the LSI were constructed, the O and M budget was small, emphasis was on equipping the systems in the early stages and most of the budget was devoted to that end. As a result, for a long time O and M divisions which were located in the equipment section had a low status within the irrigation administration. Staffing for O and M was inadequate and personnel were not properly trained. It was difficult to attract people because field incentives were limited and design and planning staff were more highly regarded.

Much greater attention is now being paid to O and M issues as the LSI systems are largely in place already. Further, new irrigation development as, for example, in the SMSI perimeters is being carefully planned so that WUAs are set up prior to project implementation with the clear understanding that they will be expected to assume responsibility for O and M. A new law in 1984 was designed to facilitate the process whereby the government enters into feasible agreements with individual WUAs for assuming responsibility for 100 percent of O and M cost recovery and varying percentages of capital cost recovery in these areas.

C. Irrigation Projects

1. Doukkala I

a. Background

(1) Description

The Doukkala I Project is part of an overall development effort to use water drawn from the Oum-er-Rbia River more effectively. Oum-er-Rbia provides irrigation water for Morocco's second largest agricultural area, after the Seboo Basin. The Oum-er-Rbia Basin has an estimated potential of 347,000 ha under large scale irrigation. About 252,000 ha are now developed of which 90,000 was under the ORMVAD (ORMVA Doukkala).[22] Under the new Doukkala II Project (being supported by a World Bank loan [1982]) 32,000 ha of the system will be rehabilitated.

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[22]The World Bank, Morocco Economic and Social Development Report, p. 198.

The Doukkala I Project was intended to fully utilize all of the water diverted into an existing "low-service" canal from the Im-Fout Reservoir and was prepared within the framework of a Water Master Plan for the Oum-er-Rbia Basin prepared in 1973-74.[23] This project included installation of a sprinkler irrigation system to serve 15,400 ha in the project area, construction of farm feeder roads and improvement of major classified roads, construction of infrastructure for agricultural support services, electric power lines and telephonic communications facilities, and a land consolidation program. Estimated cost in 1976 was US$ 85 M for which the World Bank and AID provided loans of US$ 30 M and US$ 13 M respectively. Actual disbursements under the World Bank loan totalled only US$ 27,300,000;[24] and under the AID loan, US$ 12,998,000.[25] Landholdings were newly consolidated and regularized as the result of efforts under the 1962 Regrouping Law. A significant factor in the successful implementation of the project was ORMVAD's successful completion of the land consolidation in advance of construction--an effort which required four years.

Project objectives were to double wheat production, produce a sevenfold increase in maize production and to introduce and grow substantial quantities of sugar beet, cotton, vegetables and fodder. Actual crop mix and rotations have changed from those anticipated by the World Bank's 1976 project appraisal. However, yields and crop values during the first year of full development (1980), in most cases, equaled or generally exceeded those anticipated. Based on experience, ORMVAD has deleted cotton from the prescribed cropping pattern, reduced wheat area by about one-third, increased sugar beets by 11 percent, quadrupled fruits and vegetables and increased fodder crops. This is expected to increase cropping intensity from 133 to 146 percent, which with higher yield levels, is expected by the World Bank to raise the economic rate of return from the 11.5 percent forecast in the Appraisal to 20.5 percent.[26]

The main canal system at Doukkala is constructed to supply four pumping stations each serving a zone. The water surface in the feeder and main canals is held at constant level automatically by downstream controlled gates and delivered to pump stations "on demand". Pressure is maintained automatically in the pipe distribution system by the water level in elevated equalizing tanks or by pressure in the discharge pipes. Farm units are served by valved hydrants. For the portable field system, sprinkler heads are permanently mounted on quick-coupling lengths of aluminum pipe which are placed as required by

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[23]The World Bank, Project Performance Audit Report, p. iii.

[24]Ibid, p. ii.

[25]Conversation with Andres Acedo, Program Specialist, USAID, Morocco, March 25, 1985.

[26]The World Bank. Project Performance Audit Report, p. 3.

the using farmers.[27] The intent of the project design was to charge for water on a volumetric basis. However, water meters have largely disappeared from the hydrant outlets due to undetermined cause[28] accordingly allocated on a crop area basis calculated on the total volume measured at the pumps.[29]

(2) Agriculture in project area

(a) Farm size and land holding pattern

Land consolidation resulted in 7,754 farm units representing 11,216 landholdings. With co-owners, there are some 15,600 beneficiaries in the project area. Ninety-three percent of the farm units occupy 62 percent of the land (average size, 0.92 ha); 0.5 percent of the units occupy 10 percent of the land (average size, 27.5 ha). The details of land holding size and distribution is shown in Table 3-8.

(b) Crops and cropping patterns

The land consolidation permitted the project to be laid out in blocks of approximately 16 ha. Each land holding extends the full length of the block and is provided water service by a hydrant with valves and coupling arrangement. Farm sprinkler systems consist of portable aluminum pipe with sprinkler heads attached (called "trame B" layout approach in Morocco). Crop rotation areas are delineated perpendicularly to field boundaries. This permits plowing and tillage to proceed across several holdings and would result in a uniform cropping pattern for each holding in the block if it were strictly used. But this pattern is not rigorously followed in practice.[30]

Cropping patterns are set by an ORMVAD Technical Committee consisting of agricultural agency and ORMVAD officials and farmers. They consider local conditions and national planning goals to arrive at the final cropping mix. Table 3-9 shows the cropping pattern for various crops as grown in 1980/1981 and as estimated at full development under the revised plans.[31] Cropping patterns are mandatory and, according to the ORMVAD Director, enforcement of the cropping

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[27]Ibid, pp. 24, 44; and personal observations.

[28]Many of the water meters were installed several years before settlers moved on to the land.

[29]Discussion with ORMVAD Director and staff and personal observations, March 27, 1985.

[30]Personal observation, March 27, 1985.

[31]The World Bank, Project Performance Audit Report, p. 37.

Table 3-8: Size Distribution of Land Holdings--Doukkala I

Size Range (ha)	Farm Units (no)	Percent	Land Area (ha)	Percent	Average Size (ha)
0-2	5,815	75	5,062	32	0.90
2-5	1,396	18	4,746	30	3.35
5-10	388	5	2,848	18	6.85
10-20	116	1.5	1,582	10	13.35
Above 20	39	0.5	1,582	10	31.70
TOTAL	7,754	100	15,820	100	2.05

Source: The World Bank, Project Performance Audit Report, Morocco--Doukkala I Irrigation Project (Loan-1201-MOR) (Washington, DC: The World Bank, December 30, 1982).

Table 3-9: Cropping Pattern in 1980-81 and Estimated at Full Development -- Doukkala I

Crop	1980/81 Actual		1976 Estimate at Full Development	
	Area (ha)	Percent[a]	Area (ha)	Percent[a]
Cereals: Wheat, Maize, Barley	9,965	63.1	6,101	38.6
Pulses	505	3.2	--	--
Sugar Beets	1,203	7.6	3,266	20.6
Vegetables	4,066	25.7	5,688	36.0
Forage Crops	2,996	18.9	7,360	46.5
Fruit Trees	5	--	772	4.9
TOTAL	18,740	119.0	23,187	146.0

[a]As percentage of physical area of 15,820 ha.

Source: The World Bank, Project Performance Audit Report, 1982. Morocco--Doukkala I Irrigation Project (Loan-1201-MOR) (Washington, DC: The World Bank, December 30, 1982).

pattern is not a problem because farmers find it profitable. Nor does he see ORMVAD's role as policeman. Rather the cropping patterns are accepted because the farmers like them. He estimated that compliance ranges from 70-90 percent.

(c) Yields and productivity

Yields during the first full year of project operation (1980) often exceeded yields projected by the Appraisal report.[32] According to the ORMVAD director, this trend has not fallen off.[33] Yields projected in the appraisal report, actual 1980 yields reported by the World Bank and revised projected full-development yields for principal crops are shown in Table 3-10.

Cereals production in the project area was projected at 27,600 t, actual 1978 production was 5,794 t, 1980/81 production was 63,122 t. Yields obtained from other principal crops (vegetables, sugar beets and forage) have similarly exceeded projected levels. With the proposed shift in cropping pattern, cereal production is expected to be reduced to about 50,000 t but production of sugar beet is projected to increase to 196,000 t; vegetables, to 200,000 t and fodder to 445,000 t at full development.[34]

(d) Farm income

Information on farm income is based on the World Bank models prepared at the time of appraisal and revised by the project completion report (1981). At 1981 price levels and exchange rates (US$ 1.00 = DH 5.20), net income for the one-ha model at full development was projected at US$ 2,230 or US$ 391 per capita based on 5.7 persons per farm family. For the five-ha model, this increased to US$ 9,790 with a per capita income of US$ 1,720. The Moroccan absolute poverty level is estimated at US$ 222 per capita. In this range of farm size, with the project, income increased by eight to ten times in these models: per ha net income was US$ 2,230/ha for the one-ha model, US$ 1,958/ha for the five-ha model and US$ 1,592/ha for the 25 ha model.[35]

We had no way to validate these projections in the field. Indeed, they are still in the future. Discussions with several farmers with holdings ranging from 0.5 ha to about three ha revealed that these people were extremely pleased, actually enthusiastic, about their benefits under the project. While costs have risen, prices for

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[32]Ibid., p. 37.

[33]Personal communication, March 27, 1985.

[34]The World Bank, Project Performance Audit Report, p. 62.

[35]The World Bank, Project Performance Audit Report, p. 58.

Table 3-10: Estimated, Actual and Projected Crop Yields--Doukkala I

Crop	Yield Estimated by Appraisal Report (t/ha)	1980 Actual Yield (t/ha)	Revised Yield Estimate at Full Development (t/ha)
Wheat	3.0	3.2	4.0
Maize	2.5	3.1	4.5
Sugar Beet	45.0	57.0	60.0
Summer Vegetables	40.0	27.0	40.0
Alfalfa	60.0	67.0	70.0
Berseem	25.0	58.0	60.0

Source: The World Bank, Project Performance Audit Report, Morocco--Doukkala I Irrigation Project (Loan-1201-MOR) (Washington, DC: The World Bank, December 30, 1982).

farm products have also increased. The ORMVAD Director cited the rising cost of energy for pumping as a possible serious problem for the future and this would certainly be true if energy costs were to rise substantially in relation to farm prices. However, since the government sets prices for most products, the farmer is provided some protection but rising costs would, therefore, have an impact on the national treasury.

(e) Farm services

ORMVAD provides within the project area seeds, fertilizers, pesticides, water, and tillage (if needed). The cost of these services, plus a 5 percent administrative fee are charged to farmers against their sugar factory account. Extension advice is also provided by ORMVAD. While tillage service is still available, our discussions with farmers revealed that this has largely moved to the private sector (apparently with ORMVAD's blessing). Animal power is used for lighter operations and rented tractor-power equipment for the heavier ones.

(3) Functioning of irrigation in the project area

For the main system above farm hydrants, ORMVAD officials reported that maintenance problems since the project started operations seven years ago were essentially routine technical ones. Our inspections confirmed this, at least as a general impression. Feeder canals were unusually free of weed growth and bank sloughing and erosion were nominal on reaches we were able to inspect. Maintenance work on canals has not been required to date. At the Zemara I pump station visited by the team, pumps were functioning well. Except for a leaky packing on one pump the operator confirmed that maintenance had been largely routine. He said that the leak, which was a substantial one, had started earlier that day and would be repaired by the next day. The automatic drum filter was working effectively and had required no maintenance according to the operator.

Leakage at farm hydrants and in couplings of the portable system, largely because of ruptured gaskets, leaky valve packings, etc., were not particularly serious, but were greater than "normal". Since the land was not leveled (that cost was saved by installing sprinklers) considerable micro-topography was observed with low places where water collects. This is largely a nuisance although it takes some land out of cultivation, could provide mosquito breeding sites and become more serious if leakage were to increase. The design called for drainage ditches at the ends of fields but with the variance in topography these could not be very effective. Replacement or repair of sprinkler heads does not seem to be a serious problem. According to farmers, they are available in local markets and from ORMVAD.

Both ORMVAD and the farmers themselves felt that farmer ability to maintain hydrants and portable sprinklers was technically limited. Therefore, much of this is still being done by ORMVAD. Engineers at the field level reported that farmers are learning to handle their maintenance problems and that there has been some improvement. A farmer representative who negotiates with ORMVAD is elected for each 16-ha block and local commissions and extension agents are assisting farmers to improve their capability to maintain the portable systems.

Most of the water meters have disappeared. It was not clear why this was the case. There was some feeling that farmers may have removed them because they associated them with water charges; removal or damage by children playing in the area was also mentioned. Water meters and hydrants were installed well in advance of water delivery before farmers were in control and this probably made them more vulnerable. It was reported that some farmers have requested the replacements but we were not able to confirm this. ORMVAD officials believed that water meters were not practical and our impression was that they were not interested in replacing them.

At the overall level, the Director reported that the main problem is financing. As the project develops and collections increase, he expects that revenues will become adequate and that part of the budget may be allocated to replacement of worn out or broken equipment. This conflicted with the World Bank's pessimism about future maintenance levels. The Director felt confident that maintenance would be greatly improved within five years with FAO assistance and budget increases.

Based on our observations of fields which were being cropped, water is uniformly applied. Although there are some fairly sizable ponds in depressions, soil drainage did not appear to be a problem. It should be easy enough to prevent this through proper doses and timing of sprinkler applications.

We agree with the World Bank that technical designs were, with minor exceptions, extremely satisfactory, particularly those components with high technical and low social content. The few, relatively small, components with a high social content (e.g., village infrastructure and windbreaks) proved less achievable within the project's implementation time frame.

The unique irrigation system used by Morocco warrants study by other countries for it might advantageously be introduced in situations where irregular and small landholdings are the norm or where land consolidation is desired simultaneously with development of irrigation. Sprinkler irrigation appears to be the correct tool both technically and socially for this project.

b. Project management

(1) Structure of irrigation administration

(a) Project administrative structure

As a World Bank loan condition, a Project Coordinating Committee was formed with the Governor of El Jadida as chair and local representatives of all government agencies as members. The Committee was convened only during the first year of project implementation.

The ORMVAD, headquartered in El Jadida, is the primary executing agency. It has four field divisions: construction, operation and maintenance, agricultural development and livestock. For Doukkala I, development centers (Centre de mise en valeur [CMV]) were established in each of the four zones. With completion of Doukkala I, the construction division has turned its attention to Doukkala II. Most of the Doukkala I construction staff were transferred to O and M. The O and M division is responsible for operation and maintenance of the irrigation system except for the mobile sprinkler equipment, and for roads and drains. The O and M Division has two offices in the Doukkala I Project. Each office handles two zones. Its 1981 staff of 52 include 22 ditch riders. Ditch riders normally are responsible for water distribution to about 500 ha and are the primary farmer contact persons in ORMVAD.

The CMVs integrate extension, input supply and other services at field level. Each CMV has a manager, bookkeeper, input supply agent and several extension agents. Extension agents are responsible for determining input requirements and their distribution, monitoring sugar beet cultivation, enforcing or promulgating crop rotations and collecting agricultural statistics. They are also responsible for special programs such as distribution of windbreak plants, introducing monogerm sugar beet seed and for preparation of demonstration plots for crops such as maize and sugar beet. In 1981 each extension agent served, on the average, 278 farmers and 565 ha.[36]

Divisional O and M offices at Zemara I reported that local (division level) management committees have been formed and given the task of improving O and M. The committees consist of ORMVAD representatives, representatives of the Interior Ministry and of the District.

(b) Farm level management

Farmers are responsible for O and M of portable systems which attach to the quartenary distribution system hydrants. As stated earlier, they are still given considerable

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[36]The World Bank, Project Performance Audit Report, p. 50.

assistance by ORMVAD working through a representative elected for each block. The representatives are responsible for carrying out the specified crop rotations and for various farm operations such as tillage, weeding, irrigation and harvesting where these are not contracted for with ORMVAD. Water user organizations reportedly exist at approximately the subdivision (500 ha) level and are responsible for meeting and deciding upon irrigation schedules.[37]

(2) Functioning of administration

Scheduling of the use of mobile laterals in the blocks is organized by the farmers themselves. Conflicts are resolved by ORMVAD. Water is automatically delivered to the tertiary hydrants on a demand basis. Use of water per hectare remained relatively constant but increased gradually during the three years of implementation, from 4,100 m^3 to 5,100 m^3 per cropped hectare. In 1980/81 water use increased dramatically to 7,500 m^3 per cropped ha. During the same period, the cropped area increased from about 4,000 ha to 18,740 ha and cropping intensity increased from 75-90 percent to 119 percent. Water use during 1980/81 exceeded estimated crop requirements, employing 92 percent (140.6 M m^3) of the water use expected at full development.

c. Cost recovery

Collections of water and land betterment charges by ORMVAD now provide for 90-95 percent of the cost of O and M, according to ORMVAD's Director. This is expected to rise in the future so that funds will be available for making replacements. Our understanding is that no capital recovery payments are made to the national general revenue account.

Our analysis is that collections of water and betterment charges should approach 100 percent in the Doukkala I Project. Farmers interviewed, in contrast to many other places in the world, did not complain about paying these charges; indeed they expressed willingness to pay even though charges had been raised recently. Farmers did not seem to know what they were paying for water, but this was denied by ORMVAD officials who said they knew all right but did not want to tell us. Undoubtedly, a major factor in the success of collections in Doukkala is because it is deducted from the sugar beet account as a portion of the total input package cost. Since all farmers grow sugar beet, cost recovery is good. The farmers we talked to seemed very pleased with ORMVAD. They receive a reliable water supply and farming is evidently profitable. We think that farmer satisfaction and the method of cost recovery are important factors in the success of collections in the Doukkala I Project.

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[37]Conversation with ORMVAD Director, March 27, 1985.

d. Farmer participation

Farmers did not participate in irrigation system design but they were certainly involved in land consolidation activities. With the regularization this made possible, many of the design decisions in which farmers could participate, such as location of outlets, roads, watercourses and drainage were already settled. It is hard to see how farmers could have contributed much to the design of pumping stations, downstream-controlled canals, pressurized pipelines and automatic valves which are technical issues. Had they more experience, they might have looked at alternative portable system arrangements, but it is hard to visualize an alternative to portable pipe. It is possible that some efficiencies could have been made in the scale and size of the block and possibly in the location of quartenary hydrants but this is merely conjectural and the scope for it limited by the "trame B" layout alternative selected under the Investment Code.

Farmers solved most of their immediate problems of interfacing with ORMVAD during the operations phase through their block representatives. However, they have not responded to the idea of more formal organizations at that level. Larger organizations are being formed at the division (500 ha) level. So far the responsibilities are to decide on rotations. Their share of responsibilities may have to be expanded as the system begins to wear out and replacements and repairs become more critical.

e. Summary

During its four-year existence the Doukkala I Project has been technically and financially successful at the farm and project levels. This results from a well conceived technical design providing a reliable and easy to use water supply. The preliminary step of regularizing farm boundaries was an important contributing factor as was the provision of adequate and reliable supplies of agricultural inputs. The success has been achieved under mandatory cropping rotations which farmers find help them better achieve their subsistence and cash flow objectives. At project level, ORMVAD has had considerable flexibility to adjust the cropping pattern to adapt to local conditions with the result that total benefits are significantly increased over what was expected.

2. Chichaoua

a. Background

(1) Description

Chichaoua is a traditional SMSI system located near a town of the same name in the Northern Atlas piedmont in Marrakech province about 70 km west of Marrakech. The irrigation system is gravity-fed being supplied by perennial springs that serve an area of

about 1,900 ha. The springs provide a stable supply of about 1,170 liters per second (l/s) of water to the headworks which consist of a diversion of about 18 km from the source of the spring.

The water is delivered through concrete lined channels and earthen seguias. A fairly extensive rehabilitation of the system was done in the 1940s. Concrete feed canals from the main spring, a syphon and an aqueduct were constructed as well as a concrete distribution network in the Tajoujet sub-perimeter. The syphons and aqueduct have since been destroyed by floods so a temporary diversion has now been built.

The team visited the site of the main diversion point where two main lined canals and two intermittently served ditches originated at different gradients. Whereas the upstream river flow was 600 l/s, at the diversion point it was estimated at 400 l/s. The larger of the two lined canals had three gates and the smaller had only one. No local turnouts were observed in the lined channels. Most of the 40-to-50-year-old lining was observed to be in place but it is cracked and badly eroded in some places. A walk down one of the canals revealed that field ditches are not well-maintained and are overgrown with weeds. However, we saw no leakage from the turnouts which were basically simple earth dams.

A visit to a downstream farm served by the irrigation system showed that water is taken out of a lined channel there and distributed by a ditch parallel to the fields. Here too, the ditch was very weedy, poorly sloped and there appeared to be waste at the top end of the fields. The lined channel was almost completely eroded on the bottom and partly up the sides.

(2) Agriculture in project area

(a) General

The climate in the Chichaoua area is Mediterranean with an average annual rainfall of 178 mm. Sharp year-to-year fluctuations in rainfall make this virtually a semiarid area. Soils are mostly clay-sand, about 80 cm deep and with good permeability and no salinity. Although year round there is a relatively stable supply of water for irrigation from the springs of Chichaoua, water demand patterns create a substantial average surplus during most of the year and a deficit in the dry season. As shown in Table 3-11 demand for irrigation water varies by a factor of seven from 85 l/s in November to 600 l/s in September. The result is that only 12-14 percent of water needs can be met by rainfall in April, August and September.

(b) Farm size and land holding pattern

The population in the area is about 14,400 people who represent about 2,000 households. There are about 1,690

Table 3-11: Current and Post Rehabilitation Irrigation Water Balance and Cost of Project--Chichaoua (l/s)

	Rainfall 178 mm	
	Month of Low Balance (Sept.)	Month of High Balance (Nov.)
Present Irrigation System and Cropping Pattern (24 hr. irrigation)		
Demand for irrigation water		
Net demand at parcel[a]	607	85
Gross demand at headworks	1,356[b]	189[b]
Water availability at headworks	1,163	1,174
Balance	-193	985
With Rehabilitation Project (24 hr. irrigation)		
Demand for irrigation water		
Net demand at parcel[a]	565	135
Gross demand at headworks	941[c]	226[c]
Water availability at headworks	1,163	1,174
Balance	222	948

	(DH m)			Foreign Exchange
Cost Estimates for Rehabilitation	Local	Foreign	Total	%
Irrigation infrastructure	8.1	5.0	13.1	40
Support costs	3.4	0.6	4.0	15
On-farm investments	0.5	0.4	0.9	45
Total	12.0	6.0	18.0	33

[a]Account taken of evapotranspiration and rainfall.

[b]Assumes field efficiency of 70 percent, conveyance eff. 65 percent, overall eff. 45.5 percent.

[c]Assumes field efficiency of 75 percent, conveyance eff. of 80 percent, overall eff. 60 percent.

Source: The World Bank, Staff Apparisal Report of the Small and Medium Scale Irrigation Project (Washington, DC: February 10, 1983).

farms and the average plot size is 1.13 ha. Seventy-two percent of holdings below one ha land are privately owned but a large number of farmers are members of three agrarian reform cooperatives.

(c) Crop yields, productivity and farm income

Table 3-12 shows the land use patterns. Of the total cultivated land (2,525 ha) about 77 percent is devoted to cereals, mainly barley, wheat and maize. Orchards take up 36 percent of the cultivated land on which primarily olives are grown. A relatively small proportion of the land is devoted to summer and winter vegetables and to forage production which includes planting of alfalfa. Cropping intensity in the region is about 135 percent of which about 100 percent is in winter and perennial crops and 35 percent in the summer.

Table 3-12 also shows that current crop yields are relatively low and well below the potential. Thus, wheat yields are 0.9 t/ha, barley 1.2 t/ha and maize 0.8 t/ha. It is estimated that these yields could be increased about threefold. Similarly, olive yields could be increased from the current 1.2 t/ha to about 4.0 t/ha as could yields of vegetables. As shown in Table 3-13, estimated farm incomes range between DH 1,300/yr for the smallest size farm to DH 4,000/yr of a 1.5 ha size farm and as high as DH 26,800 for the largest size.

The team visited a downstream farmer with nine ha of land, half of which was in fallow because of lack of water. The farmer was a member of a cooperative which had been formed from a colonial estate under the Agrarian Reform Law. The farmer's crops included broad beans, wheat and melons and he had a grove of olives which received priority in irrigation. The farmer's fields, crops and ditches were not impressive. Crops were not well tended. Neither was an orchard of fruit trees that also appeared to be very old and needed replacement. One of the farmer's problems clearly was the shortage of water supply even though it was reliable. There were obviously other problems as well which probably included lack of a market, extension services and improved inputs, but we could not verify these ideas.

b. System management

Management of the Chichaoua irrigation system is governed by traditional water rights which are quite complex and generally not recorded. Each ditch or canal has its WUA which employs a ditch rider. The team interviewed a ditch rider for one of the associations on a lateral serving an 85 ha area and about 200 people. The ditch rider verified that a number of associations on the laterals maintained and operated their pieces of the system but there was no larger federation of WUAs that governed the entire network.

Water is supplied to farms on a rotational basis at the rate of 60 l/s for a specified length of time. Each individual's share of the water flow is acknowledged by traditional rights and the

Table 3-12: Current and Projected Land Use and Crop Yields--Chichaoua

	Current Land Use		Projected Land Use		Current Crop Yields	Projected Crop Yields
	Area	%	Area	%	Tons/ha	Tons/ha
Wheat	300	16	390	20.5	0.9	2.5
Barley	650	24	310	16.5	1.2	2.8
Maize	515	27	390	20.5	0.8	3.0
Cereals Total	1,465	77	1,090	57.5		
Winter vegetables	125	7	175	9	17.0	24.0
Summer vegetables	110	6	260	13.5	18.0	24.0
Vegetables Total	235	11	435	22.5		
Forage	140	7[a]	305	16[b]	24.0	42.0
Orchards:						
Olives	555	27	555	21	1.2	4.0
Other	130	9	720	9		
Orchards Total	685	36	720	30		
Total land used	2,525		2,550			
Irrigable area	1,900		1,900			
Harvest intensity	135		143			

[a]Only planted in winter.

Source: The World Bank, Staff Apparisal Report of the Small and Medium Scale Irrigation Project (Washington, DC: February 10, 1983).

Table 3-13: Comparison of Farm Incomes With and Without Rehabilitation Project, Incremental Value Added and Permanent Farm Employment Added--Chichaoua

	Total Irrigable Area (ha)	Number of Farms	Income Per Farm[a] Without Project	Income Per Farm[a] With Project (DH '000s)	Income Per Farm[a] Incremental
Model 1 (0.56 ha)	677	1,209	1.3	3.3	2.0
Model 2 (1.59 ha)	684	430	4.0	10.5	6.6
Model 3 (11 ha)	539	40	26.8	68.0	41.2
Total	1,900	1,688			

	Crops	Livestock (DH m)	Total	Incremental Permanent Farm Employment at Full Development (man-years)
Incremental Gross Value of Production	9.0	1.5	10.5	490

[a]Income excludes off-farm and non-farm income.

Source: The World Bank, Staff Apparisal Report of the Small and Medium Scale Irrigation Project (Washington, DC: February 10, 1983).

ditch rider claimed to know exactly what these were although they were unwritten. Each farmer was aware of when his turn occurred and its length, but except for the ditch rider, the turns of other farmers were not necessarily known by everyone. The turns could be as short as five minutes or as long as an hour.

The ditch rider was responsible for supplying the water according to the generally acknowledged water rights. He reported that there were seldom conflicts over water in his area and that people were generally satisfied, but we were unable to verify this. The ditch rider had been selected over 20 years ago for this position. He himself was a landowner with holdings upstream from the first diversion. His landholdings were larger than the average for the area. He was obviously a trusted and respected member of the community. The WUA paid the ditch rider a salary for which the users were charged DH 47/ha/yr. Members of the cooperative WUA downstream paid DH 25/ha/yr which amounted to about the same given that water shortages compelled farmers to leave half their land fallow.

Although the water delivery administration seemed to be well-organized by the WUAs through the hired ditch riders, maintenance was obviously not paid as much attention. This was evident both at the diversion point and again downstream at the farm level. The lining of channels was eroded and cracked and ditches were overgrown with weeds. At the farm level there was a lot of wastage of water at the tops of fields in distributing the water from the main ditch. The lack of adequate maintenance is the likely reason that the Chichaoua system has undergone several rehabilitations and is now slated as one of the SMSI schemes to be rehabilitated through a World Bank project.

c. Water charges

At present it is not appropriate to discuss cost recovery in relation to the Chichaoua system because the farmers have not so far been responsible for contributing towards the periodic rehabilitations made by the government. However, cost recovery is being planned under the World Bank SMSI project and aspects of this will be discussed in Section d.

Water charges exist at Chichaoua and reference has already been made to the collections made for payment of ditch riders. An interesting dimension at Chichaoua is the existence of a water market. Since land is more abundant than water and the two are not tied to each other, water rights are sold on an annual basis. The cost of 60 l/s of the stream flow for one hour every two weeks is DH 500. This translates into DH 0.089/m^3 which is approximately the amount being charged on the LSI perimeters. The correspondence between the charges is likely coincidental.

d. Development plans

Discussion of the Chichaoua system would be incomplete without mention of the plans for the system's rehabilitation which is to be undertaken at a total cost of DH 18 M. (See Table 3-11.) This includes irrigation infrastructure rehabilitation and is to be accompanied by other on-farm investments, improved extension services and credit facilities. Infrastructure development under the project at Chichaoua will include lining or rehabilitation of about 57 km of deteriorated primary and secondary seguias and concrete canals. Two syphons totalling 450 m will be built to carry water under the Bou Enfir and Chichaoua stream beds. In addition, a drainage network and erosion control works will be constructed and 56 km of existing unsurfaced roads rehabilitated.

It is expected, as a result, of this project that the water balance in Chichaoua will be greatly improved because of more efficient use. The deficits will be eliminated and the average balance available for downstream use will be increased by more than 50 percent to about 560 l/s. (See Table 3-11.)

The intended benefits are slightly increased cropping intensity as a result of improved crop yields and planting of higher valued crops such as stone and pome fruits. At Chichaoua on-farm investment from the project will be in establishment of 40 ha of orchards. Details of the projected increase in land use and crop yields are given in Table 3-12.

A shift is projected out of cereals and into the higher valued vegetable crops. This would reflect expected gains in yields per ha of cereals and the opportunity for small farmers to obtain higher incomes from intensified and diversified crop production following upon improved water availability. As shown in Table 3-13, a greater than two-fold increase in farm income is projected for the two smallest size models which comprise the vast majority of farms. In order to achieve these goals the project plans to simultaneously develop extension programs to provide the farmers with required information for increased production, to encourage on-farm investments and to increased use of inputs. As the traditional systems have problems because of lack of levelling and inappropriate doses and timing of watering, the DPAs will help improve on-farm water management practices.

Improved O and M will also be a project concern. The overall goal is to give as much responsibility as possible to water users. Since cooperation among water users has existed for generations at Chichaoua, the WUAs will be expected to undertake management and financing of all aspects of O and M from the very beginning. However, it will be necessary to regularize water rights as a first step in improved farmer participation in O and M.

Cost recovery will be made a part of the rehabilitation project. The 1984 law provides for negotiated agreements with local WUAs

to arrive at mutually agreed-upon charges. The formula proposed for Chichaoua under the project is to set rates that would cover 100 percent of O and M costs and 40 percent of investment costs. The imputed value of O and M performed in kind by water users is estimated at DH 165/ha/yr. A range of rates is specified for investment cost recovery to allow for flexibility in terms of farmer ability to pay (as it varies greatly in the traditional systems) and other considerations.

e. Summary

The most interesting feature of the Chichaoua irrigation system is the existence of a market for water where it is sold at DH 0.089/m^3. Water distribution is well-organized and administered on the basis of traditional water rights by salaried ditch riders appointed by local WUAs. System maintenance, however, is not given much attention causing inefficiencies and water losses and recurring rehabilitation requirements. Landholdings are small and fragmented and crop yields generally low. The planned rehabilitation with World Bank assistance is designed to improve the downstream water scarcity and dry season shortages. Provisions have also been made for on-farm investments in improved water management practices, better extension and input delivery. The WUAs will be expected to assume full responsibility for O and M and to fully finance it. Users will also be expected to pay 40 percent of investment costs.

D. Summary and Conclusions; Study Issues

1. To what extent is cost recovery through direct and indirect charges a feasible goal in irrigation systems?

At farm, project and national levels recovery of annual O and M costs on Doukkala I is feasible and will likely occur. Using the 1981 monetary levels of the PRC and that year's exchange rate of US$ 1 = DH 5.00, the investment cost is DH 26,800/ha. Following the Morocco model for payment of betterment taxes over 17 years at 4 percent, this amounts to DH 2,208/ha/yr, or US$ 442. This has to be weighed against the incomes of the small farmers: it would reduce the estimated 0.5 ha projected farm income from US$ 975 to US$ 756; the 1.0 ha from US$ 2,230 to US$ 1,788; 2.0 ha from US$ 3,670 to US$ 2,786; and the 5 ha from US$ 9,790 to US$ 7,580. With 75 percent of the farms in the project below 2.0 ha in size and an average size of 0.9 ha, full recovery of capital investment from these small farms does not seem feasible. But this category of farms occupies only 32 percent of the land area. Recovery from the remaining 68 percent would probably be feasible. Cost recovery on the national scale would be more problematic because not all irrigation projects are as successful as Doukkala. This is a relatively profitable project with an estimated internal rate of return of more than 20 percent.

The Chichaoua system did not shed any light on this issue because farmers have not yet had to pay for any improvements made on the system by the government. However, clearly farmers are willing to pay for

their water and for the ditch rider as evidenced by the existence of the market in water. This factor should make it more likely than in other places that the cost recovery goals of the new rehabilitation project will be met if rates are set equitably and realistically. Whether this will prove true remains to be seen.

With respect to the effect of direct versus indirect charges on improved cost recovery, probably no one knows what the indirect charges are. Indirect charges would have an effect on farm incomes and could affect ability to pay. Furthermore, the direct charge is levied indirectly in that it is deducted from the value of the crop purchased by the state.

2. Do increased farmer participation and control contribute to improved cost recovery?

At all levels, farmer, project and national, as far as Doukkala I is concerned the answer is no. The high level of cost recovery achieved at Doukkala can be attributed to several factors which have nothing to do with farmer participation. (In fact, farmer participation and control are limited on the project.) These factors are: improved and reliable water supply, efficient system management by project officials, improved yields and incomes for farmers (as a result of prices for farm commodities rising faster than subsidized inputs). Most important, perhaps, is the method of charging which is to deduct water charges as a part of the total input bill. This is done when the sugar beet crop is purchased from the farmers. The implication then is that under the special circumstances of a successful project, with a total package of prescribed cropping patterns and input services for high value crop production, a guaranteed price and market and direct deduction for water charges it is possible to have good cost recovery.

Once again, cost recovery has not been an issue at Chichaoua although farmers buy and sell their water rights depending on their landholdings, cropping needs and water availability.

3. To what degree does improved cost recovery depend upon reliable water supply, adequate water supply, water delivery and measurement technology?

The thesis that reliable and adequate water supply are essential to improved cost recovery is strongly supported at farm and project levels. High but appropriate technology in the Doukkala I project has ensured a reliable and adequate supply and this lesson is not lost at the national level. Direct measurement of volumes using water meters did not work out. Shift to charging on a cropped area basis has not hindered collection of water charges on this project.

Although the cost recovery issue could not be studied at Chichaoua, the existence of a reliable water supply and its scarcity combine with the separation of land and water rights to make a market in water. Farmers are willing to pay for water because it is scarce

and because it is reliably delivered. Lack of measurement technology is not a hindrance to charges because the water is delivered by timed flows monitored by the ditch rider. Further, due to the importance of irrigation, farmers are willing to pay charges towards the ditch rider's salary.

4. Are increased water charges a necessary and sufficient condition for improved O and M? To what extent does efficiency of water use vary with the cost of water?

Recent increases in water rates bring the promise for adequate revenues for O and M for Doukkala I. Given the technology in use and the capability of the ORMVAD, this is probably sufficient for the project but the conclusion cannot be extrapolated to the national level because of the variety of projects and management responsibility in the country. At farm level, maintenance of the portable systems is a farmer responsibility and theoretically, would not be affected by increased charges. In practice, reduction of farm income through higher water charges could lead to poorer maintenance of these components. Nominally, however, the improved capacity of ORMVAD's personnel will help farmers because they still rely on technical assistance and material support from the agency.

We have no evidence that a higher cost for water will result in its reduced or more efficient use. The water meters never really got into service so the hypothesis that direct volumetric measurement would improve efficiency was never really tested. The theory is plausible within the rather narrow limits of variation from optimality that are likely to occur given sprinkler technology.

Water charges at Chichaoua are completely unrelated to maintenance although there is some relation to operation in that user charges are applied to ditch rider salaries. Farmers are willing to pay for an assured water supply and are traditionally organized for that purpose. However, they have not extended the organization for purposes of maintaining the system.

From all appearances and based on discussions with officials at the provincial agricultural ministry, water is used efficiently because it is scarce. Efficiency would not be affected by changes in the cost of water. In any case, it is possible that an equilibrium market price of sorts prevails at Chichaoua.

5. Do institutional arrangements whereby farmers participate in and control irrigation systems improve O and M?

This proposition is not testable on the Doukkala project. The farmers have developed their own simple organizational arrangements for participation at block level using a block representative as intermediary. Our assessment is that more intensive participation at block level would be forced and would be uninteresting to farmers and would not yield improvements. Participation in scheduling at division

level has potential for minor improvements of operations. We think these improvements, if any, would be relatively marginal in the system. We do not see how participation at above division levels on this technically complex system, which already operates "on demand," could improve on O and M. The situation here is unusual because of the nature of the system.

At Chichaoua, farmers have long been organized into traditional WUAs but this has not had any noticeable impact on O and M. In fact, system maintenance is quite neglected. On the other hand, because of the necessity to secure irrigation water for their crops, farmers are willing to pay charges and to pay for a ditch rider to monitor the rotations.

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