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A Comparative Assessment of Links Between Irrigation Water Pricing and Irrigation Performance in the Near East

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Abstract

Water pricing policy is being increasingly recognized as a key instrument for improved water allocation, better conservation and quality preservation. It induces better demand management of water resources and is seen by many as the ultimate solution in water-deficit areas where supply is limited or cannot be augmented.

The various uses of water differ in many ways and it would be too simplistic to generalize to all types of use the impact of water pricing on demand and conservation. The agricultural sector differs from the other sectors by a heavier demand for water, different water resources, different supply and management systems, the potential profit made by users and the nature of water users, to cite just a few. Social and religious dimensions and political considerations further complicate the situation of irrigation water pricing. Therefore, in many countries, particularly developing ones water pricing and cost recovery is still in very slow pace.

Irrigation water pricing is undoubtedly a means of valuing the resource, but what is not clear is the extent of inducing water conservation through pricing without negatively impacting the functions of water. In other words, is payment by farmers of the cost of irrigation water a motive for the adoption of water saving technologies and management tools? What is the extent of linkage between water tariffs and water productivity? If the link is weak and conditional, what other factors or parameters contribute to making it stronger and how these factors come into play?

This paper attempts to address irrigation water pricing from the perspectives of water use efficiency in agriculture and water conservation. It has a twofold objective. The first is to present an overview of the water pricing experience, with particular emphasis on the Near East region. The conclusion drawn from compiling the available information is that although water is still treated as a "public good" with little political will to introduce tariffs that reflect real costs, changes are being forced by water scarcity, increase in demand, funds needed to maintain irrigation infrastructure and the global changes towards liberalized market conditions. Pricing is also faced with social problems, pressure from lobbies and religious considerations.

The overwhelming majority of irrigation water continues to be managed by the public sector. The principle of recovering part of the cost of operation and maintenance of irrigation water systems has been admitted in some countries since the late sixties. It is applied in a few countries but covers only small portions of the actual costs of operation and maintenance. However, the recovered funds are not re-invested for the provision of better O&M services, which makes farmers less reluctant to pay. Capital cost is excluded from cost recovery

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programs, but the opportunity cost pricing of water is not applied even in developed countries where marginal cost pricing is not found in the water sector. The trend is changing with more countries likely to changes their policies and to adopt water pricing in the future, to fully recover the costs of operation and maintenance.

The second objective is to assess the extent of linkages between irrigation water tariffs on one hand, and water productivity and conservation on the other. The findings show that pricing alone is not the solution, but opens promising avenues when integrated in a well-planned package of reforms. In particular, farmers are willing to pay when charged correctly and provided with appropriate services.

While a promising tool, the potential of water pricing has limits and conditions. The limits are imposed by the economy of the country, the physical and climatic conditions, the available market opportunities, the share of water costs in relation with other production costs and the capacity of the country to meet the pre-requisites of water pricing. The conditions or pre-requisites consist of a set of accompanying measures and reform policies to create the enabling environment for the success of water pricing.

1. Introduction

In the Near East region, the demand for fresh water is dramatically escalating due to rapid growth of population while its supply is constant or even decreasing as a result of deterioration. Excessive use of water and degradation of the environment are considered the main issues in water management and pave the road towards more water sacristy. Yet irrigated agriculture still constitutes the backbone of the economy of most countries where seventy to eighty percent of the food need increase by the year 2030 will have to come from irrigated agriculture. With the extremely limited possibilities for augmenting supplies, the main option left is to manage demand of the available resources in a way that optimizes their productivity and guarantees their sustainability. Water pricing, along with other measures, is viewed by many as a key policy instrument for creating incentives to improve water allocation efficiency and therefore, increasing productivity.

Water serves different sectors and its value differs from one sector to another. When restricted to economic terms, the value of water in the agricultural sector is often considered the lowest compared to other sectors. Under scarcity conditions, water may be diverted to higher-usage value. Therefore, agricultural sector should produce more with less water in order to compete with other sectors. This would entail water mangers to initiate and implement water policy reforms that improve productive and allocative efficiency of water use. Reforms should consider the economic, social and political dimensions. Economic perspectives may treat water as other private goods, subject to allocation through competitive market pricing. However, social perspectives treat water as a basic human need that should be largely expanded to attain a standard level of social welfare. Policy reform should also consider the deterioration of water quality and hence, the principle of polluter pays may be one of the approaches to be adopted.

Instituting a viable cost recovery program is important for two reasons. First, as liberalization policies take momentum in other sectors, irrigation cost recovery constitutes one option to curtail demand, though its effectiveness is still debated by many. Second, the present and future investments in the water sector certainly need resources for their development and maintenance (Ahmad, 1996).

2. Water Pricing Policy Concept

Water pricing is viewed as an economic instrument to improve water allocation and mitigate water scarcity situations. Water has two set of prices, the financial or supply cost and economic or opportunity cost. The supply cost may cover O&M cost to which one can add investment cost and interest and depreciation on borrowed capital to obtain full supply cost. The opportunity cost represents its highest achievable value. Integrating the environmental cost with these two costs often represents full cost pricing. Almost nowhere do users pay anything near the financial cost of water, let alone its opportunity cost.

There is a great debate for defining water as an economic good to be treated as other private goods subject to allocation, through competitive market pricing. Economists often call for implementing water markets, which is thought to be an effective instrument in improving water allocation particularly in scarce situation. Water markets may help allocate water to high value uses, when treated through trade in water market rights. On the other hand, non-economists treat water as a basic human need that should be largely expanded from competitive market pricing and allocation. Nevertheless, water pricing is recognized to have the potential of mitigate water scarcity to a certain extent. It can provide incentives to water conservation and transfer from low-value to high-value agricultural production.

In practice, in countries that implement pricing policy, water users are paying operation and maintenance cost and in few cases a part of capital cost. This is true since the water infrastructure has been built since long time and users could not be asked to recover the capital cost (Dinar, 2000). Recently Mexico developed the basis for water pricing policy. The price of water was set to consist of three parts: water tariffs, fees and markets. Water tariffs is to recover the cost of operation, maintenance and capital cost of water structures. Water fees are the government chargers for the use of country resources and this fees is to cover the cost of monitoring, river basin planning, assessment of water quality and quantity, etc. In order to implement such policy, water rights should be first well defined and structured. In addition, devolution of water management to water users or non-governmental organization would help operate the pricing policy properly.

Several factors constrain the implementation of water pricing. The physical and hydraulic characteristics of the water distribution system often constitute a major limitation. The source of water used has also impacts on water pricing policy reform, such as groundwater versus surface water. Water management continues to be a centralized process in most countries and revealed to provide a low level of service. Lack of resources to the public agencies to maintain the water distribution systems contributes to reducing the level of service. Countries are now moving towards more de-centralization of the process, through transfer of management responsibilities to non-governmental or private sector entities. Political pressure on governments, to continue maintaining a certain level of subsidy to water management, slows down the process of water pricing. The social dimension is yet another factor that comes into play as farmers have their own perceptions of water that are derived from cultural, traditional and religions beliefs.

3. Brief Overview of Experience with Water Pricing from outside the Near East

Experience on irrigation water pricing is relatively recent and differs from one country to another. Recovery of operation and maintenance costs tends to be the main objective, but it is rarely achieved. In Spain for instance, the policy is to recover part of operation and maintenance cost. The Spanish law defines water as a "public good" that is not treated according to market forces. Water allocation is then the responsibility of the government through regional water authorities. Each authority is responsible for a watershed management and delivers water to a water management unit known as water users association. Farmers then pay two terms of the operation and maintenance cost. The first term of cost is paid to government to cover part of the cost of water distribution from reservoirs to water management unit (water users association). The second term is the cost of internal administration and maintenance within the water management unit (Berbel and Limon, 1999). The water tariff differs from one region to another. Some areas pay based on the irrigated area and some pay based on volumetric bases, particularly the new irrigation areas, when meters are installed (Tsur and Dinar, 1997). Then, the cost of water has two forms; fixed cost and variable cost. The fixed cost ranges from $0.96 to $164.48 per hectare. The variable cost ranges from $0.0001 to $0.0288 per cubic meter (Dinar, 2000). A study was conducted to investigate the impact of the water pricing policy on irrigation sector in three irrigated areas in Spain (Berbel and Limon, 1999). The study proved that water pricing as a single instrument for control of water use is not a valid means of significantly reducing agricultural water consumption. Increase in water pricing may result in replacing high profit crops that consume large amounts of water by low-profit crops of low consumption. It may also have negative impacts on environment through increase in the consumption of fertilizers and chemicals, to compensate production, which represents the main sources of agricultural pollution. The low price also has negative impacts on water savings as farmers may not be aware of the water scarcity problems. The study recommended that the revenue should be administrated by water management units, i.e. by water users, in order to make the water pricing policy works properly. The financial resources could be, then, used to improve the water distribution and

implementing water-saving technologies. The revenues that are not properly invested by water management units can be transferred to the Regional Water Authority (Government) in order to keep the system under control.

Water pricing through establishing water banks and water markets has been practiced recently in California state, in USA, to be the basis for determining water price that farmers have to pay, based on water availability and scarcity conditions. In the past, farmers used to pay, on the average, $5 per acre-foot (area-based pricing) to the Central Valley Project. Cummigs and Nercissiantz, in 1992, proved that an average value of water price of $19.32 would cover only 39% of the estimated scarcity value.

In Chile, tradable rights are officially practiced where water rights are allocated to users in the form of water shares. Each share is one liter per second. This approach showed substantial economic gains.

Informal water pricing has been practiced in most of south Asia through private groundwater well since a long time. In Pakistan, agriculture is heavily dependent on irrigation through canal system. However, canal water in some cases is not adequate to provide all users with their requirements. Consequently, farmers rely on groundwater either as a sole irrigation source or a supplementary source. Some well owners sell water to nearby farmers particularly those who do not own wells. Large farmers who own more than 25 acres tend to have their own tube-wells, while small farmers or tenants tend to buy water (IFPRI, 2002). Water sales are limited to neighbors who are, in most cases, relatives. This informal water market resulted in shifting to high-value crops, as water became available either through their own wells or through buying water. India is also similar to Pakistan where groundwater is traded informally among farmers. It was reported that water price ranges in Pakistan and India at $1.49 – $5.8 per hectare per year and $0.164 – $27.4 per hectare per year, respectively (Dinar 2000).

Mexico has also a similar situation. It was reported that small farmers who suffer from severe groundwater overdraft and cannot invest in deepening the tube-wells could sell their water rights to large farmers. Of course, small farmers win because without water market, they can neither invest nor receive any compensation. However, large farmers who are able to invest heavily in developing deeper groundwater hurt more small farmers who in turn will find themselves enforced to sell their rights (Kemper, 2002). In order to have these water markets work properly, a set of institutional arrangements are needed. Water price in Mexico ranges from $33 to $60 per hectare per year.

In 1989, a National Water Commission (CNA) has been established in Mexico to be responsible for modernization of the deteriorated irrigation system management where water users suffered from the centralized water management. The CNA made an appreciable progress towards decentralization of water management and creation of water user associations. In 1992, the national water law, and subsequently its regulation, was issued to provide the framework to officials to improve the water management in Mexico. This law allows establishing river basin councils, representing the water users. It also allows forming aquifer committees to mange and operate groundwater. Moreover, the law mandates the implementation of a complete system of water rights, including the discharge permits. The government is currently regulating the registration of water rights over the country. Then, water pricing can be implemented as soon as water rights are well defined and structured. Water pricing policy is planned to consist of three parts, water tariffs, fees and markets. Water tariffs is to recover the cost of operation, maintenance and capital cost of water structures. Water fees are the government chargers for the use of country resources and this fees is to cover the cost of monitoring, river basin planning, assessment of water quality and quantity, etc. The water markets enable trading water rights among water users and to move water to its high-value use. Mexico experience could provide a clear example of water management reforms that developing countries, especially large irrigation systems, can follow.

In most of Developing countries, adopting water pricing policy is still very slow. There are political and institutional reasons behind their implementation. However, informal water pricing is practiced among farmers in particular those who own groundwater tubewells. Recently, these countries showed a great recognition of the importance of cost recovery of operation and maintenance cost. Some of them have taken steps towards the implementation of such policy through re-institutionalization of water management entities and allowing for the participation of the private sector and non-governmental organization. Regulatory systems are also being reformed in order to facilitate devolution of water management authorities to water users.

4. Water Pricing in the Near East Region

Several RNE countries with ample renewable water resources made important efforts since the 1960s and 70s to develop their irrigation sector. The objective of this orientation was to promote intensive agriculture with a high economic value, capable of satisfying part or all of the national food needs and achieving an exportable surplus, while stabilizing production through mitigation of the negative effects of drought that make rainfed agriculture fragile and non reliable. In order to encourage adoption of this policy by farmers, states supported the initial investments and the operational costs of the hydraulic and irrigation schemes installed, but soon this became a heavy financial burden.

With transition of the economy towards liberalization and a progressive shift to open market mechanisms, it is now more and more recognized that governmental subsidy at least to the operational and maintenance costs cannot continue while ensuring the level of services required. *Huge budget deficits, rising cost of maintenance and over extended institutions are widening the gap of resources needed and the current level of expenditures. As a result about $12.5 billion of yearly investment in water resources go unrecovered in the region (FAO 1993).* With varying levels between countries, governments are shifting their policy to demand management as the key instrument for improving water utilization in agriculture. This policy is based on three axes. More participation and involvement of water users in water resources management, the promotion of modern irrigation technology and management tools and the adoption of water pricing regime to recover the operation and maintenance cost, but also future investments.

A few countries introduced timid water tariffs since the 1960s and 70s or even earlier, but it wasn't until recently that the policy of irrigation water pricing is making its way. In some countries, even the idea has not matured enough, whereas in the countries where the policy has been adopted, slow strides are being taken in the field of cost recovery. Pilot areas and small-scale programs are just being implemented to test the policy, but in general the experience is encouraging to the countries that took the lead as well as to the other ones.

The lead countries provide substantial experience in water pricing and demonstrate its feasibility, but not without problems. Other countries are in the process of adopting such policies or re-institutionalizing existing policies and programs. Water pricing is also being recognized since illegal water markets have been established to sell water in many countries.

In Cyprus, the price of the water from the Government major water works is given to the farmers at one fifth its actual cost. This heavy subsidy is a drawback to the national efforts in saving as much water as possible. A considerable amount of water, although not estimated, is lost due to pipe networks leakages due to improper maintenance, operation and management of the farmers' systems installations (Phocaides, 2002). Private boreholes provide more that 35% of total water demand. There are approximately 20 000 licensed private boreholes and other wells. Pumping is controlled and the permissible water extraction for irrigation is

calculated on the basis of the specific crop water requirements with minimum 75% application efficiency in a defined commanded area. Private well owners support the entire costs.

In Algeria, water tariff is recognized to be an important instrument to conserve water and to improve water use efficiency. The tariff system, which aims at recovering the operation and maintenance expenses, is single tariff to cover O&M costs. There is, in addition to O&M tariff, a tax applied on maximal discharge which varies according to the irrigation specifies. The fixed rate per hectare ranges from $3.97 to $7.59 per year or per season. The variable rate ranges from $0.019 to $0.022 per cubic meter (Dinar, 2001).

Morocco introduced the policy of water pricing in its 1969 Agriculture Investment Code that regulated investment and management of irrigation in the country. It was decided at the time that farmers would participate with a maximum of 40% of the total costs excluding the part attributable to the production of energy from hydraulic structures. These costs correspond to both on-farm works, such as land consolidation and leveling, and external as well as internal infrastructure (dams, transport and distribution networks, drainage, etc.) The participation of farmers was divided into two parts: 30% as direct participation or land betterment levy, proportional to the irrigated area above five hectares, and 10% as a permanent annual tariff for the usage of water. Farmers whose holding size was below five hectares were exempted from direct participation and those with larger holdings were exempted for the first five hectares. The law, which was intended for all large public irrigation schemes, also fixed the betterment levy to 1500 Moroccan Dirhams[3] per hectare, corresponding to US$ 4500 at the time of its promulgation, to be paid over a period of time. The water tariff was to be supplemented by a tax reflecting the cost of energy, applicable to the users supplied through pumping or pressurizing systems.

Enforcement of the law was loose during the first fifteen years following its promulgation because of the overriding policy to expand the irrigated area. In addition to a low rate of recovery as explained below, this law revealed several weaknesses when put into practice. The major difficulty stemmed from the fixation in the body of the law of the direct participation amount to 1.500 DH/ha, an amount that reflects 30% of the actual average costs under the conditions of 1969, without considering the inflation rate and devaluation during the subsequent years. This constraint created problems for fixing water tariffs in the irrigation schemes developed after 1969 and which constitute the largest share of the irrigated area at present. The law lacked a legal mechanism to revise the pricing system. In addition, it took the authorities more than ten years to fix the supplemental energy component of water price. In the absence of adequate solutions, the prices adopted in the newly developed schemes were indexed on those applicable in the neighboring old schemes. These discrepancies of the pricing system continued to constitute a burden for a long time.

A review of the pricing system was undertaken in 1984 fixing the direct participation to 30% of the weighted actual investment cost and water tariff to include 10% of the investment cost, amortization, the cost of operation and maintenance, rehabilitation cost, and the cost of energy when applicable. Since the promulgation of this new decree, the price of water has been revised 15 times. The tariffs were reviewed again in 1996, increasing the direct participation from 30% to 40% of the investment costs and abolishing the exemption of holdings of less than five hectares from this participation. As a result, the direct participation reached more than 26764 Moroccan Dirhams per hectare, corresponding to nearly US$ 2300 as per the exchange rate of April 2002. The revision also catered for the introduction of step increase in tariffs with increasing layers of demand, as a means to enhance water conservation by farmers and the introduction of water saving irrigation technology. According to officials, the revised

[3] The current exchange rate is MD 11.7 for US$ 1.

prices balance more that 100% of operation and maintenance costs in nearly all schemes, but not the cost of rehabilitation.

Implementation of the supplementary energy tax started in 1980 and is directly indexed on the tariff of electricity. It has been revised several times with a mean annual increase of 9.3% during 1980-96, 7.1% during 1996-2001 (9.7% for the entire period 1980-2001.) In real terms, the average annual increase of water tariffs amounted to 7.3% during 1969-1996 and 2.5% during 1996-2001; the mean increase since the promulgation of the Agricultural Investment Code in 1969 is 6.5%, i.e. less than the mean inflation rate during the same period. The current water tariffs are 0.20 – 0.25 DH/m^3 (US$ 0.02) for gravity irrigation schemes, 0.24-0.47 DH/m^3 (US$ 0.02 - 0.04) for water lifted through pumping from rivers and 0.48 - 0.62 DH/m^3 (US$ 0.04 - 0.053) for sprinkler schemes.

While water tariffs were revised to reflect a large share of operation and maintenance costs, the cost recovery did not follow the same pace. The discrepancies of water pricing policy and its implementing laws also resulted in a slow recovery of water tariffs. The recovery rate has even decreased since 1996 in most schemes, for several reasons including a severe drought period. The main reason however is the nature of the public agencies managing the irrigated schemes and the social and political interference to which they are subjected. During the period 1981-1989, the recovery rate increased regularly from 47% in 1981 to 70% in 1989. It stagnated around 70-73% during the period 1990-1997, before decreasing again to between 58 and 52% during the period 1997-2000, despite a six-year program to recover overdue arrears that came into force in 1997. In absolute terms, the recovered amounts which were 320 and 420 million Dirhams during the 1991-1997, have been increased during 1997-2000 to between 480 and 594 millions DH. As this period was characterized by a very low inflation rate, the increase is nearly 40%. Officials believe that the current decrease of the recovery rate is conjectural because of droughts and is expected to get back again to normal.

Morocco started also an ambitious program to treat sewage wastewater to protect the environment and to relieve the pressure on fresh water. The treated wastewater is considered as a water resource and sold to farmers. Treated waste water cost ranges from 1.12 to 1.70 DH per cubic meter and is sold to water users at a rate around 0.5 DH. This rate of charge is not sufficient to recover even the cost of operation, maintenance and distribution of the distribution network after receiving the treated waste water from the plant (Aomar and Abdel Majid, 2002).

Pumping from groundwater is under the sole responsibility of farmers. The pumping cost reaches up to 1.5 Dirham (US$ 0.13) per cubic meter and is entirely paid by farmers. This approximately reflects opportunity cost of water and provides an indication of the level of subsidy when comparing with what farmers pay (US$ 0.02 for gravity irrigation schemes.) It is clear that pumping from groundwater aquifers is more costly than other water resources such as surface water and treated wastewater. The number of private pumps increased from 4,000 units in 1974 to 154,000 in 1996.

The current level of water tariffs, if fully recovered, would cover more than 100% of the recurrent charges of water services, excluding rehabilitation costs. The recovered amounts would permit a satisfactory level of operation and maintenance of water distribution networks if used entirely to this end. In practice however, even the recovered fraction is used mostly for charges that are not related to water. As a result, the level of services provided is still below the required standards and leads to rapid deterioration of the infrastructure the rehabilitation of which continues to constitute a high burden on public resources.

According to a study conducted in 1997 in Morocco, the cost of price of water varies between schemes from 470 Dirhams (US$ 40) to 2863 Dirhams (US$ 245) per hectare per year, with a mean in all irrigated schemes of 1413 Dirhams (US$ 121). The mean gross margin in all

schemes is 9369 Dirhams (US$ 800) per hectare and the share of water in variable costs varies from 8% to 33% with a mean of nearly 20%.

In Tunisia, 45% of the total irrigated area is under private management and concerns small-scale schemes relying essentially on shallow aquifers. Farmers in these schemes support investment and management costs of their individual systems, with a subsidy from the State representing 25% of investment costs and reduced energy costs. Cooperative management by Collective Interest Groupings (groupements d'intérêt collectif - GIC) concern 33% of the irrigated area. The collective hydraulic networks are supported by public funds, but their management is delegated to GIC. The latter fix water tariffs and partition the total expenditure charges over beneficiaries in proportion to their respective interests. Large schemes (22% of the total area) are still managed entirely by the public sector.

Tunisia adopted water pricing in the irrigated schemes since the late 60s and early 70, but the tariffs were low (4 to 6 millimes[4]/m^3), which did not allow the public agencies managing these schemes to equilibrate their O&M budgets. The deficits limited the capacity of these agencies to adequately maintain the installed hydraulic and irrigation networks systems, and all costly and successive rehabilitation works had to be supported by the public sector. Starting in 1990, a new water pricing policy was developed. It consists of encouraging the creation of Collective Interest Groupings (groupements d'intérêt collectif - GIC), to take over public agencies for the management of irrigation schemes, and increasing water prices at an annual rate of 15% in nominal terms (9% in actual terms). The policy aims in a first phase at the integral coverage of operation and maintenance costs. Table 1 shows the evolution of tariffs and recovery rate (RR) between 1991 and 2000.

Table 1: Evolution of operation and maintenance costs and of water tariffs by region

Region	Year					
	1991			2000		
	Tariff(*) (Millime/m^3)	Cost (Millime/m^3)	RR (%)	Tariff (Millime/m^3)	Cost (Millime/m^3)	RR (%)
North	45	59	76	101 (US$ 0.07)	85	119
Sahel	49	87	56	116 (US$ 0.08)	143	81
Centre	36	81	44	68 (US$ 0.05)	63	107
South	21	35	60	35 (US$ 0.025)	42	83
Total	43	61	70	94 (US$0.066)	82	115

The new policy has been implemented in some Governorates, but in others where low-income small farms dominate, farmers have been reluctant. As a result of this new policy, water prices have more than doubled in all the country. The rate of increase is higher than that of most other entrants. During the same period, the price of fertilizers was increased by only 44% (potassium sulfate and ammonium Nitrate) to 53% (super-phosphate), despite the dismantling of subsidies for these products. Similarly, the price of labor and mechanized works increased by 58% and 60%, respectively.

The total cost of irrigation water, excluding amortization, in the public irrigated schemes, varies at present from 42 to 143 millimes/m^3, depending on the region. The cost increase followed fluctuations of the inflation rate in Tunisia, with 4 to 6% per year during the last ten years. This increase was generally lower than that of water tariffs, which allowed a slight improvement in the rate of recovery of operation and maintenance costs. The latter went from

[4] 1 millime = 1/1000 Dinar; Tunisian Dinar = US$ 0.7

70% in 1991 to 115% in the year 2002, at the level of the country. The cost structure of irrigation water consists of 41% for staff, 30% for energy and 29% for consumables, and shows the high shares of staff and energy components. However, not all recovered funds are invested back in the schemes to provide adequate operation and maintenance. As a result, the services provided remain below standards and farmers find the prices too high in comparison with what they get in return.

In the private irrigation schemes supplied from groundwater aquifers, the cost of water is supported entirely by farmers and varies between 50 and 95 millimes/m^3, depending on pumping depth. The price difference between the cost of this category of water and the price paid by farmers in the public schemes explains the orientation of farmers to dig their own surface wells when the geo-hydrologic conditions are favorable.

The new policy to increase irrigation water tariffs resulted in reducing the subsidies accorded for the management of collective irrigation networks. In certain schemes, a surplus has even been achieved, which allowed the improvement of maintenance services of hydraulic infrastructure and of the quality of services provided to farmers by the managing agencies. However, in general there is a high variability in the budget equilibrium of these agencies, with a close link to the climatic conditions of the year. The latter determine to a large extent water demand and the rate of intensification in the irrigated schemes, particularly those located North of the country. The global situation hides certain realities with regard to the irrigated schemes managed by GIC where water costs are very high (pumping from deep aquifers in the Centre and South of the country.) Certain GIC are in the incapacity to maintain their financial equilibrium and the State continues to provide its support to these associations for the rehabilitation of their irrigation infrastructures.

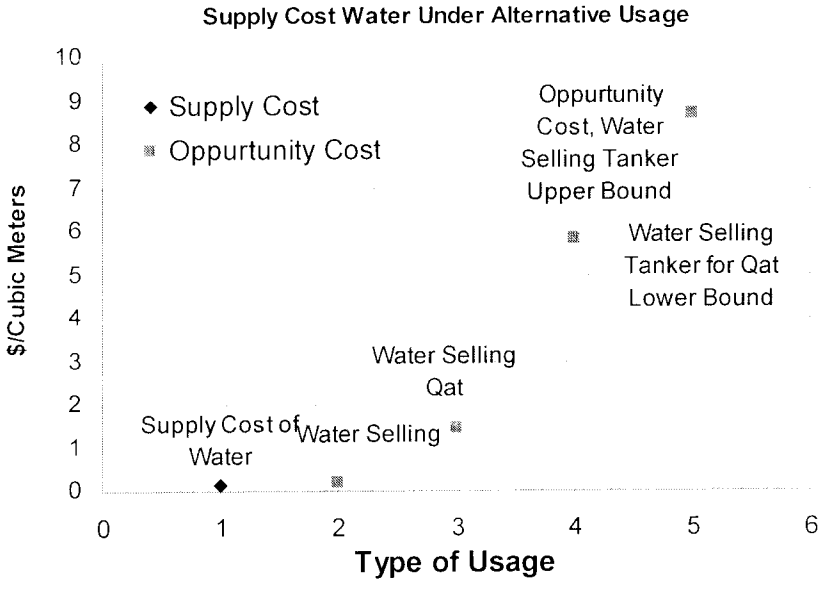
The current water pricing system accords preferential tariffs to cereals, with a reduction of 50% from normal prices. The objective of this measure is to encourage extension of the irrigated area under cereals, which is considered to be still low in the irrigated schemes. Similarly a preferential tariff of 20 millimes/m^3 is accorded for the reuse of treated wastewater in agriculture. This measure concerns all public irrigated schemes intended for the use of such water (around 7000 ha) and aims at encouraging the irrigation of cereals and forages. The mean cost of the treated wastewater made available to farmers is 123 millimes/m^3, of which 16% are covered by the current tariff.

In Yemen, water pricing is not applied because of the lack of a water law, weak political will and the power of tribes who actually control and use water. Groundwater is the dominant source of supply and the government has no control on this resource. For groundwater, two costs might be used: the supply cost and opportunity cost. The main factor that affects the price of $1m^3$ is the depth of the well. Farmers bear the cost of drilling and operating wells and water pricing is applied among them in a manner similar to water markets. The constitution states that water is a property of the state, but under the traditions farmers who develop groundwater wells have the right to it. Speculations among farmers and the selling of water tanks to villagers and city dwellers are very common. The drilling of wells was encouraged by the government in the seventies and eighties to boost agricultural production. The government subsidized drilling equipment and fuel and provided soft loans to farmers. The policy resulted in a spectacular increase in the number of wells and rapid lowering of water tables, threatening drinking water supplies in the major cities including the capital and increased use of water for Qat cultivation.

The operational cost of groundwater varies between US$ 0.05 and 0.2 /m^3 depending on pumping depth, but farmers sell water amongst them for lower prices (Bazza, 2001). Irrigation water is a high-volume, low-value user of water. But there is an important and

growing sector of high-value irrigation (often for fruits and vegetables), with typical values between 200 to 300 Yemeni Rials (YR)[5] per cubic meter. The value of the same water for Qat is estimated at YR 600 per cubic meter. The water sold through tankers assumes a much higher value and is often used as supplementary irrigation. The main point is that farmer's willingness to pay for high value crops is much higher than some other traditional crops.

The opportunity cost of water is the value of water in next best alternative use. Water markets provide a good proxy in estimating opportunity cost of water. The lower bound of this price or short run marginal cost is provided by purchase or selling price or cost of water to the farmers. Well water now is increasing competition for different needs. Consumers willingness to pay for domestic use and growing Qat is case in point. A recent FAO survey has revealed that Qat is grown under four different principal water regimes: rainfed, spate irrigation, well water, and tanker water, in order of increasing cost to the farmer. Spate irrigation involves annual costs in erecting and maintaining the earthen diversion structures, but those costs are low, typically about YR 5 per cu. meter of water. Well water is more expensive, ranging in cost from about YR 12 to about YR 70 per cu. meter, with a typical cost of around YR 25 ($.15) per cu. Meter (Figure below). Water sold to other farmers is at YR 35 ($.20).Tanker water is far more expensive, ranging from YR 150 to more than YR 2000 per cu. meter. A typical cost is YR 1000 to 1500 ($5.8 to $8.7) per cu. meter, and usually it does not fall below YR 250 ($1.4) per cu. meter. Tanker-based cultivation is found in a number of places, especially in Yaher and Labaus Provinces of Lahej Governorate, but it is always supplementary irrigation in rainfed or well-irrigated areas, and not the primary source of irrigation. Quantities of tanker water applied to the fields per hectare are quite small, usually supplying 5-10% of the plants' total water requirements, and often even less. (FAO, 2002)



From the policy perspective the great challenge in well irrigated agriculture in Yemen is how to ensure that farmers take into account the opportunity costs, which are often an order of magnitude higher than current charges. This is the essence of the appeal of the approach of water markets. Despite the high cost of irrigation water, farmers have not introduced water saving irrigation technology because of their perception of it as being not adapted. Water is applied from a hose connected to the tank of water and moving from one tree to another to fill

[5] Current exchange rate is 175 YR per US$

small basins around trees. As a measure against the high cost of water, farmers subject their crops to water stress by adopting deficit-irrigation practices.

Irrigation water in Jordan is subsidized by the government, but in a proportion relatively less than in most other countries. In the Jordan Valley, the operation and maintenance cost is estimated at 18 fils[6]/m^3 (US$ 0.025) The cost of water pumped from the Valley for domestic use and big consumers is 55 fils/m^3. In addition, exemption of custom duties is granted on all imported materials for agricultural production.

The water pricing policy adopted in 1996 considered the increased-tariff blocks system, based on the delivered volume of water. Crop type was also considered in the pricing policy. For each crop, an upper limit for water demand was determined and farmers were not allowed to withdraw water above this limit otherwise they are to pay an additional fine. The Jordan Valley farmers have metered water supplies and pay on a monthly basis 8 fils/m^3 (US$ 0.01) for the first 1000 m^3, 12 fils/m^3 (US$ 0.017) for the second 1,000 m^3, 20 fils/m^3 (US$ 0.028) for the third and 35 fils/m^3 (US$ 0.05) above 3,000 m^3/month, per farm unit of approximately 3.89 ha. The cost of pumping water from aquifers in the high land is above 50 fils/m^3 and is paid for entirely by farmers.

Attempts to raise tariffs to recover full operation and maintenance costs as well as part of the capital investment are met with pre-requisites from farmers to secure the export market for agricultural products. In addition, they request the lifting of agreements to allow imports during the local production season and to stop pumping water to Amman for domestic use as a priority allocation. Farmers believe that their traditional rights to get free water from springs and nearby wadis have been violated when the Government started charging them the operation and maintenance costs.

Under pricing policy of water in Jordan Valley, groundwater from shallow aquifer is not allowed so as not to impact the surface water delivery. However, in other areas where groundwater is the only source of water, farmers are responsible for pumping groundwater on their own. The cost of pumping water from aquifers in the high land is above 50 fils/m^3 and is paid for entirely by farmers.

The relatively high water tariff paid by farmers is not reflected in the quality services provided for operation and maintenance, which indicates that the recovered funds are not re-invested for such services.

In Syria, the policy of water pricing to control demand management is recent. Charges are only applied for water diverted from governmental irrigation networks. Farmers who benefit from public irrigation systems pay a fee intended to recover part of the investments, taking into consideration irrigation development cost for an amortization period of 30 years with no interest. The amounts paid range from the equivalent of US$ 40 to 120/ha, depending on investment costs. As of 1999, the cost of operation and maintenance of public networks are also paid as a flat fee equivalent to US$ 70/ha for permanent irrigation and US$ 12/ha for winter crops. The fee represents the average actual cost of operation and maintenance in the main irrigation networks. Where water is pumped from wells, farmers bear all the costs. In this category, operation and maintenance costs amount to the equivalent of more than US$ 110, in comparison with surface irrigation with US$ 35. The recovery rate of operation and maintenance costs is reported to be 90%, which is high in comparison with most countries. However, out of the total irrigated area of 1213000 ha, 715509 ha (59%) get water from wells which number is estimated at 201259. This has resulted in major decrease of groundwater

[6] US$1=710 Fils

level in all basins. Farmers who have excess water often sell it to their neighbors at a range of 6 SP[7]/m^3.

In Egypt, no water pricing has been adopted up to date. The growing increase in water demand is leading officials to adopt policies to improve water allocation and productivity. Irrigation management transfer, irrigation improvement and matching irrigation supply and demand are three major policy reforms to help in improving water allocation. The transfer of water management responsibilities to water users and non-governmental organizations is expected to reduce the public contribution to the operation and maintenance of irrigation schemes. The current funding to maintain irrigation infrastructure is inadequate. In 1993, the budget allocation for operation, maintenance and rehabilitation was LE 555.00 million or $ 164 million which covered only 70 percent of the adequate level of funding of LE 792 million or $ 234 million (ISPAN 1993). Instituting a cost recovery program was recently studied under a pilot project. The cost recovery in real terms is still very minimal ($ 735 per ha to be paid over 20 years), though the approval of the legal process in itself was an achievement. Implementing the program on larger scale and obtaining legislative approval could take considerable efforts and time.

In Pakistan, irrigation water charges were introduced in 1873 under a legislative Act. Water charges were specified in 1891 for one large canal, and later on for other canals as they were completed. The charges came into application in 1924 but were reduced in 1934 in response to a fall in farm prices that reduced the repayment capacity of farmers. The new water tariffs remained in effect until 1953 when their level was raised by 50 percent for areas fed by inundation canals. Water charges for gardens and orchards were doubled in 1954 to account for extra supplies permitted for their irrigation. A special reclamation charge was imposed at the rate of 6 Rupees[8] (Rs) per irrigated acre in 1954 to recoup the capital investment from farmers irrespective of the type of crop. In 1955, an overall enhancement was legislated in water charges for all canals in order to bring them to the level that prevailed back in 1924. The latter vary from 4.5 Rupees per acre for maize to 12 Rupees for sugarcane.

In 1959 it was decided to classify canals with common characteristics into groups, to split the composite levy into its components, to rationalize water charges and to revise water charges on a uniform basis throughout the country. After the classification of canals and rates for each crop, water charges applicable since 1934 were uniformly raised in 1959. The revised decision raised water rates for cotton and oilseeds by Rs.2.95 and Rs.2.43 per acre respectively. Water charges were enhanced several times between 1959 and 1969, with an overall increase during this period of 10%. Gardens and orchards have been regarded as intensive consumers and were charged additional 3 to 4 Rupees per acre and per year. The revised water charge of 1969 (Rs. 14.4 per acre) remained effective till 1978. They were revised several times since then and reached in 1978 Rs 18-21 per acre for wheat, 18-34 for rice, 18-32 for cotton and 18-71 for sugarcane, the differences being between project areas. In the other areas, water tariffs have evolved since 1955 from a minimum of Rs. 4 for fodder and a maximum of Rs. 12 for sugarcane to the current values of Rs. 38 (US$ 0.6) for fodder and Rs.177 (US$ 3) for sugarcane. All other crops are between fodder and sugarcane, except gardens and orchards the rate of which are currently between Rs. 115 and 140 (US$ 1.9 and 2.3) per acre. The recovery rate of water charges remained low in general and varied from 50-60% in certain regions to less than 30% in the others. Government subsidies covered the cost of rehabilitation of watercourses.

Water charges are assessed on the cropped area and crop basis. Crops are taxed differently, based on differences in crop income (ability to pay principle) and water requirements. The

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[7] The current exchange rate is SP 50 for 1 US$.

[8] Exchange rate in 2002 is 60 Rupees to a US $.

current water charge per acre-inch (around 100 m^3) of water is Rs.2.04 for rice, Rs.3.09 for wheat and Rs 2.36 for sugarcane. As a result, farmers tend to maximize water use even under scarcity conditions. It further implies that irrigation water is subsidized more for certain crops than other crops. As irrigation water supply is related to canal commanded area and water charges are assessed on the basis of cropland, the relative burdens of payable water rates per canal commanded acre is essentially determined by the intensity of cultivation on various farm sizes. The cultivation intensities are substantially higher on small farms as compared to large farms; thus the water rate burden per canal commanded acre is more on small farms than on large ones. It has been reported that the smallest farm size category of under 1.0 acre are subjected to at least 2.5 times the water charge per unit of water payable by the largest category of "150 acres and above". Similarly, farmers who are supplementing the canal water supplies with cost intensive tubewell water are paying more water rates per canal commanded acre as compared to those farmers who are receiving the same water supply and solely dependent on canal water. As the water charges for any crop are not related to the quantity of actual canal water applied, changes in these rates have not led to significant improvement in economic efficiency. The system does not encourage farmers to take measures such as reducing the quantity of water applied, increasing cropping intensity, introducing modern irrigation technology and shifting to crops with low water requirement or to high value.

The revenues from water charges are pooled in the provincial treasury along with other tax revenues and lose their source identification. Therefore, revenues from water charges cannot be claimed to bear any direct relationship with funds allocated for O&M activities. Expenditure on operation and maintenance on irrigation has been in excess of receipts from irrigation. Receipts from irrigation correspond to 30-70% percent of expenditures on operation and maintenance.

The ability of farmers to pay for water can be estimated from those relying on water markets from groundwater. Private tubewells provided nearly 30% of farm gate water during the year 1997-98. The selling of groundwater is widely practiced among farmers throughout the country. In Punjab about 40 percent of total water availability is through tubewells. Currently, the average selling price of tubewell water is about Rs.120 per hour, for an installed capacity of one cubic foot per second, which is equivalent to approximately one acre-inch of water per hour (100 m^3/hr). This charge is more than double what a farmer relying entirely on canal water pays for the same volume of water and for the same crops.

The residual left after paying all non-water inputs from the gross revenue earned from the crops represents returns to water and can be considered the maximum amount a farmer can pay. The results for year 2000-01 give Rs 121 per acre-inch for wheat, 57 for rice, 26 for cotton and 66 for sugarcane. These results are consistent with the conclusion drawn based on the costs of water from private tubewells. The estimated marginal value product per acre–inch of water was Rs.70-107 in 1992. Expressed in 2000-2001 prices, it corresponds to Rs.148-226. Thus the marginal value product of water is many times higher than the current water rates.

Based on estimates of gross income per acre obtained using the average yields for the year 1999-2000 and the government floor prices for the same year, the ratio of current water charges to gross income varied from 0.57 percent to 1.22 percent for various crops. With increase in water rates by twofold, farmers would have to pay from 1.74 to 3.66 percent of their gross income, depending on the crop practiced, for canal water. A reasonable charge for irrigation water as a percentage of gross income is 6 percent for Asian countries. This level will not be reached in Pakistan even under a twofold increase in water charges. The current tariffs are less than 4.0 percent of the net cash income for the major crops. Increasing tariffs even by 100 percent would result in ratios of water charges to net farm income that are roughly comparable to those of several other Asian countries. This ratio is about 6.5 percent for Indonesia, Philippines and South Korea.

By all estimation means, even if water rates were increased by large percentages over the current rate, they would be well below the average ability of farmers to pay. However, raising water charges would have little or no effect on water use because of the charging mechanism. Farmers would be willing to pay substantially higher water charges for reliable good quality water and better services.

In Sudan, the actual area of irrigated land was around 1.95 million ha by 1980, or 25% of the cultivated area. Of this area, 1.7 million ha (87%) is gravity fed, 0.2 million ha is pumped from rivers and 50,000 ha are spate irrigation. The situation regarding recovery of irrigation costs is confused. At present, a mandatory annual charge of SD3 000/feddan (US$27/ha) is levied on tenants and is recovered through deductions from farmers' gross earnings from their production. It is estimated that this level of charge is less than half of the total actual cost. However, in the face of deteriorating water supply, farmers have been increasingly resistant to making any payment.

Table 2: Summary of Public Irrigation Water Prices in some Near East Countries

Country	Fixed Price (US$ per hectare per year or per season)	Variable Price (US $ per cubic meter)
Algeria	3.79 – 7.59[9]	0.019 – 0.022
Cyprus		0.1078
Jordan		0.01 - 0.05
Morocco		0.02 – 0.053
Pakistan	1.5 - 7.5	
Sudan	27	
Syria	70 permanent irrigation 12 for winter crops	
Tunisia	--	0.025 – 0.08

5. Implications of Water Pricing Policy

Water pricing policy, as a strategy for water demand management, aims at water conservation and consequently increase in agricultural production. It is anticipated that irrigation water efficiency will be improved, as farmers change their strategy and practices in irrigated agriculture. They may shift to high-value crops that consume less water and introduce irrigation technologies that reduce water losses and increase the revenue per unit of water. This in turn would reduce the negative effects of water logging, groundwater rise and pollution of aquifers from irrigation. Negative impacts could also result from the pricing of irrigation water. Reduction of water use may reduce the leaching of salts and cause their accumulation with time. Crop yields could decrease since farmers tend to apply less irrigation water to limit charges. They could also modify the cropping patterns or reduce crop intensification as a measure to reduce water use. This would in turn affect food security and reduce farm income. The change from traditional to modern irrigation technology and management requires precautionary measures to ensure that the systems are designed and operated properly. Often, the knowledge of farmers and technicians on the new technology is

[9] Per liter per second per hectare

limited and these measures are omitted, and consequently the new technology does not achieve its objectives. Negative impacts on labour opportunities may also be incurred.

In Jordan, the on-farm irrigation efficiency is less than 50 per cent on 60 per cent of the farms. In the remaining 40%, efficiency values of 70% and above are reached as a result of the introduction of modern technology that provided farmers with the tools to improve the control of water distribution and application. It is believed that the scarcity of water imposed during nine years of continuous drought in the late nineties forced farmers to reduce the amount of water applied under irrigation more than the price of water. (Serpekian, 2002).

Despite water scarcity and the costs that farmers have to pay, 60% of the total irrigated area is still under traditional methods. Experiments conducted in pilot farms proved that one third of the amount applied under these traditional techniques is sufficient to produce higher yield and better quality. In a country like Jordan where water deficit is very acute, it is not only the low price of water that explains why the introduction of modern techniques has not been generalized to all irrigated area.

In Morocco, the major problem remains the low water use efficiency. Out of 939000 hectares of irrigated land, surface irrigation is practiced on 85%, sprinkler on 15% and localized systems on 2%. On-farm efficiency remains low with 50% and 70%, respectively for surface and sprinkler irrigation (global efficiency of 40% and 60%, respectively.) The highest efficiency values are encountered under private sector irrigation from wells which accounts for 200000 hectares. The farmers on these farms pay much higher cost than the farmers provided with surface irrigation.

The water price levels have had no effects on water demand under irrigation by gravity, which is due essentially to the collective charging system[10]. Under sprinkler systems where farmers are equipped with individual water meters, the effect is remarkable. In this regard, the special case of a sub-sector in one of the schemes is eloquent and merits attention. The sub-sector of 1537.4 ha is irrigated by sprinklers and owned by a cooperative. The land ownership structure permitted the modification of the land consolidation scheme so that each farmer was equipped with an individual water-meter. The increase of water tariff by 21% induced a reduction of 5% in water demand and 38% increase in crop intensification, which is actually equivalent to 32% actual reduction in water demand. By comparison, an adjacent sub-sector of 2123 ha where the land ownership status does not allow similar modifications, the increase of water tariff by 21% resulted in 6% increase of water demand and 15% increase in crop intensification (actual decrease in demand of only 7.8%.). A similar situation is found in another large scheme where, in the areas equipped with individual water meters, a 5% price increase resulted in 10% reduction in water demand; whereas in those where water allocation and charging are done on a collective basis, demand increased in response to price increase.

Restrictions on the amounts of water allocated for each water application to match water-holding capacity of soils had very positive results. It led farmers to improve their lands, through leveling and deep plowing, and to adopt improved surface irrigation methods (basins, furrows, etc.) and, consequently, to achieve higher efficiency values. Another measure adopted by the government is to encourage the conversion from surface to modern irrigation methods, particularly trickle irrigation. The policy is implemented through the provision of technical advice and subsidies to farmers. The government supports 40% of the total cost of equipment and installation in the areas with acute water deficit and 30% in the other areas. In the current five-year plan and budget, the sum of US$ 86 million is allocate

[10] Invoices are made each semester for the amounts of water delivered to each farmer when individual meters are installed. In the case of collective allocation, the price is partitioned on the basis of the area actually cropped and irrigated.

It is believed that if prices are increased by 50%, tariffs would have an effect on demand in the case of sprinkler irrigation, but in the case of gravity systems, even 100% increase would not have a significant effect on demand because of the pricing mechanism. Even in the schemes where water is the most expensive, water charges remain within acceptable limits.

In Syria, traditional surface irrigation is the prevailing method in the country and covers 93% of the irrigated area. Only around 80000 ha are irrigated by sprinkler systems and 110000 hectares by trickle irrigation systems. Irrigation efficiency at the field level is below 60% and does not exceed 50% in most of the area. The average water consumption per hectare is more than 12434 m^3/year and exceeds 16000m^3/year in the Euphrates basin. To reduce water usage, several measures have been taken by the government, including a resolution to convert all the irrigated area to modern irrigation within four years. In addition, all wells are to be licensed and metered and water quotas imposed. Farmers who use more that the allowed quotas, would pay an additional fee. The resolutions also aim at creating farmers' awareness on the advantages of modern irrigation and supporting them with soft loans to convert their irrigation systems.

In Egypt, over use of water at the farm level and losses during transportation and distribution are pre-dominant. On-farm irrigation efficiency can be as low as 45% in canal heads, which affects tail-end farmers, and it is estimated that about 20 percent of the water could be saved through canal-level improvements alone. The overall efficiency level gets as high as 70% when considering the recycling of agricultural drainage and groundwater (Attia, 1996). The options to save water include the adoption of modern irrigation technology, crop substitutions and reduction of drainage outflow.

In Pakistan, the overall irrigation efficiency of irrigation systems is estimated to be in the order of 35 to 40 percent as a result of high leakage in canals and low on-farm irrigation efficiency. Irrigation is entirely traditional, modern irrigation methods are essentially in the testing stage. Because water rates charged are independent of the quantity of water used by a particular crop, there is no relationship between the efficiency and the price of water

In Sudan, the cropping intensity on the Rahad Irrigation Scheme declined from 75% to 57% by the year 2000, due to siltation that halved the required quantity of water supplied and 126,000 hectares were taken out of production. Bad water management resulted in water supply to the fields 12% below crop requirements at crucial points in the growth cycle. At the same time, it is estimated that at least 30% of the water delivered is wasted due to excessive water application and poor land leveling.

In Tunisia, the overall performance of irrigation is still low in general. Surface irrigation is practiced on more than 70 percent of the total irrigated area, with almost 60% in traditional surface irrigation and 42% as improved surface irrigation. The overall efficiency under this type of irrigation is still low and does not exceed 60% at the most. With the subsidies granted by the government for the introduction of modern irrigation, the area under localized irrigation has risen from 10 000 ha in 1995 to 55,000 ha in 2001. Efficiency under this system is still below the potential but estimated to be more than 70%. Sprinkle systems are used on 88,000 ha with a lower efficiency range than that of localized systems.

The main difficulty encountered when implementing the new water pricing policy was acceptability by farmers of the continuous increase of tariffs, the consequence of which was a substantial increase in operational charges at the farm level. The part of water as a production "factor" in these charges varies between 7% for winter irrigated crops (cereals, forages, etc.) to 30% for summer crops (vegetables and fruit trees). Two important measures allowed the progressive reduction of farmers' reluctance:

- Liberalization of the prices of most irrigated products within the framework of economic structural adjustments, with the exception of cereals the price of which is still being fixed by the State. This explains the orientation of farmers to fruit trees and vegetable crops in the irrigated schemes, in comparison with the low proportion of cereals which marginal benefit is comparatively lower.
- A "National Progamme to Economize Irrigation Water", launched in 1995, provided farmers with subsidies of 40 to 60% of the investment costs for purchasing modern irrigation equipment. This measure had a considerable impact on the evolution of the areas irrigated with water saving techniques, thus reducing the volumes applied and cutting the related prices supported by farmers, while improving the yields sensibly. The program also allowed the country to catch up the delay in encouraging water saving technology at the farm level.

6. Policy Options and Conclusion

In Arid Region like Near East, irrigation is needed to produce or increase productivity above the levels if rainfall was the only source. Water is one of many factors that contribute to this factor. Irrigation water derives its value from the contribution it makes to the profit. If additional water is available at free of cost the farmer will apply water until there is no marginal benefit from additional water. When water comes at cost to farmers, he must compare the marginal profit generated by additional water and if profit is less than cost of water he would try cut back on extra water that generates negative marginal profit. Incentive pricing regime that moves farmers from fixed price regime to a combination of fixed and water rate would contribute to dual policy objectives of water saving and generating revenues.

Is there a close link between water prices and irrigation performance? In other words, do we have higher efficiency and productivity and better allocation of water when water prices are higher? Based on our review, to a certain extent "yes", but the relationship perhaps depends on number of other non price factors. Water pricing serves to provide incentive for more efficient use of water. On the other hand non-price water saving policies are designed to directly reduce inefficient use of water. In addition to saving water, instituting an incentive price regime also acts as means to raise revenues. It is clearly demonstrated in above analysis that the dual policy objectives of saving water and generating revenues are generally not met. The question is why, number of factors are listed indicating when water pricing works and when it does not.

Firstly, the pricing as an instrument to save water will not work as long as there is no relation between quantity of water supplied and its price. This means that irrigation policy should move from fixed water charges regime to one that provides water charge rate. One needs to adopt an incentive price regime that meets both conservation goals and revenue generation. The case of Morocco clearly demonstrated that relation.

Secondly, instituting a water price regime or cost recovery is not very important, if the generated revenues are not pumped back in irrigation infrastructure maintenance and its development. Farmers often don't see the benefits of water charges, if it does not enhance its farm productivity on a sustainable basis

Thirdly, in order for water pricing policy to be effective, it must be embedded into an integrated set of measures that create the synergy necessary for achieving the anticipated objectives - particularly better water allocation though appropriate control and productivity and higher water use efficiency. Achievement of these objectives guarantees not only acceptance of the policy by farmers, but ensures development objectives and the creation of water market conditions. The reform measures should cover all relevant aspects (technical, institutional, social, economic and legal.)

The strongest argument that water cannot be treated like any other economic commodity is the fact that its shortage does not determine its value. Under market rules, scarcity is often linked with higher value, but this is not the case for water, at least in the agriculture sector. Surprisingly, it is in water-scarce countries or parts thereof that water productivity is low, with the exception of rich economies that do not depend on agriculture. In Yemen for instance, one of the poorest countries in terms of water resources, water productivity and the performance of irrigation are among the lowest in the world. The same situation applies to poor regions of the other countries, such as Jordan and the oases south of Egypt, Tunisia, Algeria and Morocco, to cite just a few. In fact water productivity seems to be the lowest in water scarce regions of agriculture based economies. Here the macroscopic and apparent limiting factor is water, but the real limitation is poverty. The vicious cycle seems to be "water shortage-poverty-low capacity to invest-low performance of the available water-more acute shortage of water". The cycle is exacerbated by the harsh climatic conditions, with low productivity potential, by poor quality standards of produce, and by lack of access to markets. Subsistence farmers bear the cost of water, such as pumping from groundwater, up to a certain extent, then give up for economic reasons. With increase in the price of water, more layers of the poor are excluded, leaving access to the resources to the rich layers. Thus, increasing the price of water is equivalent to creating inequities that favor the rich and discriminate against the poor. The role of the government should be to protect the right of the poor rather than encouraging these inequities. Water rights and appropriate regulations that enhance water markets and sustain the resources would be the right solution. They would allow farmers to sell their rights and permit preservation of the resource from depletion and quality degradation.

The impact of the current irrigation water pricing policy in Tunisia was evaluated in 1998. Estimates of demand elasticity with respect to price give an indication of the efficacy of water pricing policy and of its limits, as applied in the different regions of the country. The results showed that the elasticity of water demand with respect to price is relatively weak (weighted-average around - 0.17). Therefore, a given percentage variation in water price induces a lower percentage variation in demand. Elasticity values in the South and the Northwest, where the cost of groundwater is already high, were way above the average, which implies that increasing the price of water in these regions will result in substantial decreases in the amounts applied, in comparison with the other regions. In these regions farmers are relatively poor and shift to low value added crops in response to higher water prices.

Within the framework of the same study, an agro-economic model was used to estimate the medium-term impact of increasing water tariffs by 15% each year. The analysis showed large differences in the reaction of farmers to the increase of water tariffs. In the Northwest, and the South where demand is relatively elastic, an important decrease in water demand is observed. In the Centre-West and Northeast regions where high value added crops are produced (fruit trees, vegetables, plastic-cover agriculture), demand remains relatively inelastic and the decrease in water use is only limited

Finally the overall incentive structure facing the farm sector is important. For traded inputs, farmers now generally face input prices close to world prices, the main distortion on domestic factors such as water remains pervasive. This is often offset by uncertain and generally declining world prices in real terms for key commodities. Food security and water link at micro level is also very important. The past policies in the region taxed some of key commodities on the output and subsidized inputs such as fertilizers, pesticides, energy, irrigation water and credit. Consumers were subsidized for strategic food commodities. On balance, if we price water at its opportunity cost the sector was generally subsidized and provided income to farm sector, ensuring food availability at reasonable prices for urban poor and landless rural agricultural labourer. Under reform programmes, on the production side, most of the subsidy other than water have been removed or are in the process of being

removed. In a drive to improve allocative and productive efficiency and mobilize financial resources to maintain and develop irrigation subsector, a viable cost recover and water-pricing policy is inevitable. The consumer subsidy is also being phased out. The delicate balance between farm profitability, food availability and food prices brings us to question of water pricing that take into consideration the efficiency, equity, social and environmental consideration. This would be one single challenge that policy makers in the region have to deal in coming years and the answer is not easy due to policy conflict of food security, trade reforms and reducing subsidy on water. FAO future work will try to address these issues in light of enormous work done on estimating domestic resource cost analysis for Syria, Yemen, Egypt, Palestine, Jordan and work initiated in other countries.

The economic value of water as a production factor and the share of its cost with respect to the other production costs are the most important elements that determine demand elasticity with respect to price. The share of water costs integrates the effects of most factors that impose limits on water pricing increase, particularly the physical and climatic conditions for agricultural production and the available market opportunities. With high value crops, the share of water costs remains low and demand is inelastic. In response to water price increase, farmers shift to higher value crops and invest for improving water productivity but production is not affected. When the share of water costs goes beyond a certain limit, believed to be between 15 and 20%, demand decreases but at the same time production starts to be negatively impacted.

In short, the current water prices in the Near East Region are still low, with relative differences between countries. The average share of water costs is way below 10% when considering all countries on which data is available. In countries where the prices are still very low such as Pakistan (see above) and Syria, even doubling the current prices, which would be very sensitive from the political standpoint, would keep the share of water costs below 5 to 10%. Within countries, the share of water costs varies between regions as well as from one crop to another. In Cyprus for instance, where the price of water is relatively higher in comparison with other countries, the share of water costs varies from less than 1% for tomatoes and French beans, to 29% for low value crops, such as alfalfa; the mean for eleven main crops is 8.5%. In Tunisia, the share varies from 7% for winter irrigated crops, such as cereals and forages, to 30% for summer crops, such as vegetable crops and fruit trees. Whereas in Morocco, the share of water costs to variable costs varies from 8 to 33%, with a mean in all irrigated schemes of 20%.

Adopting a water pricing policy requires establishment of a relevant institutional framework. One of the important institutional reforms is decentralization of water management. This infers handing over water management responsibilities and decision-making to the local entities, either governmental or non-governmental, to improve the water allocation process through clearing out the redundancies in the management process. Organization of water users and their participation in the process of water management is also essential so that they feel the ownership of water allocation networks. The participatory approach in water management is currently undertaken by most of developed and developing countries through establishing of water users associations (WUAs) and transferring water management to these entities.

Legislation to define and preserve water rights and to protect water resources from degradation is an integral part of the process. Introducing water pricing involves reforming the existing regulations to cope with the pricing policy and other water management innovations. Judicial systems are needed to regulate the collection of water tariffs, to resolve disputes emerging from water allocation and to provide suitable services. The legislation and regulatory systems should also consider the different water resources, such as surface water, groundwater and low quality water. For each type of resource, a set of regulations would be needed to manage and operate it.

Legislation opens avenues to water markets. On the long term, such markets play a positive role in the optimal allocation of water resources. The definition of transferable water rights implies the necessity of reforming the judicial and institutional system, to guarantee proper transfers and resolution of any associated conflicts.

Technical modifications are often needed for implementing water pricing. This includes improved water conveyance and distribution systems that are able to deliver the right amount of water at the right time. Installing water meters on the distribution system permits a better water tariff system based on the actual volume of water delivered to farmers. Through water meters, a progressive tariff system could also be implemented that provides more control on water delivery. In Jordan, this system seems to work properly as water is delivered on progressive-rate basis and linked also to crop type. Even volume-based water delivery and pricing may not achieve the high water use efficiency in surface flood irrigation. Therefore, introducing modern irrigation technologies, such as sprinkler, trickle or subsurface irrigation would, provide efficient tools to control farm application efficiency.

Economic reforms play an important role in the success of water pricing policy and the level of water charges. Liberalization of the prices of agricultural inputs and outputs should be made within the framework of economic structural adjustments. In Tunisia, where prices of cereals are fixed by the government, most farmers shift to fruit trees and vegetables in the irrigated schemes since these crops provide higher benefits compared to cereal production.

The management of irrigation water entails a number of problems related to the particular context of each country as well as to the different regions within a given country. These problems include the climatic conditions and production potentials; the sources, amounts and quality of water resources; the socio-economic conditions and revenues of water users; market conditions for agricultural production; etc. These conditions should inevitably be given due consideration in order for water pricing to be compatible in term with the objectives of water resources preservation. From the political standpoint, developing countries are under political pressure from both outside and within. While donors and finance organizations pressure for the adoption of water pricing, the political will to do so is still weak due to internal political pressure and socio-economic reasons. The latter favor continuation of subsidies to a certain level, to support poor people particularly when they constitute the majority of the society. In these countries, economic reforms should have the priority of alleviating the poverty burdens, as a pre-requisite to successful water pricing. Political power of interest groups may also influence the decision-making resulting in slowing or even preventing the implementation of water pricing reforms.

Considerable work has been done in the region on cost recovery and its allocation. The experience shows that there is good understanding of the need to institute acceptable cost recovery regimes, although actual implementation of viable cost recovery programs is slow. The key objectives of demand management strategy should be to increase water productivity, to sustain the available resources and to preserve and maintain the large water infrastructure built in the past and planned for the future. To achieve these objectives, it is necessary to institute a stronger policy aimed at recovering costs and creating the enabling environment for better water allocation and conservation. However, any reform of water pricing has narrow limits if considered in an isolated manner. Water being only a factor of production, the reform should be in a set of technical, economic and institutional reforms to be implemented in an integrated manner to support irrigation sector performance.

The economic value of water as a production factor and the share of its cost with respect to the other production costs are the most important elements that determine demand elasticity with respect to price. The share of water costs integrates the effects of most factors that impose limits on water pricing increase, particularly the physical and climatic conditions for

agricultural production and the available market opportunities. The current water prices in the Near East Region are still low, with relative differences between countries. The average share of water costs is way below 10% when considering all countries. In countries where the prices are still very low, even doubling the current prices would keep the share of water costs below 5 to 10%.

A range of economic and non-economic tools is available to implement a cost recovery program that can meet the financial and economic requirements. Water prices that cover O&M should be sought. This level of tariffs, applied where the conditions are favorable, would be bearable and acceptable to farmers. The policy should be introduced in a progressive manner, accompanied by a system of incentives aimed at the adoption by farmers of water saving technology, to reduce the amounts applied and the costs associated with water, and to improve the services provided to farmers, particularly operation and maintenance. Adequate pricing mechanisms that reflect the actual use by farmers are also a pre-requisite to the acceptance of water prices by farmers but also to an improvement of water productivity. In poor areas, improving the revenue of farmers remains the best guarantor of their adhesion to pricing policy reforms. Another important ingredient is the institution of water right conducive to water markets and sustainability of the resources, but also to protect the poor.

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