I. INTRODUCTION

The availability of fresh water in the world is finite, whereas demands on this finite quantity are continuously increasing. For ensuring food security of the increasing population, the agricultural productivity must increase. Production of foodgrains is very much dependent on availability of water. Around 70% of the harnessed water is currently diverted for use in agriculture. While aiming at the increases in crop production, agriculture will have to make do with lesser-than-present fresh water quantum by adopting scientific methods for irrigation and by resorting to improved technologies for saving water so that water can be made available for other competing uses in municipal and industrial sectors.

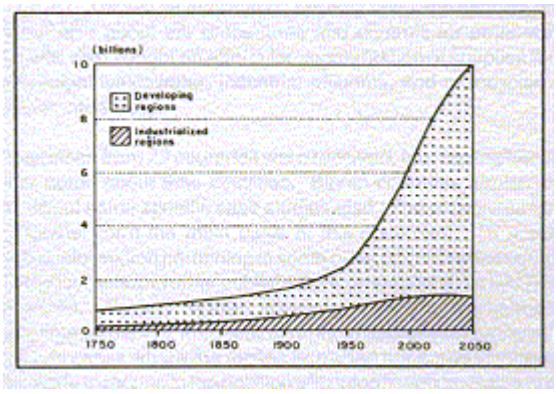

Figure 1. Trends & Projection in World Population Growth, 1750-2050 (Source : World Resources 1994-95)

It is estimated that the world as a whole uses around 69% of the total surface water withdrawn, for irrigation, 23% by industries and 8% by the domestic sector. In the last 15 years the total irrigated area in world has increased from 206.879 M.ha to 255.46 M.ha in 1995 i.e. an increase of 20.6%. Nearly 60% of water used domestically however is returned back as wastewater. Water quantities returned by the industries are also substantial. The industries, which currently withdraw 745 BCM may need an increased quantity of 1200 BCM by the turn of the century (an increase of 62%). The demand for domestic use of freshwater is also likewise bound to increase as a result of population growth, although a good part of it would be available back. The balance may have to be met from savings in

agriculture-wherever water uses have been stretched to the limit of their natural availability. On the other hand, irrigated areas in the world are expected to increase by about 19% during the next fifteen years, drawing 17% more from the available fresh waters. Unless new policies for sustainable irrigated agriculture are chieseled out to implement water savings, the future may be grim in many parts of the world.

International Rice Research Institute (IRRI), Philippines, rendering Yeoman's service to the rice growers of Asia have promoted practices or developed varieties for increasing water productivity in the rice crop. Successes have been noticed in central Luzon of Philippines and Muda irrigation scheme of Malaysia. A key note "More rice with less water", specially contributed by Mr. Kenneth S. Fischer, Deputy Director General for Research in the IRRI has been included in this compilation as an appendix to the Chapter on WatSave Successes. As rice is regarded as one of the high water consuming crop, this note has a special significance in the WatSave document of ICID.

II. AN OVERVIEW OF RESPONSES

Encouraged by the responses to the first WatSave questionnaire circulated in 1993-94, the ICID WatSave Team, as a second step in the learning mode devised another questionnaire seeking more detailed and systematic information on issues and concerns which have complex inter-relationship in the Water Resource Management for understanding the procedures for administration of water and for identifying the achievements in WatSave. It also sought for information on case studies and about the examples of successful water conservation programmes with data on measures adopted, quantum of water saved and the costs of programmes to assess as to how far could those be replicated elsewhere. The questionnaire was sent to 66 active member countries of ICID. It called for information not only about the aspects of irrigation water use but also about the procedures and controls for other water uses. Information was also sought on efforts for augmentation of supplies through the reuse of municipal wastewater, industrial effluents, and of recycled drainage water or desalinated water.

Detailed responses from 23 countries were received, four having furnished only brief general notes about their activities. Seven countries furnished detailed information about some specific case studies also. The responses from the 27 countries together form the main basis of this document. To supplement it further, related information pertaining to some other countries has been obtained from published journals and other published documents such as FAO Production Yearbook'95/96, World's Water Resources'94-95, workshop/seminar proceedings, country papers, Proceedings of International Conferences, including those of ICID. In cases where the replies furnished appeared incoherent, some efforts were made to reconcile the position with information available in published documents.

The responding countries together represented 60% of the world's irrigated area of 255.46 M.ha [FAO Production Book Vol.50, 1996]. The responses were received from the following countries from the different regions of the world.

(i) Africa - Responding countries; Egypt, Nigeria, South Africa and brief note from Zambia. [Irrigation area of the continent represented : 40%].

(ii) Asia - Responding countries; China, Cyprus, India, Israel, Indonesia, Korea, Malaysia, Mongolia, Pakistan and Turkey. [Irrigated area of continent represented: 92%]

(iii) Europe - Responding countries; Austria, France, Germany, Italy, Slovenia, United Kingdom. [Irrigated area of the continent represented : 51%]

ARAL SEA TEAM OF ICID

A special Work Team of ICID has been established in 1994 to work with the international agencies like the World Bank, UNDP, UNEP who are supporting the development of a plan of action to tackle Aral Sea Basin issues such as salinity control, conjunctive use of water, quality of agricultural water, automated control and reuse of drainage water. A special technical session was organised by the ICID on 24 April 1996 on the problems of the basin at the International Drainage Workshop held in Slovenia when the basin states could also participate with the active financial support from the World Bank. An Aral Sea Basin programme's Phase I costing US$ 470 M has been in place. It is being implemented through multilateral funding by the World Bank, UNDP, UNEP and others. Major regional issues to be addressed are, informative improvement, management of transboundary resources, increasing water use efficiency, water quality control, salinity management and improving the implementation capability of the basin states. ICID proposes to play an active role in providing the required technical inputs for the successful implementation of the programmes.

(iv) North and Central America: United States of America [Area represented of the continent : 60%]

(v) Oceania: Australia

(vi) South America: Chile [A brief note representing 14% of the irrigated area of the continent]

In addition, Chinese Taipei Committee and the National Committee of Spain have furnished notes on the states of water resources and other activities which have also been taken note of while compiling this book.

Agroclimatic Significance

Looked at from the agroclimatic point of view, large countries like Australia, India, Pakistan, China and USA represent the aggregate experience of many agroclimatic regions, while others broadly represent one or two specific agroclimatic characteristics. Thus, Austria, China, Cyprus, France, Germany, Italy and Turkey have areas representing dry, sub-tropical climate with hot and dry summers, cool and moderately rainy winters. Slovenia, Chinese (Taipei), UK have areas in Humid sub-tropic climate with cold winters and precipitation in all seasons, the maximum being in the long and warm summers.

Chile and Pakistan have large areas with semi-arid mid-latitude climate with light precipitation, warm or hot summers and cool or cold winters. Mongolia has arid mid-latitude pattern with extremely light precipitation, warm or hot summers with cool or cold winters. South Africa is faced with light precipitation, rapid

evaporation in all the months. Egypt, North-West India, South-East Pakistan and Israel lie in hot arid climatic zone with negligible precipitations, rapid evaporation and with all months as hot or warm.

Korea has Temperate marine climate with rainy days in all seasons, moderate total precipitation, warm runners and cool winters.

The countries also have different irrigation practices. The three responding countries from the African region irrigate about 70% of their areas under Border/ Contour/Furrow surface gravity methods and only about 30% lies under modern practices. In fact only two African countries, Egypt and South Africa adopt modern methods. In the eleven countries of the Asian region the traditional methods of irrigation are followed in 96% of their irrigated area, only 2% of the area is under modern methods like sprinkler or drip. On the other hand European Region has 82% of its irrigated area under modern methods and only 14% is under surface gravity system. In USA area under modern methods is significant.

Source of irrigation water is widely different in different countries with India having as much as nearly 50% of their irrigation from groundwater followed by 43% of USA 27% of China and 25% of Pakistan. It is interesting to note that the main stay of Austrian and German irrigation is groundwater (80% and 90% respectively). Physiography, climate and hydrology have a dominant role in this respect. The balance of these is that the different countries clearly stand on a different footing with reference to the WatSave practices.

The current status of water supply, withdrawals, augmentation by reuse and irrigated area is compiled in Table 1, while areas under surface or ground water sources and that irrigated by gravity or modern techniques is summarised in Table 2.

The comprehensive assessment of the world's water resources carried out on behalf of the UN Agencies in 1997, placed the worlds' countries under four broad categories: (i) High income countries with low water stress, (ii) High income countries with high water stress, (iii) Low income countries with low water stress and (iv) Low income countries with high water stress. The first two categories have the financial resources to deal with the situations as they arise. But the next two categories may suffer flooding or acute water shortages as they do not have enough financial resources to tackle the problems. It is hoped that countries facing the water stress will be able to get some clues from this compilation for overcoming their problems arising from water shortage.

(i) In the high income group countries with low water stress, the main problem is water pollution but they can meet with the situation owing to their financial resources.

(ii) As regards the high income countries with high water stress, they face stress due to continuous overuse or pollution, groundwater depletion in

Table 1. Current supply, withdrawals, use and irrigated areas (available in ws_table.pdf)

Table 2. Irrigated areas and cultivation practices (1994-1995) (available in ws_table.pdf)

near future. They would be left with little water for supply to human uses through conventional means and/or without causing a damage on aquatic ecosystem or further/serious depletion of groundwater aquifers.

(iii) Low income countries (income less than US $ 796) with low water stress are large countries of tropical region having abundant water resources and may suffer from too much water by way of floods due to short rainy seasons. But, being poor they are unable to supply drinking water or sanitation. Another sub-category under this set is of those who have little water and owing to poor resources are not able to tap much of the resources or resort to reuse of their wastewaters.

(iv) Low income countries with high water stress. A number of countries in arid or semi-arid regions of Africa and Asia fall under this country. Currently they use water heavily, mostly for food production. They are also unable to prevent pollution. The constraints in future development will further aggravate the problems. Thus the net availability of water in the future will have to be correctly understood in the context of the country's capacity to prevent pollution or treat the polluted waters for reuse, particularly where the natural availability of water is very low.

Water Pollution and Pollution Control

Water pollution and its control will have a significant and distinct impact not only on the environment but on the sustainability of the irrigation activity also. Of the 23 responding countries, 16 countries namely Australia, Austria, China, Egypt, France, Israel, India, Indonesia, Korea, Mongolia, Germany, Italy, Pakistan, Slovenia, USA and Thailand have reported about polluting sources. The countries who have already experienced limitation in the use of water for agriculture on account of pollution situation are UK, China, France, Italy, Indonesia, Korea, Mongolia, Pakistan, Slovenia, South Africa, Thailand and USA.

Various point or non-point sources in the descending order of their mentions as made by the responding countries are listed below:

A. Point Sources (in descending order of mentions)

Industrial Wastewater	16
Municipal Wastewater	14
Farms/Dairy/Piggery	4(Israel, Italy, Slovenia, China)
Agriculture Drainage	2(Egypt, Italy)
Thermal releases	1(Egypt)
Leather Industry	1(Mongolia)
Mining Industry	1(Mongolia)

B. Non-point sources (in descending order)

Nutrients washoff	4(USA, Israel, Italy & China)
Agriculture Land Washings	4(Egypt, France, Slovenia & Mongolia)
Land use	2(Austria, Egypt)
Fertilizers/pesticides	2(Italy, Israel)
Ground water flux	1(Egypt)

From this list it is clear that the major risk is from the Industrial and Municipal waste waters. But agricultural wash-off and livestock farms also pose a problem in many developed countries. Standards established for water quality by countries are shown in Appendix G.

Monitoring of Water Pollution

Fortunately most of the countries have reported that water pollution control agency (s) do exist in their countries. Water quality standards for monitoring have also been set by Austria, Australia, China, Cyprus, Egypt, France, Germany, India, Israel, Italy, Indonesia, South Africa, Turkey, USA, United Kingdom and in most of them, relevant acts/rules have also been promulgated. In large countries like India, the states play a key role in monitoring the water quality while some apex body (s) at the National level such as a Central Pollution Control Boards oversee the activities in States and also set the national standards. Cyprus and Israel have adopted the International standards in toto. European community have developed standards as applicable to the countries of the community. It appears that the pollution prevention and control measures will have a major role in the water conservation programme at large alongwith "WatSave" activities for physically saving the quantity of water in use.

Water Savings

Farm Level

As regards the physical saving of water in use, Australia, Cyprus, China, Egypt, Italy, Malaysia, Pakistan, Thailand, Turkey and USA have reported that they do conduct surveys to monitor losses and water-use at the farm level. On that basis the quantum of water savings have also been identified by Australia, China, Egypt, Italy, India and Turkey. The main reasons for excessive use of water at the farm level have been stated as below:

- Evaporation
- Seepage
- Wind drift
- Absence of proper farm management
- Lack of O&M
- Lack of farmers know-how

- Over irrigation
- Poor flooding of fields
- Ground water accession
- Low water price

Australia, Cyprus, China, Egypt, France, Germany, Italy, India, Pakistan, Thailand and Turkey have also further informed that they have a mechanism for collecting and publishing the data on the use of water. Country indications are given in Appendix A.

As regards the adoption of improved methods of irrigation, the responses reveal that the first priority, by and large is for Drip irrigation and the second one is Sprinkler. Surface irrigation methods with improved O&M like small borders, proper scheduling and computerised scheduling come thereafter. Automation in flow control and furrow surface method, on-farm development works, flooding in a better way are also mentioned by some. The specific preferences indicated by the responding countries have been listed in Appendix B.

System Level

In the four countries, Austria, Cyprus, Israel, Mongolia the canal systems are reported to be fully lined, whereas they are partially lined in China, France, Australia, Egypt, Indonesia, India, Korea, Malaysia, Nigeria, Pakistan, South Africa and Thailand. Two countries namely Germany and Slovenia have adopted totally piped distribution systems.

Twelve of the responding countries, Australia, China, Cyprus, Egypt, France, India, Korea, Mongolia, Nigeria, Pakistan, South Africa and USA have conducted surveys to assess losses from canals. The reasons for system level losses are attributed to (i) Improper irrigation system, (ii) Inefficient distribution of water, and (iii) Farmers lack of training and knowledge. Egypt, China, France, Pakistan and South Africa have also given data about the losses incurred by their canal systems as shown in Table 3 :

Table 3. Water losses in canals

Country	Lined channels per annum	Unlined channels per annum
China	20-30%	40-50%
Pakistan	2.7 BCM	22 BCM
Egypt	3%	20%
France	25000 m^3	2.7 MCM
South Africa	1.5 l/s per Th.cum	30%

The cost of lining of canals has been reported by the different countries as shown in Table 4 :

Table 4. Cost of Lining of Canals

Cost in Million US$/km length

Country	Main canal	Dist. canal	Minor canal	Field channels
Australia	1.12	1.12	0.45	–
China	0.25	0.15	0.10	0.01
Egypt	0.25 to 0.3	0.2 to 0.25	0.15	–
France	1200 US$ per sq.m	800 US$ per sq.m		
Italy	0.40	0.25	.075	.05
Indonesia:				
Concrete	.08	.052	0.029	–
Stone	.04	.03	.019	–
Malaysia	–	.01	–	.009
Pakistan	12.9 US$ per sq.m			
Spain	.13	.07	.01	–
Thailand	80 US$ per cum of concrete			
USA	.061	.022	.0147	.013

Reservoir Losses

The losses from Reservoirs are found to be substantial. They have been reported by Cyprus, Egypt, France, Israel, Pakistan, India, Italy and Spain as shown in Table 5 :

Table 5. Losses in Reservoirs

Country	Losses BCM			Surface water supply BCM	% loss
	Summers	Winters	Total		
Cyprus	9.03	3.35	12.38	60	21
Egypt	2	2	2	55.5	12.5
France	600 mm	800 mm	–	108.6	–
Israel	0.17	0.08	0.25	0.65	38
Pakistan			3.16	178	1.8*
India			27	362	7*
Italy	8.5	4.5	13	40	33
Spain	.001 BCM/sq.km in Humid regions and .002 BCM/sq.km in dry areas				

* These percentages are apparently very small because a large proportion of the surface water supply by canal is from the direct run of the river

Some measures are said to have been adopted for reducing the reservoir losses but fuller quantification thereof are not available. The measures mentioned by some of the countries are :

- Plastic lining to reduce infiltration (Israel)
- Clay lining of small reservoirs (Australia)
- Improved system operation efficiency (South Africa)
- Treatment with chemicals, use of water-evapo-retardants (WEP) (India)
- Integrated operation of reservoirs to first deplete the shallow portions (India)
- Reduction in Lake surface area in shallow portion with dykes (India)

In addition, weed control and channel cleaning, and rotational or intermittent running of canals have also been mentioned by Egypt and Korea respectively.

Reuse of Municipal and Industrial Wastewaters

Australia, Cyprus, China, Egypt, France, Germany, Italy, Israel, South Africa and USA have assessed the potential for reuse of the wastewaters. Ten countries in the table 6 are actually putting the treated or untreated wastewaters into use for different purposes, have also indicated the costs experienced.

The total area reported from three countries is seen to be a relatively very small proportion of the current withdrawals (in 1995) except in Egypt and Israel. Major use of the treated water is for irrigating vegetables, landscaping and golf courses, or for cooling purposes in industries. Israel has been using the water so available for specified crops with controlled farm management.

Data on costs also show that the treated water for reuse is available at high cost.

Use of Saline, Brackish and Sea Water

Another supplementary source for irrigation water is from the treatment of saline/brackish and the sea water out right. China, Italy, Israel and Spain have reported the irrigation areas and/or the costs of obtaining such water as shown in Table 7.

In Australia the costs are said to be within the range of 1.6 to 2.5 per cum while in Egypt these are $ 1.0 for sea water and 0.8$ for brackish water. In Egypt the use of desalination plants is limited to the coastal areas and mainly for summer resorts. Egypt also has a state funded programme to encourage the use of Saline/Brackish/Sea water. Surveys in Cyprus have shown that potential exists for developing this type of a source but no plants are yet installed. The major use of this water is in agriculture for vegetables or for land scaping and Golf courses or for industrial cooling purposes.

Table 6. Use of waste waters (available in ws_table.pdf)

Table 6. Use of waste waters (available in ws_table.pdf)

Table 7. Area irrigated by desalinated water

Country	Irrigation with such water in M. ha	No. of plants		Cost of Desalinisation US$/m^3
		Sea based	Land based	
China	67000	–	–	–
Italy	15000	11	–	4.0
Israel	45000	1	20	1.0 - Sea 0.8 - Land
Spain	.029	–	–	0.6 to 1.4 - Sea 0.2 to 0.8 - Land
Australia	–	–	–	1.6 to 2.5 1.0 - Sea
Egypt	–	–	–	0.8 - Brackish

Use of Modern Water Saving Irrigation Practices.

From the data available for the fifteen countries as given in Table 8 (overleaf) it is clear that the sprinkler technology has a much greater and wide spread application compared to that of the drip systems except in Israel where the drip technology provides service to two-thirds of their irrigation. World wide, sprinklers are irrigating almost ten times more area than drips. It is also clear that the modern irrigation systems have been able to substantially reduce the water requirement and push it well below 5000 cum/ha, while the traditional systems are able to provide the irrigation service at 10000 cum/ha and above particularly in the dry arid areas as can be seen from the case of Egypt. Incidentally the countries who have been able to take the full advantage of the modern irrigation techniques are the wealthier countries.

R&D Support

In addition, development of low water consuming crops or hybrid variety of crops has already been attempted in Australia, Egypt, India, Pakistan and USA. In these countries and in Israel and Turkey research institutes are collaborating in the development of crops requiring less water, their list can be seen at Appendix C. Further for coordination between the field and the research, multidisciplinary teams or National Boards or committees exist in these countries. Agricultural extension Authority also plays an important role. Countrywise details are given in Appendix D.

Management of Irrigation Systems

Almost in all the responding countries, there exists a designated authority to determine and lay down the requirement of water for various purposes and to oversee the proper distribution. In Cyprus, China, Australia, Egypt, Israel, Korea,

Table 8. Table showing area irrigated by sprinkler, drip and other irrigation methods (Principal crops)

Country	Area Irrigated			Total modern	As a % of TIA	Remarks
	Sprinkler	Drip	Others			
1	2	3	4	5	6	7
Austria	0.76	.003	.001	.08	100	
China	.676	.034	–	0.71	1.4	
Cyprus	.02	.0029	–	.0229	69	
Egypt	.45	–	–	.45	14	
France	.89	.14	.087	1.11	47	
Germany	.53	–	–	.53	100	
Israel	.07	.15	–	.22	100	
Italy	.345	–	–	.345	13	
Korea	.005	–	–	.005	0.5	
Mongolia	.032	–	–	.032	91	
Turkey	.05	–	–	.05	1.3	
India	0.78	–	–	.78	.1	
Slovenia	.005	–	–	.005	82	
South Africa	.67	.05	–	.72	59	
Spain	.9	.23	–	1.13	33	
USA	3.38	0.34	0.17	3.89*	27	*Does not include subsurface irrigation

Pakistan, South Africa, Germany, Italy, India, USA, Austria, Thailand, Malaysia, Mongolia, the authority has to fix the allocation for all the four categories of water use namely Domestic, General Municipal, Industries and Irrigation. The concerned agencies namely, the Agriculture department, Water Resources department, Industrial department, Local Municipalities or Local/State Governments are also involved in the related exercises from time to time and play an important role in the process. The users are involved either through the water agencies, irrigation authorities or the Agriculture extension wing. Generally the above said nodal agencies carryout the task of allocation of water on a basin wise consideration. To ensure that the account of allocated water is properly kept, Cyprus, UK, Egypt, Israel, Mongolia, South Africa, Austria, China, Italy, India, Pakistan and USA have some system or the other to conduct water audit. However a multiplicity in control is there in some cases.

In Australia, Egypt, India, Malaysia and Pakistan, the operation of irrigation system is done wholly by the government agencies, but in Austria, UK, Mongolia and USA, it is done mainly by the water user associations while in France, Germany, Italy, Indonesia, Israel, Korea, Nigeria, Slovenia, South Africa, Turkey

and Thailand the systems are operated jointly with users and government agencies together. In some countries, there are some that are operated either by the government or by the users exclusively, practices in respect of funding of O&M activity however differ greatly from country to country as is clear from the table below. The country Governments have still been playing a dominant role in many countries with large irrigation areas. Most of them are the developing countries. These governments will have to be involved in a major way for improvements in Irrigation system and for affecting the desirable water saving.

Table 9. Funding of O&M activity and agencies collecting the water charges.

Country	Funding %, for O & M			Agencies collecting the water charges
	Govt.	Users water agency	From other levies	
Australia	85	12	3	Government
Austria	–	100	–	Water agencies
China	80	20	–	Government
Cyprus	100	–	–	Govt. & agencies
France	–	100	–	Agencies
Germany	–	100	–	Agencies
Israel	30	70	–	Agencies
India	100	–	–	Govt.
Korea	90	10	–	Agencies
Malaysia	100	–	–	Govt.
Mongolia	10	10	80	Govt.
Nigeria	60	20	20	Govt.
Pakistan	100	–	–	Govt.
Thailand	100	–	–	Govt.
USA	–	100	–	Agencies
South Africa	100	–	–	Govt./Agencies
Spain	50	50	–	Govt./Agencies

Eventhough the methods and procedures for assessing the requirement of O&M funds vary from country to country, the O&M needs are determined on the basis of assessed actual needs in the majority of the countries (Australia, Austria, China, Cyprus, Israel, Germany, Korea, Mongolia, Slovenia, South Africa). But they are fixed on historical basis with respect to previous expenditure in Indonesia, India and Thailand. South Africa and UK have prescribed other methods to arrive at the needs of O&M funds.

The water price is charged in India and Malaysia on the basis of fixed rates which may not have been revised. While in Australia, Austria, China and Pakistan the

water price is levied with due consideration of intervening inflation. Average cost pricing is followed in France, Germany, Italy, USA and Turkey. Egypt, Mongolia and Indonesia do not charge for supply of irrigation water. In South Africa the charges are fixed on a number of considerations specific to the different areas. Nigeria levies a lumpsum charge for each crop season but in Korea the charges are leviable for the rice crop only. Slovenia charges the water price on a volumetric basis, while India, Korea, Mongolia, Nigeria and Turkey do so on crop and area basis. China, Cyprus, Malaysia, Pakistan and USA charge for water only on area basis. In Spain, the River Basin Agencies and Hydrographic confederation (users) do the price fixation.

The collection of water charges is done annually in most of the countries (Australia, Austria, China, Cyprus, Germany, Italy, Indonesia, Korea, Malaysia, Mongolia, Nigeria, Spain, UK and USA); but it is bi-annual in Pakistan and India, and bi-monthly in Israel. Water users in 8 countries pay to the Govt. (Australia, China, Italy, Indonesia, India, Malaysia, Mongolia, Pakistan) while in 9 countries the water agencies or the other user groups collect the charges (Austria, China, Cyprus, France, Germany, Israel, Korea, Spain, Turkey).

The success in recovery of water charges varies from country to country. In Australia, Austria, Cyprus, Germany, Italy, Malaysia, Spain, UK & USA it is reported to be 100%. It is between 50-100% in China, Indonesia and South Africa while it is even less than 50% in India, Nigeria and Pakistan, eventhough the recovery of water charges is subject to the provisions and sanctions in the country's Law. In Australia, China France, Israel, Korea, Nigeria, South Africa, Spain, UK & USA, the irrigation facility is liable to be withdrawn for non-payment, but in Austria, Cyprus, India and Pakistan the legal provision can be invoked only for the recovery of the payments due. In Australia, India, Malaysia, Mongolia, Indonesia, Pakistan and Nigeria, the amounts collected go to the Government's general revenue. In France, Italy, Israel, Germany, Korea, UK & USA, the revenue goes to the water agencies or to the user groups directly. In Spain it is payable to two agencies viz. River Basin Agency and Hydrographic Confederation.

The Water Price

The rates of water prevalent in 1995 for various types of uses as reported by the responding countries can be seen in Table 10.

One thing is clear, worldwide, that the price for irrigation water per cum is far less than that for domestic/municipal and Industrial uses. Even in France, Germany and Israel who are said to be developed countries and to be having their water management on system on a self sustained financial basis, the irrigation water rates are just one tenth of those for other uses. Elsewhere the difference is much larger. It is interesting to note that Australia, Cyprus, Egypt, India, France, Pakistan, South Africa, UK, USA have reported that they have a water pricing

Table 10. Water charges in US $ per cum (1995) (available in ws_table.pdf)

policy. In Spain the water pricing is currently under review. Even countries with defined water policy have adopted a large differential in the rates for irrigation water and for other water uses. The relative difference between domestic and Industrial rates is however not that large.

National Authority for Integrated/comprehensive planning of water resources.

Most of the countries have made some agency or the other as responsible for comprehensive planning of the country's water Resources. They are generally the agencies of the government working under the direct control of a ministry and operate in accordance with the law of the country or by an executive order. The responsibilities entrusted to these however differ widely. In China, Cyprus, Egypt, France, Germany, Israel, India, Korea, Mongolia, Nigeria, Pakistan, Spain, South Africa, Turkey, UK and USA, this agency has the responsibility for water allocation amongst different uses. In Italy, South Africa, Austria and Australia, the agency also monitors the water use. In Indonesia, Malaysia, Slovenia and Thailand this agency also monitors water savings and measures therefor. In addition to the regular monitoring of water use, evaluation is also carried out by the designated agency in China, Cyprus, Egypt, Israel, Indonesia, Pakistan and South Africa. Information about the national agencies entrusted with responsibilities for planning, monitoring and evaluation is given at Appendix E.

The In-house valuation carried out in China, Cyprus, Egypt, Israel, Indonesia, India, Pakistan and South Africa have indicated the need for the following measures to achieve better and more efficient management of the country's waters.

- Introduction of centralised control (China)
- Establishment of water markets (China)
- Involving of the farmers in planning and operation of the systems. (Egypt, Turkey, India)
- Communication and coordination between intra and inter agencies on one hand and users on the other (Egypt)
- Building-up capacity of users and service agencies (Cyprus, Egypt, German, Nigeria, Thailand)
- Improvement in preservation of water and in the water quality standards (Israel)
- Long term considerations in water allocation to tackle drought conditions (Israel)
- Improving Drainage in irrigated areas (India, Pakistan)
- Improving conveyance efficiency (India)

- Upgrading the physical system (India, Korea)
- Preventing of water wastages in farming (Korea)
- Greater attention to O&M and improved fuller utilisation (Nigeria)
- Introduction of water saving systems and improved farm management (Turkey)

National Policies and Programs for Saving Water

China, Slovenia, Egypt, Pakistan and Thailand have further reported that they already have a programme of water saving at the National level as indicated in Table 11 below.

Table 11. National Programs for water savings

Country	Name of Proj.	Cost US$	Start	Completing target	Anticipated saving
China	300 counties for water saving demonstration	375M	1996	2000	6 BCM
Egypt	Irrigation improvement	70 M	1984	1996	5 BCM
Pakistan	(i) Programme of lining canals	735M	1995	1998	8.46 BCM
	(ii) National programme of drainage	835M	1996	2002	–
Slovenia	Irrgation Programme	–	1996	2002	–
Thailand	(i) Chhaya Management and strategy project	1.6 M	1996	1997	–
	(ii) Pipe irrgation programme	8.0 M	1996	1997	–

Sectoral & National Priorities for Water Conservation and types of measures

The country reports have also given some indication of their priorities. In Austria, the priority is for taking legal measures for water quality monitoring, rehabilitation of groundwater quality and redimensioning of water rights after 10 years. Priority

in Cyprus is for dam construction and groundwater recharge. Israel has mentioned (i) Water saving devices, (ii) Automation and (iii) Improved O&M of the irrigation systems as the priority elements of their future programs. Pakistan has stated (i) Lining of canals and preventing over-exploitation of groundwater, (ii) Providing interceptor drains and (iii) demand based irrigation supply coupled with increase in water charges as their consideration. Appendix F contains country-wise information about the national acts and policies which have a bearing on water conservation.

Public Awareness

Australia has formally adopted a "Water-Wise" public awareness programme. Israel has indicated that, in addition, specific decrees are issued in drought years cutting down water allocations and use. In many other countries also public awareness is being promoted by using the media and other communication systems. Australia, Egypt, Israel, South Africa and USA have found that the launching of awareness programs did cause an impact. Australia has experienced that in the last two years the "Water-Wise" movement has made an impact and the states who adopted the "Water-Wise" programme have shown reduction in water use. Israel also finds that the impact is perceptible from demonstrable reduced water use and market purchases of water saving devices.

The Chinese Taipei Committee celebrates the world Water Day thro publishing educative leaflets for the water agencies and the people. The resources Bureau of the country has assigned the status of "a Water Resources Month" to the month of March. Activities during the month include release of educative posters, commemorative postal envelopes, Video Tapes, photographs, painting and writing contests on water topics and ecology field trip. From the responses of the countries it is seen that similar activities have become popular in other parts of the world also.

Gender Aspects

Traditionally women are involved in on-farm activities, in Australia, France, India, South Africa, USA and many other countries also. They work hand-in-hand with the male members and assist them in their work. It is seen that women generally look after the safety and security of the equipment on the farm but sparsely handle operations, maintenance and repairs of the water equipment. But they do look after the live stock. The women farmers receive some sort of training in 8 countries which is through the visiting officials of the Agriculture Extension service or in their schools as in Austria, China, Cyprus, Egypt, France, Nigeria, South Africa and USA. The women are also already involved in water user groups as its full members in fourteen countries namely Australia, Austria, China, Cyprus, France, Germany, Italy, India, South Africa and Mongolia, Slovenia, South Africa, Thailand and USA. In addition Australia, China, Italy,

India, South Africa and Mongolia have some specific acts/rules/regulations which encourage the participation of women, in water user groups and in the water management. But the quantitative impact of women's involvement in water management in the water saving measures do not appear to have been yet fully studied anywhere.

Manpower Planning and Capacity building

A manpower planning policy for irrigation service personnel exists in China, Egypt, India, Pakistan and Thailand. alongwith the quantification of manpower needs. A specialised irrigation service exists in one form or the other in China, Australia, Cyprus, Egypt, Italy, Indonesia, India, Pakistan and Thailand. Perusal of details supplied by the mentioned countries reveal that in their staffing patterns generally have a "district-in-charge" who is supported by field deputies, subordinates and fieldmen. Many countries have expressed that there is a need for the training of these personnel as well as training for the farmers, particularly those directly involved in the management of water.

GLOBAL WATER PARTNERSHIP Supports Water Conservation

The Global Water Partnership (GWP) will be able to assist the developing countries in implementing water savings in agriculture as a part of its water conservation programme through its various 'windows' established for support to the water related activities. The associated programme for conserving water in agriculture will provide information, synthesised knowledge and capacity building support to the irrigation service agencies to bring about a change in water use practices to save water.

ICID is an accredited member of GWP and has been active in its work since its inception. The National Committees of ICID particularly those from developing countries have been requested by ICID Central Office to identify their needs and formulate schemes for seeking financial support through GWP. The Central Office of ICID has separately proposed a number of workshops/ seminars and International Conferences for helping the countrywise/regionwise and continent efforts. The aim of ICID is to bring together through the support of GWP, senior policy makers and international irrigation experts to identify options available for effecting water savings in agriculture.

Share of Agriculture in GWP, 1994

III. COUNTRY SPECIFICITIES

This chapter provides information on the country specific plans and programs which have an impact on watsave aspects. Actual achievements from development of new techniques/studies are covered in chapter IV on Watsave successes.

While the overview of prevalent water management and Watsave gives a comparative picture of the current situation in the world, it will be useful to have a closer look at some of the important features of the water situation in these countries. On the basis of the information received from them, a brief resume of their important characteristics in respect of Watsave is presented. It is not intended to provide any exhaustive information, here, about the countries' water scenarios, the objective is to invite attention to the features that supplement the global overview presented in Chapter II.

AUSTRALIA

Contrary to the position in Germany or Israel, surface flooding methods of irrigation are still very much in vogue in Australia. But efforts have been launched recently to adopt modern methods. Lots of studies are in hand to demonstrate to the users of irrigation water, that they would grow more by conserving water, while earning more too. The potential for water savings at the field level have been studied and such savings for some of the crops have been quantified. Propagation of correct and scientific practices based on soil water relationships are being pursued. Agronomical institutes are working on different crops to evolve the varieties which use less water and give higher yields. Potential for the reuse of wastewater has also been assessed. Use of recycled water is so far limited mainly to recreation areas, pastures and forestry. The users' participation is growing, 20% of the area is already covered by joint management. The water pricing is currently based on traditional approaches, but lately an awakening is clearly visible from the various programs of public consultation. It is being done in conjunction with New Zealand. Australian states have already promulgated statutory regulations for water conservation, prevention of pollution and water use. Public awareness is being promoted by adopting persuasive policies, education, advertisement and holding of water saving conferences/seminars. The women of Australia are involved in the agricultural activity and join the water user groups or associations. The irrigation services are manned jointly by the agricultural engineers and the civil engineers.

New approach to meet the Watsave objectives.

- Water pricing and cost recovery to reflect true cost of water service.
- Appropriate organisational arrangements with separation of regulatory function from delivery function.
- Clear allocation and water trading arrangements provide security and flexibility to water users.
- Integrated land and water management to mitigate any general adverse impacts on water quality and the environment.
- Enhanced public education and consultation process to emphasise the value of water.
- Task force appointed on Water reforms (COAG)

Australia accords recognition and significance to the complexity of the water reforms. The Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) established a task force comprised of senior water policy representatives, Australian and New Zealand Environment and conservation, council representatives of water industry and National competition council. The Murray Darling Basin commission agreed to participate on the reforms, task force has the following terms of reference :

- Manage and report on the implementation of water reforms and associated National Competition Policy.
- In particular report on establishment of goals and milestones and progress of implementation of the reforms across jurisdiction.
- In addition consult the key stake holders the operators, and the economic and environmental regulators recommendations about inter-governmental issues.

AUSTRIA

Austria is in a highly advanced stage of water management. Modern methods of irrigation have been adopted by the users, and who operate the system collectively for irrigation water on volumetric basis to cover expenses of the entire O & M activity. The national water policy provides for water quality safeguards, the rehabilitation of ground water quality and redimensioning of water rights every ten years.

CHINA

China currently uses 385 BCM for irrigation out of its total withdrawal of 535.5 BCM and irrigates an area of 50 M.ha. At the same time it aims at achieving an area of 60 M.ha by the year 2015, without any increase in the allocation of 385 BCM to the agriculture sector. This is indicative of the resolve to improve the

management of water in quite a significant way. More areas are planned to be covered by the modern techniques at the rate of 0.16 M.ha. per year to raise the area under modern methods from the current level of 1.4% to 6% by the year 2015. China has already passed on 25% of its irrigated area to the operational control of the users with another 25% getting operated jointly by the Government agencies and the users together. The remaining 50% is however, still under government operation. China is steadily identifying the possible water savings at the farm level. A programme of water savings known as "300 counties for water saving demonstration" costing US $ 375 M is in hand since 1986, to be completed by the year 2000. This programme and successes therefrom are being used for promoting greater public awareness about potential for water saving. China is making good strides in monitoring of water quality also after establishing water quality standards for each of the sector using water. It is augmenting its supplies through reuse of 2.9 BCM of treated effluents. Even untreated municipal wastewater is being put to use to the extent of 3.1 BCM. They, together provide for more than 1% of the current supply of fresh water. The country has assessed the potential for use of saline and/or brackish water and has introduced irrigation in an area of 67 Th.ha. by such waters.

China is examining the possibility of diverting water from the abundant south to the thirsty north. Three alternative routes are under consideration. The western route involves 75 Km long tunnel to transfer 20 BCM of water. Eastern route can bring 15 BCM while the middle route can also bring 20 BCM. The last one, the middle route, is thought to be operable and affordable. It also does not involve pumping unlike others and can bring water to Beijing by gravity. Alongwith other projects of reservoirs Building, diversion and ground water use, China's supply is expected to increase by 100 BCM in near future.

Having taken a conscious decision not to increase its present Agriculture water allocation of 385 BCM (irrigating 50 M.ha), it aims at increasing irrigated area by 0.667 M.ha a year by saving water and implementing improved management approaches and/or by exploiting non-conventional sources. To promote propagation of modern methods of irrigation and improving water use efficiency, China has provided incentives by way of subsidized soft interest loan schemes.

The strategy is to improve overall irrigation efficiency by reconstructing major canal systems, adopting conjunctive use of water and by preventing seepage from canals by lining them. The first priority is to old main canals, second to the canals performing at lowest efficiency and the third to canals with high water levels than the ground. Lower priority is to the networks which run for short terms.

CYPRUS

Cyprus is already engaged in augmenting its water resources. It currently uses 1.6 BCM of the treated effluents and 0.66 BCM of desalinised water i.e. a total

A National Conference on Exchange of Experiences in water saving irrigation technologies of Rice field was held in Gulin, Guanxi in China from 3-7 May 1997, sponsored by the Ministry of Water Resources (MWR) and the State Science Technology Commission (SSTC). Vice Ministry of MWR and Vice-Chairman of SSTC delivered important speeches. The Chinese Government in recent years has launched a programme for encouraging a new technology for growing rice called "Shallow Water Depth, wet situation and sun drying field" instead of 'deep submergence' method, which saves upto 1500 cum/ha of water and increases yield by 375 Kg/ha. The total area under rice in main land China, (32.1 M.ha) produced 188.5 M.Tons of rice in 1996 and consumed 65% of the water allocated to agriculture (35 BCM). The new technique has spread in 3 M.ha. It is estimated that if two thirds of the rice area (32 M.ha) could adopt this approach, the water savings of the order of 7.5 BCM can be achieved, simultaneously producing 7.5 billion tons of MORE rice.

of 2.26 BCM which is 2.5% of its water resources. This proportion is expected to increase in the coming years. Irrigation is practiced with modern methods with piped (pressure) supplies. It has also laid down the criteria and the guide lines for water pricing on volumetric basis. The women do work in the agricultural activities and have a high level of training.

EGYPT

The Aswan High Dam (AHD) was constructed to improve the long term availability of Nile water for Egypt and Sudan and plays a key role in the development of irrigation in Egypt. Agriculture is using 85% of the available water at an efficiency of 65-75% after accounting for pumping and drainwater reuses. The rest is used in domestic sector (3.1 BCM) and the industrial sector (4.6 BCM). The effluents from these two sources are highly polluted. Yet the importance of using and exploring non-convential water resources is very well realised for the future.

Out of a total irrigated area of 3.23 M.ha, modern methods are used on 14% which is proposed to be increased further at a rapid pace. The increases were noticed to be nearly 9% within a span of 5-8 years. It is implementing an irrigation improvement project with the support of the World Bank, which, during 1984-1996 has strengthened the country's resolve for improving the infrastructure and the management techniques. The causes for excessive use of water and loss of water have been identified. It is planned to achieve an irrigated area of 4.00 M.ha. The organisational structure has undergone improvements coupled with institutional innovations to promote a large scale participation of the users and the establishment of many research centers.

Egypt currently augments its water supply by reuse of 0.4 BCM of treated municipal wastewater, another 0.4 BCM by reuse of industrial waste, and by reuse of drainage water to the extent of 4.5 BCM as also by the reuse of groundwater (from recharge by irrigation) to the extent of 3.80 BCM, adding altogether 9.1 BCM or a little more than 16% to its available surface water supply of 55.5 BCM and groundwater of 0.7 BCM. Egypt aims at stepping up the augmentation to 16.7 BCM by the year 2010 when it will also have added a desalinised quantity of 0.5 BCM i.e. to reach a level of more than 28% of its natural resources of 58.7 BCM likely to be available by then, Egypt has planned for a significant increase in reuse category as shown in Table 12 below :

Table 12

Reuse-source	Current (BCM)	Projected for 2010 (BCM)
Municipal wastewater	0.4	1.6
Industrial effluent	0.4	1.8
Desalinated	N	0.5
Drainage water	4.5	7.0
Ground water (Reuse)	3.8	5.8
	9.1	16.7
Supply		
Nile River	55.5	57.5
Ground water	0.7	1.2
Sub. Total of supply	56.2	58.7
Augmentation %	16	27

FRANCE

France, an industrialized country has a well organised irrigation infrastructure, policy framework, well developed irrigation service and the required institutional set-up. Out of the current total irrigated area of 2.38 M.ha, modern methods are used in 47% of the area. France aims at raising its irrigated area to 3.98 M.ha by the year 2015, an increase of nearly 67%. The water distribution is through water agencies and water pricing is mostly on average cost price, though these agencies may also charge an opportunity cost. Women are involved in the water user groups. France has a good system of management of water in each of its basin for which there are well developed basin organisations.

the rate of 4% and 6% for surface and groundwaters respectively. By 2015, the total irrigated area is expected to increase to 138.6 M.ha. The table below depicts the current and projected increase in water uses in various sectors:

Table 13. Water Withdrawals (BCM)

Usage	Current (1990)	Projected (2000)	Projected (2025)
Irrigation	460	630	770
Domestic	25	33	52
Industry	15	30	120
Evap.loss and misc.	33	27	37
Energy	19	30	71
Total Withdrawals	552	750	1050
Percent increase		35.8	90

A movement for participatory management has been launched all over the country which is demonstrating encouraging response.

ITALY

Italy augments its supply by reuse of treated municipal wastewaters and industrial effluents. Irrigation is organised by the Improvement agencies, Private Public Associations of production and overseen by the regional Governments and is controlled by the Catchment Area Authorities. The irrigation systems are operated both by the government and the users. The charges for water are based on Average Cost Price by volume or per permit issued to the user.

JORDAN

Jordan an arid country is realigning its water management strategy since 1986. Surface water resource have increased from 0.428 BCM (1986) to 0.985 BCM (1996) and groundwater from 0.183 BCM to 0.318 BCM it presently uses 0.31 to 0.34 BCM per year for agriculture allocating 61% for trees, 30% for vegetables and 9% on crops. The treated effluents to the extent of 80% (0.64 BCM) are also used. Jordan proposes taking resort to demand management with new tariff and pricing policies. Irrigation channels are to be changed to conduits for attaining efficiency of 85%.

With total water resources of 1.31 BCM contributed by Yarmuk river (35%), flow in river Zaraqa is augmented with treated sewage effluents. Irrigation uses 74%

of water. The Jordan valley authority adopts surface methods in 52% area while 48% is under modern methods. The uplands of the country employ surface methods in 84% areas and only 16% is under modern methods. The overdrawal in 1995 was found to be 0.480 BCM. Likely to reach 0.654 by 2010. Fresh water will thus have to be supplemented by reuse of water by installing/expanding treatment facilities. The water quality standards are under review and measures for alerting the polluters are adopted, the WHO guidelines however may enable only category 'B' irrigation and crop restrictions will have to be considered.

MAURITIUS

Mauritius uses 0.85 BCM of water of which 0.44 BCM is for agriculture. It proposes to reduce the area under flood irrigation from 20% to 7%, increase the drip area from 6% to 27%, attain field efficiency from 50% to 90% and reduce canal losses from 60% to 15%, take up reuse of water and reduce the irrigation requirement to 0.42 BCM. Currently 48% of cultivable area is irrigated, of this 50% is sugarcane.

PAKISTAN

The irrigation service in Pakistan is in the government hands. Irrigation systems are operated by government agencies. The reasons for excessive use of water or the loss of water have been identified. The water pricing is on land area irrigated, and may include a levy due to betterment of the lands. Two water saving programmes are in hand. The first is lining of canals and water courses, an accelerated water management project to be completed in 1998 at a cost of US $ 735 M. The other is the National Drainage programme to be completed by 2002 at a cost of US $ 853 M. The two programmes are aimed at the retrieval of 8.465 BCM of water i.e. 6.5% of the water allocation to irrigation.

SLOVENIA

Slovenia uses modern methods for application of water and the water supply is through pipes. The irrigation systems are operated mostly by the users, though at places they may be operated jointly with the government. The matter of water pricing which is on the basis of volumetric measurements is currently under review, in conjunction with the country's National Irrigation Programme.

SOUTH AFRICA

South Africa augments its water supply by reuse of 4.6 BCM of its municipal and industrial waste waters adding 8% to its water resources. The use of desalinised water is presently insignificant but an acceleration of its use is planned for adding 1% of supply per annum. South Africa is taking measures to balance its supply

and demand through water savings and by promoting public awareness on the water issues. Out of the total irrigated area of 1.22 M.ha, it is already employing modern methods in nearly 60% of the area. It is expected that the improvements in system operation policy could bring a saving of nearly 20%. The O & M funds for the systems are drawn from a trading account budget. Water prices in different areas are based on the considerations specific to the area or the schemes in that area. The farmers pay for the water quota while domestic consumers make payment on the basis of pipe diameter that brings water to them. A National Programme for 15% water savings in agriculture has been taken up in 1995. The womenfolk do take part in the agricultural activity and are involved even in water user groups. Facilities for training them are available.

SPAIN

With 0.5 M. sq.Km. area, 39.3 M population, 114.3 BCM of natural water wealth, 37.1 BCM of which is withdrawn, Spain allocates 65% of water (24.25 BCM) to irrigate 3.4 M.ha adopting surface irrigation methods in 67% area, and modern methods in 33%. The management is controlled by "Hydrographic Confederation" under the Ministry of Public Works and Transport (MOPTMA) and Reservoir Commission (MAPA). The irrigators combine to form a community.

In Spain the water resources are managed by nine River Basin Agencies (RBA) under the Ministry of Environment and Hydraulic works, through hydrographic confederation (users groups) in the field. While identifying the reasons for excessive use it has been reported that pricing by land area results in lack of incentive to save water. Faulty grading of the land is stated to be another main feature for excessive use.

Spain augments its supply by reuse of 0.86 BCM of treated effluents besides 0.03 BCM of desalinated water for irrigation. Water allocations are made by the Ministry of Environment, Health and Agriculture in consultation with the RBAs and then managed by RBAs and the confederation (communities). The water charges are fixed by the managing agencies and irrigators follow a dual payment system. One part goes to RBA and the other to confederation. The actual cost of O&M is recovered. The women participate in the irrigation activity while women officers also exist in irrigators communities.

A country with old tradition of irrigation enacted a water law in 1878 providing concessions in water uses. The water law has since been revised in 1985 which still carries concessionary provisions. A need is being felt for improving the deficient infrastructure, review of concessionary regime and support for Research and development to effect water sowings.

THAILAND

Thailand irrigates an area of 4.83 M.ha. The irrigation is by "Border" surface gravity methods. Modern irrigation practices to effect water savings are now being promoted. The country has identified that savings in water at farm level hold a promise for the rice crop. The irrigation system are operated by government agencies and the water pricing policy is decided by the Royal Irrigation Department's National Water Resources committee. Two programmes for water savings have been taken up namely; A Chhaya Management Strategy Project taken up in 1994 (due for completion in 1997) while the second was a pipe-irrigation study in the year 1996-97. The findings of these ventures are likely to lead to improvements in water management. The womenfolk are involved in the agricultural activity and are trained too by the extension service wing of the Agriculture Department and join the activities of water user groups also.

Irrigation systems in Thailand built on USBR guidelines of full supply level (FSL) control or controlled water surface (CWS) concept are now proposed to be modernised. Improvements are also to be made in the management by (i) Proper allocation of water (ii) Improving canal efficiency (iii) Land levelling in the command areas and (iv) Stabilisation of flows in canal networks. Similar measures for the run-of-the river systems and/or small/medium scale schemes are also under consideration.

TURKEY

Turkey irrigates an area of 3.8 M.ha. It is likely to increase to 6.00 M.ha by the year 2015. Presently, only 1% is under modern irrigation methods. Large savings of water at farm level have already been experienced in crops like Sugar-beet, Wheat, Fodder and Cotton. Potential for savings in other crops and on other farms have also been assessed. Operation of irrigation systems are handled both by the users and the government agencies. The water charges are based on average cost price and the perceived affordability, after evaluation. The water price is collected by the agency managing the system. The General Directorate of Hydraulic works (HGI) is the main controlling authority for water allocation, use and savings.

Turkey has undertaken a review of its National Water sector policy to provide for institutional changes, capability building, increased water use efficiency, improved quality of water services, enhanced role of water users, privatisation, reorientation of cost recovery and support to regional developmental efforts. The draft policy includes provision of several laws and regulations for private participation, environmental protection, accelerated transfer of O & M of systems to users and amendments for penalty-payment in water fees. The law enacted in 1994 to Build, Operate and Transfer (BOT) for hydropower plants is proposed to cover water supply sector too.

UNITED KINGDOM

The National Rivers Authority is the statutory body for licensing water abstractions and for keeping a balance between the environmental needs and the abstractors. Its sustainable Water Resources Development objectives are:

- Investment in new resources
- Management initiatives
- Improving efficiency

The management initiatives comprise cash buyout of licenses, pooling of licenses, incentives for demand control, inter-farm transfers, reallocations through tradable rights, reinforcing river flows from under-utilised sources and use of surplus river flows early in the season. The efficiency increase is to be achieved by improving operational practices, artificial recharge, effluents reuse and desalination. Under-Sea pipe lines to divert water from surplus to deficit areas is also under consideration.

The water pricing and allocations is done by water agencies who also decide the distribution options. There is a permanent user operated system for extracting of water. The water charges are based on duration of supply, the license holder being responsible for payments. The Environment Agency is authorised by law, to allocate, audit and monitor water savings.

Zambia is promoting modern water lifting devices to upgrade the efficiency in the indigenous use. National Master Plan for irrigation development has been drawn up with assistance from Japan. Nearly 200 dams constructed earlier for water harvesting and conservation are proposed to be rehabilitated by (i) Desilting (ii) Restoring Spillway, diaphragm walls and (iii) Mobilising users in management.

USA

USA irrigates an area of 19.99 M.he (1995) and has 11.11 M.ha of it under “Furrow” method of irrigation. Sub-surface irrigation is also practiced. Increase in the area under modern methods is quite rapid with 27% currently under sprinkler and drip. There is a good and ample R&D support, the systems are user operated. The dissemination of technology is also quite rapid and wide. There are a number of research centers who remain in regular touch with the user group in the field. The water price is based on Average Cost Price and volumetric measurements, fixed by water agencies. The price covers O & M costs and additional obligations of the Government for conservation.

CHINESE TAIPEI COMMITTEE

The Chinese Taipei Committee has indicated that in addition to its surface and groundwater resources it has 36 natural lakes too. The total supply was 17.6 BCM in 1992 comprising 5.6 BCM of surface water, 7.1 BCM of groundwater and 4.9 BCM from the lakes and has now increased to 20.5 BCM by 1996. Allocation to agriculture stood at 13.5 BCM (76.7%) with an irrigated area of 0.457 M.ha. A rise in demand is foreseen, likely to reach 15 BCM (from 13.5 BCM) by the year 2012. Water allocation to agriculture has been steadily increasing since 1961 when the total withdrawal was 9 BCM.

The Executive Council has promulgated guidelines on water resources planning and water conservation, promotion of new technologies, reuse of waste waters, increase in water use efficiency, prevention of wastage. Introduction of reward system, rational pricing of water usages and Public education. A saving of 2 BCM was targeted for the year 1996.

The Strategy of water conservation recently adopted lays down the objectives for water users: Increase sale by 2% but maintain Zero growth of water use per capita, Increase wastewater reuse by 5%, increase channel lining by 2% and keep zero growth of water use per unit area.

Further, to achieve efficient management of water, it will promote efficient water distribution and O&M, reuse at users level, use of water saving devices, forecasting/warning systems to combat drought and other exigencies, develop technologies for conservation and water use. Dual water supply, drinking and flushing (reclaimed water for the later) establishing rational water use standards for each usage, development of water users' groups, education and water awareness and Campaigns for protection and saving of water.

It will thus be seen that all the responding countries are conscious about the increasing demands for water and many of them have also initiated various measures for supplementing their natural resources as well as for effecting savings in the current pattern of water uses.

Tabulated Summary of Responses

A tabulated summary of responses of the Watsave Questionnaire from the responding National Committees is given in the ensuing pages. The information supplied by the committees is generally as for the year 1995. Where it pertains to other years, the same have been mentioned in the bracket. The tabulation has been done, by and large, to cover all the points that were referred, but the column numbers do not necessarily tally with issue number in the questionnaire. Wherever information is not available or not reported or is unclear, a blank space with a small dash/dot appears.

Tabulated summary of responses to Watsave Questionnaire from the responding ICID Committees (available in ws_table.pdf)

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IV. PACE SETTING SUCCESSES

The chapter on country specificities already recounts the general country scenario with reference to the watsave aspects. In addition, there are many notable outcomes of their studies and experiments with watsave techniques and procedures. These have been summarised in this chapter to indicate the patterns in watsave activities that are likely to emerge in future.

AUSTRALIA

Australia is fastly improving its water management scenario through field studies that promote regional specific solutions.

- Use of modern techniques by measuring soil-moisture by installation of watershed Neutron probes for integrated crop management was tested in Queensland where cotton is grown in 20 Th.ha, when significant water savings were demonstrated. Recycling of tail water and a new pricing system prompted the irrigators for efficient water use for better returns.

- Adoption of Trickle/Drip irrigation enabled reduction in water and power consumption by 30% as was revealed by a study conducted by Queensland Department of Primary Industries on yields of sugarcane.

- Experiments on adoption of sub-surface irrigation through buried pipes to allow the water to seep in, that were taken up by Sunreysia Rural Water Authority, have demonstrated the potential benefits for irrigators using furrow irrigation methods.

- Water management with appropriate investigation of soil characteristics in South Australia by a fruit grower enabled growing of more vines with less water, increasing his return from $ 7000 per ha to $ 20000 per ha.

- In Barrybank Farm, Windemere, a 12000 head piggery, producing 210 KL of wastewater, a treatment/recycling plant was provided at a cost of US $ 2.3M which reduced freshwater intake by 70%, and the plant is slated to recover its cost in a period of 7 years.

AUSTRIA

Water metering, redimensioning of legal water allowances on stripfing-Zevendorf Project in Austria, and installation of 60 km conduit pipe line, 300 pressure outlets and water meters in an area covered by 200 small-medium size wells costing US

$ 50M proved to be an automatic incentive for water savings while use of diesel pumping sets reduced pollution too.

BANGLADESH

Bangladesh has erected 2 rubber dam structures with expertise from China, having 3 and 3.5M height which can be inflated to volumes of 800 and 1200 cum to weigh 7 and 14 Tons respectively. Skin of the dam-bags is 7mm and 8 mm thick with a tensile strength of 25T and 37T per metre width. Water is stored during the peak season for supply of water to the area of 2000 and 6000 ha respectively during lean periods and is managed by the farmers. The unit cost worked out to US $ 56 and 67 per ha. The dams also act as barriers to tidal water inroads to prevent salinity.

In a case study conducted by Loughborough University of Technology and Bangladesh Agriculture Research Institute, it was found that in a piped water supply upto fields and with earthen field channels from canals/reservoirs in 50/100 ha areas, the size and spacing of the pipes will depend on the capability to cope with water hammer and pressure surge for which pressure control structures may be needed. It was also found that by following this method the land-intake could be reduced by 0.5 to 2% and transit losses reduced by 75 to 90%. It was adjudged to be suitable for areas upto 100 ha to be preferred when (i) soils are poor in cohesion and cause significant seepage losses, (ii) Micro-topography inhibits construction of earthen channels or when the cost is high, and (iii) Water is limited and valuable or restrictions on abstraction (groundwater) are in vogue.

A study on the role of a NGO, Grameen Krishi Foundation - GFE-1991 {having a bank as a subsidiary with a turnover of US $ 7.0M) revealed that the advent of tubewells.when crops could be grown all the year, significantly increased income by 78% and 100% for marginal and middle level households. The foundation (GFE) helped women in access to the land and water alongwith direct irrigation services individually or in groups and discovered positive impacts since 1992. An increase in income, contribution to household, increased self confidence was noticed with less dependence on the male-folk. The GFE is emphasising on the bank to support better marketing facilities, control and education.

CHILE

A study on adoption of modern methods of irrigation (Drip) in place of furrow irrigation (Lliu-Lliu Project) on Avocado Pear Plantation demonstrated a big increase in application efficiency from 45% to 90% reducing the water input by half i.e. from 20198 cum/ha/yr to only 10198 cum/ha/yr.

Water is a tradable commodity and rights of use can be granted to private agents/enterprenuers who organise the best use of the water.

CYPRUS

Cyprus is promoting piped (pressure) supplies, and constructing small to medium scale irrigation schemes. The 'Southern Conveyor' Project in Cyprus covering 13500 ha (cost US $ 350M) includes one tertiary sewage treatment plant. Treated water is blended with freshwater and supplied for irrigation use in five of its districts.

'Vasilkos-Pendes-Kisiors' Project contemplates conjunctive use of water in an area of 1525 ha as also supplying water for domestic use (50%) at a cost of US $ 50M, and resorting to distribution of water through pipes.

'Paphos' Irrigation Project is providing irrigation to an area of 5110 ha using 24 borewells and water-supply through pipes. Pumping stations and other regulating structures have been built for supply at constant discharge and pressure for Sprinkler/Drip Irrigation.

EGYPT

An irrigation improvement project was implemented in the last 12 years at a cost of US $ 70M and with the support of USAID and UNDP for improving overall efficiency of water use as also, to over come the constraints in optimum crop production. The major findings arrived at from this experience now constitute a model for others to be replicated in more areas. The extension of the project is now supported by the World Bank, and the objectives have under gone some refinements. The lessons/findings reproduced here, have been highly revealing:

- Delivery efficiencies increased by 30-40%
- Pumping costs per unit area per season reduced
- Time-duration for irrigation was cut short by 50-60% with single point lift mesqa.
- Number of pumps required reduced
- Land savings were noticed
- Average mesqa O&M reduced
- Inequitable distribution between head and tail eliminated
- Farmers participation increased
- Crop yield increased, for example, Cotton increased by 9.2%, Maize by 14.1%, wheat by 30% and sugarcane by 16%

Enriched with the experiences of its earlier MPWWR Project of 1984, the project has now been extended to another 147 Th.ha costing US $ 120M and renamed as irrigation management system project.

It aims at upgrading of the system efficiency from 50% (1990) to 90% (Yr 2000). The old existing system is to be improved by reconstruction, realignment of all types of canals, lining of canals, elevated water courses, buried pipeline water courses to save 10% of water. Water user groups are to be formed and irrigation advisory body comprising of government authorities is to provide technological assistance to users groups wherever established. Replacement of all old and non-functional small or medium sized structures has been undertaken. A good number, 20000 structures had been completed by 1994.

The first use of treated wastewater in Egypt was made way back in 1915 in the eastern desert, north-east of Cairo, irrigating an area of 1000 ha under this project. It is now proposed to be increased to 61500 ha by the year 2000.

INDIA

Chambal Project (Rajasthan)

The project provides water to an area of 0.229 M.ha. A package of improved on farm development includes improved water courses, surface drainage, landgrading, realignment of fields, farm roads and provision of main, carrier, seepage and field drains. Steps to arrest seepage from main canal in small length by providing diaphragm wall are also in hand. Sub-surface drainage is being provided with support from CIDA in some of the areas. A large number of unauthorised or oversized outlets from canals have been removed to save overdrawal of water, thereby incurring a saving of 8 to 10 BCM of water. The project originally designed for irrigation at 76% intensity has now touched a level of 137% of intensity. To lend agronomic support, the State Government provided two agricultural demonstration farms for evolving crops and crop culture. Participatory management of water has also been introduced with encouraging results. The National bank for Agricultural Reconstruction and Development and the World Bank are helping these measures.

ISRAEL

Achievement of successful irrigated agriculture in an arid country with only about 5000 cum/ha (freshwater) has, by itself been a success story. A paper presented by the Chairmen of Israel's Public Commissioner on Reforms in Water Sector in a recent workshop in April 1997, highlights the measures that Israel has adopted to prosper with less than 300 cum of water per capita per year. Appropriate policies, legislative measures and acting on selected economical issues had enabled the country to reach a high GDP of US $ 14,400 per capita per annum and to meet much of its agricultural needs (except grains) through export of agricultural products and maintain a high standard of living, all with very limited freshwater resources.

The paper emphasised that the strategy for the future lies with a balanced combination of measures: legislative, institutional, economic and technological, focussing on water demand management, increased efficiency of water use in agriculture and the industry and reuse of its total surface and groundwater resources, future water markets (internal) and regional and continuous changes in water scarce conditions within the general background of supply and demand management. A number of major policy options are available in changing the supply and demand pressures. Israel is already using a host of such measures like water rate adjustments, government incentives and penalties, investment credits to increase water use efficiency, enhanced research and development, wide scale use of soil conservation and extension service as well as local manufacture of high quality technological systems. Israel has already gone a long way in changing the basic production cycle leading to more economical cropping patterns thus factually producing water through savings and water use efficiency coupled with emphasis on the need to reuse domestic and industrial wastewaters and creating a water market.

PAKISTAN

In Pakistan an examination by IIMI of the salinity balances in 3 differently placed regions which use water from different sources (canals, pumped groundwater) shows that adoption of suitable cropping pattern and agronomic practices can sustain irrigation. One of the three areas (Chasma) used only canal water while the other two used both sources of water. The sustainability solutions were found to be (i) Application of less water, (ii) Lowering the intensity of irrigation and (iii) Lowering of water table by design. It was seen that in Chasma reduction in supply reduced the rice crop. In another plot (Gugera) where the groundwater drawals were twice the recharge, a reduction in cropping intensity was helpful.

UNITED STATES OF AMERICA

USA is promoting sub-surface method of irrigation besides the micro-irrigation techniques which already cover a large chunk of its irrigated area of 19.99 m.ha. The USBR and various other institutions spread over the country provide a good support in developing crops for specific regions, climatic conditions and water availability regimes. Several economic incentives for promoting modern cultivation techniques have been introduced in USA.

- Impact of the programme of modern techniques came to be examined in Broad-View Water district where syphon-tubes were used for pre irrigation of rice crop and germination of tomato, using surface irrigation in summer months. The data for five years (1989-94) revealed that pre-irrigation depth for rice with the modern methods reduced from 0.28m (0.91ft) to 0.17m (0.55ft) while in case of early irrigation for tomato the yield increased from 81 tons/ha(33T/acre) to 99 tons/ha (40T/acre). It was

concluded that low interest soft loans for initial purchase of sprinklers and supportive demonstration can promote the modern techniques without any change in the basic policies.

- USBR have introduced automated control for water delivery in 'Dolores' Project. The system is controlled through a programmable Master Supervisory Control Unit (PMSC) and 94 terminal units, this system attached a water delivery efficiency of 96% compared to a typical value of 80-90 on other canal projects. This project is a model USBR showpiece of automated control.

- A study on Deficit Irrigation (with less water) in California basin over a period of 10 years demonstrated that deficit (less) irrigation provides better production per unit of water than per unit of land. After taking into account direct as well as other costs, it was found that the net income from farms practicing deficit irrigation may have been lower but they earned higher income per unit of water indicating that the new irrigation practices using less water were non-optional. The deficit irrigation has been a profitable long-term strategy for all those who have limited water supplies. Returns on land were low for such farms because the actual water use therein was often less than half of the nominal water requirements.

- A five year study on reuse of tertiary municipal wastewater effluent for irrigation of crops that are eaten raw was conducted in response to the demand from vegetable growers to establish that such reuse did not pose any health hazard. Three different types of water were used, (i) filtered effluent, (ii) coagulated, flocculated, settled and filtered effluent and (iii) local well water in 96 sub-plots. Six crops were common to all. The data on quality of water and the crops was compiled and analysed.

The finding was that crops irrigated by the two types of tertiary waters did not differ from those grown with the well water. It was also found that there were no viruses in any of the effluent samples and that there was no significant difference in the growth or quality of food crops irrigated with reclaimed domestic waste water; reclaimed with the currently acceptable norms for treated water or that by filtration method. No degradation of soil or groundwater was observed. The risk level from use of reclaimed water for the quality of food appeared to be within the acceptable range.

International Rice Research Institute (IRRI), Philippines

The IRRI is engaged in research and development in water savings in Rice Crop, a crop that is dominant in this part of Asia. Dr. Kenneth S. Fischer, Deputy Director General for Research on request from ICID sent a keynote on the activities undertaken by (IRRI) and in water savings, under the title "More rice

with less water" which is reproduced here. The note depicts the success in the efforts and the dissemination being organised by IRRI. It speaks of strategies and approaches for rice production by using less water.

More Rice with Less Water – keynote by Kenneth S. Fischer, Deputy Director General for Research, International Rice Research Institute, Manila.

The amount of water available to each person on this globe is decreasing. And with unprecedented growth in industrialisation and urbanisation, agriculture's share of water in many Asian countries is becoming smaller. Urbanisation and industrial demands are generally given higher priority than agriculture. Since more than 90% of the agriculture water use in Asia is for rice it follows that rice production could be surely affected unless we can increase the efficiency of water use.

Irrigated rice land produce about three fourths of the 580 million tons of rice needed to feed one half of the world people. In 30 years, that figure will rise to around 800 million tons of rice annually. Increasing water-use efficiency of rice production is doubly important, not only because of less water but because of the increase in production needed to meet demand of rice.

Strategies for increasing water productivity include reducing the non-productive components (wastes) of water input and increasing crop yield. In rice farms, the amount of water that farmers apply to the field is about 2 to 3 times higher than the evapo-transpirative demand of the rice plant. As much as 50% of the applied water during the land preparation period can move down the soil cracks, bypassing the top soil matrix. This is aggravated by farmers practice of prolonging the land preparation duration more than necessary. During the crop growth period, 50-80% of the amount of water supplied leave the field via percolation and seepage. Indeed some estimates indicate as much as 5000 liters of water are diverted at the source of the canal system to produce 1kg. of rice.

But there are opportunities to greatly increase the efficiency of water use. The bypass flow during land preparation can be reduced by soil surface management that minimise the formation of soil cracks or impede the flow of water in the cracks. An example is the practice of dry shallow tillage of the soil soon after harvesting the previous crop, which is now widely practiced in Muda irrigation scheme in Malaysia. Numerous studies have demonstrated that water saving irrigation techniques such as maintaining soil at saturated or alternate wet and dry conditions could reduce 30-75 percent of the percolation water without substantially lowering yield compared with the continuous flooding. These practices were particularly effective in light-textured soils.

Changing crop establishment technique from transplanted to direct seeded systems can create a major opportunity for reducing the non-productive water consumption. In transplanted rice culture, the seedlings are grown in small seedbeds for about one month before transplanting. During this period, farmers continue to use water in the main field for land preparation leading to high amount of percolation and evaporation. In wet-seeded rice, where pre-germinated seed are sown directly to the puddled fields, land preparation duration is not tied up with seeding culture and can be much shortened. A reduction of land preparation period of 13-14 days and savings of 150-300 mm of water were assigned to this process in Central Luzon of the Philippines and in Muda irrigation scheme.

In dry-seeded rice, the crop is established and nurtured initially as a dry-footed crop by the early season rainfall. Later in the season the crop can be irrigated when needed. The amount of irrigation water supply needed for wet land preparation can be avoided. The process also leads to early crop establishment and early harvest of the first crop, allowing irrigation systems to avoid or reduce water shortage toward the end of the second season. In Muda irrigation scheme dry-seeded rice could save up to 500 mm of irrigation water compared to transplanted rice. Dry-seeded rice systems are very effective in utilising rain water. In some countries such as Indonesia, Vietnam, Philippines the practice of dry seeding allows two short duration rice crops to be grown entirely with about 1600-1800 mm of rain water during the wet season.

By breeding for early maturity, high-yielding varieties of rice. IRRI has contributed greatly to increasing water productivity in rice production. The adoption of these varieties during the last 25 years has increased the average yield of irrigated rice from 2-3 T/ha 1 to 5-6 T/ha and reduced the crop duration from about 140 days to 110 days. In effect, this has contributed to a 2.5 - 3.5 fold increase in water productivity. The availability of hybrid varieties, which have 15-20% higher yield potentials than inbred high-yielding rice of comparable maturity periods, offers another opportunity for increasing water productivity in rice culture. Improved agronomic practices such as better nutrient and weed management, resulting in higher rice yield with the same amount of water input, further increase the water productivity of rice cultivation.

Though promising, the above innovations will not make a major impact beyond the farm scale unless they are widely implemented in the public sector rice irrigation systems. This will require an in-depth understanding of major changes in labour input, social and institutional arrangements, weed and fertiliser management and system infrastructures that are required for large scale adoption of the innovations. Further more, th off-site effects of increasing water efficiency at the farm level must be fully assessed. On-farm water savings may not result in a net water savings at irrigation system or basin level if losses from one field are already used in other fields.

Because of the interdependence among different scales, economical and sustainable water-efficient irrigated rice system can only be achieved when we consider it as a total entity and address its issues holistically, with full attention to interactions among them. Policies and regulations to supply farmers and irrigation managers with adequate incentives in using water more effectively are also urgently needed.

"We never know the worth of water till the well runs dry", went the 17th century proverb. According to some observers, we may soon know it because the world's freshwater well is beginning to show signs of exhaustion. With the basic ingredients of developing water-efficient rice production system now in place, we are better equipped for the declining resource. The immediate challenge lies in replacing the long standing practices and operational procedures in the farm and the irrigation system with the prospective elements. Bold, but scientifically sound and systematic actions are now needed. The cost of non-action may be too high to bear.

Population and Irrigated Area

V. TOWARDS THE FUTURE

Without dependable water supply to the agricultural plants the food production is bound to suffer, jeopardising the chance of fulfilling the object of food security for the increasing population. FAO has observed that lack of freshwater is likely to be a major physical constraint to food security and rural development in future ... but the potential for water savings are enormous. It is anticipated that addition in irrigated areas in many countries will be difficult because of the rising costs both in economic and environmental terms. There is thus an obvious need for increasing the efficiency of the existing supplies so that crops can be grown with less water. In many of the irrigation networks less than half of the water actually benefits crops, the rest is lost in seepage through lined or unlined canals, evaporation and as a run off from poorly applied water on the fields, riddled with poor management that fails to deliver right quantity of water at the appropriate time. On the other hand, over-extraction of groundwater is making the irrigation too costly and even forcing land out of the irrigation.

Pressures on irrigation water are being caused by the growing demands for water from other sectors also due to rapid increase in urban population. This may ultimately result in transfer of water to non-irrigation uses and expanding industrialisation, particularly for those who are able to pay more for the water.

And, such an eventuality will compel the exploration of non-conventional resources which in the global context are adopted sporadically at present. As is seen from the information presented in the earlier chapters many countries like Cyprus, China, Egypt, France, Italy, Israel, South Africa and USA are meeting their part of the demand through reuse of wastewaters. Particularly, countries with limited resources when faced with water stress, will feel compelled for acceleration of programmes to increase reuse and the use of non-conventional waters for irrigation such as from the sea. As already noted in the earlier chapter views are vociferous in Israel to lend a 'national resource' status to sewerage. The countries where no reuse of wastewaters is practiced, may shortly have to start looking out to non-conventional sources for augmenting their supply.

The augmentation of water resources with reused wastewater however requires a comprehensive planning, stringent monitoring and precise water quality standards as this reuse impinges on the health aspects and environmental complexities, particularly when used in agriculture for eatable crops.

The goal of sustainable development is that the natural resources remain available in the future too. The limited natural availability balance of water and

high rate of population growth is a major constraint for future agriculture and socio-economic development. The increasing demand for water clearly necessitates savings in good quality water by using low quality water in agriculture, not only using less water, use of non-conventional water resources such as saline water, drainage water, groundwater and treated municipal and industrial effluents could help to ease the situation in many cases.

The use of marginal quality water, that is the water that possess characteristics which can cause problems (like brackish water for agriculture can cause high salinity or municipal wastewater could cause severe health hazards) requires very careful planning, very complex management practices and stringent monitoring, covering Hydraulics, Physical, Chemical, Biological and Human Management components, only a multi-pronged management strategy can provide a sustainable arrangement.

The assessment of losses at the farm level has revealed that improvements in management of waters are necessary and possible, to achieve water savings. It is now emerging that suitable crop rotation recycles the soil fertility when combined with other practices. Soils under mono culture, taking the same crop year after year, reduces the water storage capacity of the soils with adverse effects on the health of the plant whereby the lands ultimately turn non-productive. Proper water management on the farm is therefore necessarily to be coupled with the proper soil and crop management practices. No general prescription of water management as such can be provided, the strategy would differ from soil to soil, climate to climate and environment to environment. The skill lies in carving out area specific approaches.

The knowledge of the rooting characteristic of a crop plant and its water intake is of prime importance. The volume of water exploited by the plant is determined mostly by the plant rooting characteristic. The distribution and activity of plants' roots help determine water extracted from various depths of the soil profile. Computer technology is now available for simulating the movement of water in the soil and help a precise forecast of water needs.

The farmers seldom have means to monitor soil water depletion. Schedules based on soil moisture tension in the active root zone are useful but the farmers are unable to use them for want of availability of equipment (e.g. tensiometer) and/or understanding. With the advancement of technology it is now possible to know the soil moisture status by using remote control probes, as can be seen from the studies conducted in Australia, Germany and USA and many other countries.

Substantial saving in agriculture water can be attained if the correct and actual requirements of water and the crop growth are kept in focus, modern and scientific cultivation and water application techniques are adopted, new varieties of crops which require less water for the same nutritional output could be

developed and by changing the crop types from high water consuming to lower water consuming. Under conditions of water scarcity the emphasis in the productivity of crops per unit of land has to give way to criteria of production per unit of water. A multidisciplinary approach is therefore necessary for devising a proper strategy.

The water storage and delivery system will have to be managed to achieve storage and delivery efficiencies, including reduction in losses in the reservoir and in canals conveying water to the fields. Lining of canals with suitable materials, proper maintenance of the system, suitable flow control, regulation, operation and communication procedures and rigorous and agile monitoring can substantially help to improve the efficiencies.

Advancements in automated controls will further improve the canal operation and reduce the water use. Adoption of automated control will however warrant some structural modifications and provision of additional equipment for the system.

For improved efficiency in application of water, land grading, introduction of modern irrigation methods (sprinkler/drip) are also required.

A rigorous and agile monitoring of the system is where the success will finally rest. System responses to climatic events, cropping activities and feed back responses depend on the monitoring. With the development of telemetry and automatic control for regulation or handling of structural fixtures to allow or stop the flows to meet the demands of water between various zones of the command area has become very precise. A computer programme can be used and hooked-up with the Master Computer Unit to carry out the operation. The computerised programme can be made to respond to all the major events within a cropping season, barring responses to the climatic events for which intervention is needed. 'Dolores' automated flow control in USA is a good showpiece of USBR, as an example of the automated control.

All these activities together call for considerable investment in the improved infrastructure for handling the water supply to agriculture. Information on the investment patterns in the water sector and in the irrigation sector has not been available. But it is clear that watsave programmes will need substantial stepping up of investments in the irrigation sector.

Adoption of modern irrigation practices enables the management to cope up with situations of supply, lesser than what the crops may otherwise require. Australia, Germany, USA and other countries have conducted studies on adoption of these practices and found that not only the input of water was reduced but even the yields were better. Induction of modern irrigation methods has therefore been synonymous with modernisation of the irrigation system in many countries. Policies have been adopted which provide incentives for promoting these irrigation techniques. Eight years performance of the subsidised interest loan

scheme of the Government of China which supported modern methods was very encouraging. The schemes strongly pushed forward the development of sprinkler irrigation, conveying irrigation water through low-pressure pipe-line systems and micro irrigation (Hague, 1993). To support use of modern water saving practices some incentives will have to be built into the campaign of converting the conventional methods into modern techniques.

Research & Development support

Due to rapid advancements in scientific approaches in soil/salt and crop management, development of crop varieties giving high yield using less than conventional quantity of water are being developed by various Agricultural Research Institutes and Universities. Even though many countries have taken steps to transfer the improved technology to the field, yet the impact has not been uniform. A much greater involvement and commitment appears necessary. Some Research Institutes may have to adopt the irrigation command areas and demonstrate the success of the new techniques in the farmers fields on the lines of the "300 counties for water saving demonstration" programme in China which could save them nearly 6 BCM of water. There is also a necessity of evolving an organisational interdisciplinary mechanism under which the research scientists, the extension specialists and irrigation service personnel could sit together, plan the strategy and implement the research findings in a big way in the field.

Queensland State in Australia has carved out its approach for implementing water reforms mandated by the council of the Australian Governments (COAG) on the basis of a comprehensive and integrated approach which covers all the related issues like cost recovery, water pricing, metropolitan bulk services, commercial focus for water services, trading in water entitlement, wastewater/ storm water management, public consultations and public education.

Authority for comprehensive/integrated planning of water resources

In water short areas, there is a need for a clearly mandated authority at the basin or sub-basin level with a comprehensive responsibility for managing water in their area of jurisdiction. A unified control can provide for proper allocations of water, monitoring of the use, conduct of water audit and thereby achieve the desired water savings effectively which is otherwise not possible under a situation of fragmented water control. The "Seven Rivers Commission" in China in their evaluation of irrigation sector of the country found `Centralised Control' as one of the essential requirements for improved management of water.

Water Users Association

As already observed at the 16th ICID Congress, Cairo, 1996 the most important means to reduce intrinsic fields of conflicts in the sustained resource utilisation

is undoubtedly the decentralisation of the operational structures by establishing appropriate water users organisations in which the water users themselves regulate water distribution. The irrigation agencies can only mitigate the conflict potential, but never remove it.

The individual goals of each farmer will have to be welded into a common collective strategy of all the user's together. As long as the activity of O&M is handled by the Government in one way or the other, this is difficult to happen in its true spirit. In industralised/developed countries, enough progress has already been made in this direction and irrigated areas in most of those countries are today wholly looked after by the water users themselves. The developing countries will have to understand this managerial reform very early. It also does not cost much, if at all, financially.

In the International Conference on Irrigation Management Transfer in September 1994 at Wuhan-China (sponsored by IIMI and Wuhan University together) efforts in this direction made by Indonesia, Sri Lanka, Nigeria, Nepal, India, Egypt, Colombia, Dominican Republic, Philippines, Mexico, China, Sudan, USA and Colombia were reported. There was a model of leasing out of tubewells to cooperative societies in India (Gujarat). In Indonesia, the Ministry of Public Works had transferred about 1500 small irrigation systems irrigating more than 115 Th.ha. Sri Lanka had created a policy for Integrated Management of Major Irrigation Schemes (INMAS) in 1984 requiring farmer participation in O&M activity in 35 major schemes, through distributory canal organisations and joint management committees. In Egypt a flexible but systematic process was evolved for helping farmers to form their private users associations. Other countries too had carved out their approaches for addressing the local situations. The basic ingredient for implementing the philosophy of Irrigation Management Transfer (IMT) was a firm policy and political support creating a favourable environment and an efficiently working physical infrastructure (duly rehabilitated as per need). A prelude to the IMT was the need of defining government policy, means of transfer and legislated rules, availability of budget and trained staff. Though no general prescription as such could be suggested for the different ground realities and the social scenarios in the different countries. It was clear that government support for such a process was very important. The experiences presented there revealed that users participation had benefited the management and the productivity.

Irrigation service manpower

For managing the irrigation agency activity there is a need of a well organised and distinct agency to lend service to the users, with a clear mandate on its functions and accountability.

A manpower planning policy for organising the service is obviously needed for determining the personnel to be placed in the field. Most of the countries are

found to have some irrigation service agency, it is hoped that the mandate given to them is clear and detailed. The management of the irrigational activity should in fact, better start at the manpower planning policy.

Water pricing

To efficiently use a resource, a set of economic instruments are helpful and best effects become perceptible when one has to pay for the use of that resource or service in a proper manner. Pricing of water thus has had a crucial role in any water policy. Proper pricing also generates more funds for use in upkeep or rehabilitation of the systems and enables improved operating measures. But, because of the development lag perceivable in the rural communities, there is generally a hesitation in the governments of the developing countries. It is hoped that with increasing scarcities of water, attitudes will change. Low value of water does not motivate the users to employ the rightful minimum quantities only.

In Chile in South America, the water rights are a tradable commodity. Republic of China has also been contemplating water markets as a measure of 'demand management', this is a very 'strong tool', which places irrigation use in direct juxtaposition with other uses of water.

FAO has observed in their paper No.52, that 'one attendant legal issue is the legal status of water vis-a-vis the land it 'serves', i.e. whether water rights should be tied to ownership or possession of the land and to a particular use, or should have independent status, success of market mechanism will greatly depend on the societies, approach to this largely socio-philosophical issue.

In Victoria (Australia), restricted water markets were allowed to develop in the irrigation sector alone, within the same irrigation district or among different irrigation districts. Transfers were subject to prior screening and approval by the irrigation district authorities, who could impose restrictions to the affect of minimum amount of water rights that must be retained by any landowner. Transfers could be seasonal or permanent, with water 'attaching' to the land of the transferee in the latter case.

In Mexico, the new Federal water act allows the transfer of water rights, subject to prior government approval if the proposed transfer affects the right of third parties, or affects the hydrology or ecology of the basin or aquifer, in the case of groundwater. Water markets are also allowed to develop within a basin or aquifer on the basis of regional, basin-wide, state-wide or local stipulations made by the government. Under the new Act however, groundwater cannot be transferred separately from the land.

In Chile, water rights which have accrued under the existing legislation and those which will be granted under the new legislation will remain freely transferable to

different uses and places of use through market transactions. However, all transactions involving water abstraction works will require prior government authorisation. Furthermore, in the arid north of the country, transferability will be effectively impeded in so far as water rights are made to terminate automatically when the use for which they have been granted.

How far the irrigation countries will be able to adopt this approach is not yet very clear. But, in any case water pricing reform is going to be a major issue in the next decade. A realistic rate structure for O&M and cost effective recovery processes appear to be an immediate urgency in many countries.

With heavy subsidisation of irrigation water, rationalisation of water use or water savings will be difficult to achieve. Current rates in many countries make the water appear as a cheap goods and do not reflect the scarcity value of water. A higher water price reflecting the marginal value of water in its productivity on the farm can alone bring in the real savings finally. None-the less, the water pricing has ramification in larger socio-economic and political implications. Many governments also tried to subsidise water as an instrument of food policy. The question of pricing is also linked with the mechanism of water delivery. Evidence is, that where measured and priced water is supplied to user group(s), the farmers do not mind the increased price as they derive advantages of increased production. The money realised should also not be diverted to general revenue or to other activities. It must be transparent that the funds are used on the same irrigation system for O&M and improvements. That will generate a climate conducive for bearing the higher charges for water.

National Level Acts, Policies and Rules

One of the dominant factors in the shaping of a country's Law/Act/Policy is its geo-climatic condition. In arid areas of water shortage, water law addresses issues in water allocation more clearly, while in humid areas, they tend to dwell on the requirements of drainage and flood control. But with the changing demands on water, new situations call for a drastic change in the provisions in the water law also. Policies are required to be reviewed and reframed due to change of priorities. Sometime a higher priority could be for development of new resources while later, it could shift to optimum use of the created assets. Institutions, policies and acts are therefore bound to continue to be in transition for quite sometime, as is clearly seen from the frequent changes that have taken places in the water acts of many countries. It therefore appears that reflection of the countries concerns on watsave issues will also pass through a process of gradual evolution. But to expedite that process through exchange of lessons and experiences the "watsave" rules of ICID will have to be kept active and clicking all the time over the next two decades atleast. Countries have reviewed their national policies in the background of the changing water availability, Water quality, socio-economic changes and new developmental and management

objectives. In the recent past we see such reviews being made by the Republic of China, Australia, Jordan, Chinese Taipei Committee, Spain, Germany and Egypt. It is hoped that other countries, particularly those that are identified as likely to be under water stress by 2025 according to the recent water resources assessment made through the UN initiatives, will also undertake similar reviews of their water policies/acts not before long.

Australia: Objectives identified for reforms

- Ensure a coordinated approach with particular attention to environmental aspects.
- Develop methodology to quantify cost to the environment in deployment of assets.
- Develop strategy to deal with unintended consequences of reform appropriate regulation structures, disappearing research and development investments and dimensioning skill base.
- Provide opportunities for “cross fertilisation” of generic approaches.
- Develop means and opportunities for implementation of the work of Task Force and the Governments.

It is seen that water laws covering the quantity aspects are separate from the water laws dealing with water quality and are not necessarily overseen by the same agency. There is thus a necessity of integrating the two, e.g. in Mexico, the new Federal Water Act confers legal status and powers needed for effectively managing the irrigation systems to water users groups proposed for transfer from the government to the private sector. The service customers sit on the Boards of Management of the public irrigation companies. Separately, at the state level, legislation has been enacted to strengthen the financial and managerial flexibility of the urbanwater and sewerage utilities by turning them into commercial companies with authority to fix and collect service charges and to take other panel actions including cutting off the services. The managing boards of these companies contain amongst others, customers’ representatives, to ensure some accountability.

Women in irrigation

The role played by women in irrigation management as a whole and at farm level in particular has remained unrecognised for long. In many countries, the womenfolk work hand in hand with their male counterparts by tradition. They also rear the family, manage the household, tend the livestock and participate in the farming activity. But their special influence on the meticulous management of water did not receive much attention so far.

GENDER PERFORMANCE

A study conducted by IIMI, Sri Lanka, in Burkina Faso where women owned only 9% plots (0.15 to 0.25 ha) and husbands too had plots, the incomes from farm households where only men had plots were found to be lower than where both had plots. The productivity of the land as well as labour increased sharply while proportion of labour remained the same. Productivity of the irrigated lands also increased in comparison to men-only plots.

The role of women in agriculture has changed dramatically in developed countries. Both farm-men and women have been drawn into industrial and services sectors from the routine operation of farming. In developed countries where mechanised agriculture is done, it is possible to manage with a small number of work force and very few women remain in the agriculture sector except in food processing industries and backyard live stock and vegetable production. In contrast, in developing countries there are strong linkages between the welfare of an entire family and the ability of women to enhance total family income. In many countries and particularly in Africa, East and Southeast Asia, women play major roles in farm and financial management. Moreover, many of their agricultural roles require considerable skills, eg. in seed selection, storage and preservation, testing, organic recycling, the identification and control of pests, pathogens and weeds, and post-harvest technology. As men's decision-making roles are more publicly visible, government policy makers, scientists, and manufacturers of agricultural machinery have generally tended to neglect women's technology needs. Women have also been generally by-passed by extension services. Their numbers in scientific and extension services are generally small. Consequently, they continue to remain 'unskilled workers' with uncertain income.

A careful consideration is thus required for assessing the training needs for women particularly on the aspects of :

- Impact of new technologies on women=specific activities
- Developing technologies for women
- Involving women in technological development and transfer thereof
- Input in agricultural activity
- Marketing and trading of farm products, accounting and book keeping
- Seed production
- Soil fertility and fertiliser management
- Pest management
- Weed management
- Water management skill

Women's contribution in Extension Services is currently nominal while a larger share in this activity will be helpful particularly due to their 'inherent' instinctive persuasion faculty.

Lessons of studies conducted in Bangladesh and Burkina Faso do affirm that given the importance, women deserve a leading role in decision making, incomes of farm households can substantially increase leading to socio-economic upliftment.

An experience on "Women in tertiary unit development" (ICID – 15th Congress, 1993) also demonstrated that efficiency could be introduced by conducting a special programme of training. With extension and intensive guidance, women farmers participated in the planning, construction and water management of the tertiary irrigation system. The participation was not limited to implementation tasks only but they were also given a say in decision making and organization building. Having been pleased with their involvement, they have taken up important roles in the Water Users Association boards and actively support the management of irrigation water in the field. In one village, women even organised literacy classes and in two of the villages they formed women's groups for establishment of a collective money saving system and dry field crop cultivation on community fields.

Even otherwise women have played and will continue to play a key role in the conservation of basic life support systems eg. land, water, flora and fauna on the farm. In many areas, when men have to go out for better economic earnings and for socio-economic activities, it is the women who take care of the land and grow crops on them. They protect health of the soil and promote crop security. Women tend to look at the problems of the farm in their totality. For an economically and ecologically sustainable agriculture, involvement of women farmers or farm women (without assets) for modernisation of the farming practices is thus most essential. Particularly, for promoting water savings on the farm, their role is likely to be very critical, as various studies carried out through USAID projects in India and elsewhere have shown. Hence as an important part of capacity building measures, women's training in water application techniques and management of water distribution systems will have a key role in the future training programmes.

Public awareness and involvement

Australia has designed its public awareness movement by fully utilising the opportunities available through the nationwide celebration of the Water Conservation days at least twice a year; one week in October prior to high water demand, and second on World Water Day i.e. 22nd March. Water conservation is promoted by press release, community displays, public education activities, with political leaders and community groups recognising the values of integrated resource management.

Water conservation has been Australia's number one environmental priority. Messages as below are sent out during the national Water Week which do cause impact. "Set water targets or face shortage"; "Without community involvement Australia is not going to meet its future water demands let alone maintaining existing standards"; "Implement policy that brings about water conservation in the home, office and farm"

- Ensure development application in agriculture
- Plant high dollar yield crops that consume less water
- Do not over stock and over fertilise
- Protect groundwater resources

Australian Government jointly with New Zealand have also carved out a policy which makes public consultation a mandatory process for enforcing water policies/programmes. In this process, as planned in the Queensland State of Australia community consultation is ensured through community reference panels which provide community input to discussions and negotiation on acceptable balance between the competing water uses. A steering group comprising water users and government representatives developed a programme for consultation and negotiation with water users in 1997 and 1998 to implement the water pricing and local management proposals outlined in the public policy statement.

In Israel also the public is educated on the water cycles in the country and the emerging necessities of a deficient resource availability. The countries water commission issues special 'decrees' to cut down, the allocations on a transparent basis. In fact, procedures are being inducted for public consultation.

Recently the European Community Council requested the ICID National Committee of Germany to prepare a policy framework for reforms in the water sector commensurate with environmental safeguards. The National Committee laboriously went through the process of consultation with the user groups, governmental agencies and authorities to finally come up with the proposal on "a frame work for community action in the field of water policy".

These are some of the pace-setting mechanisms, which many countries faced with water shortages of serious water conservation issues would like to emulate in the coming years. It is expected that ICID WatSave Team will provide a continuous platform for exchange of information and experiences in this respect also.

The ICID Action Programme

ICID, in its pursuit for promoting water conservation is developing programmes to spread awareness about the limitations on water availability and the pressures

on the finite quantities of freshwater in the world. The need to strive for an effective balance in the supply and demand regime is to be stressed. ICID will also strive for the dissemination of successes and achievements in watsave, so that countrys facing similar situations could benefit from the experiences of others.

Yet another step in this respect proposed is to conduct a study of the legal provision for water conservation/savings vis-a-vis the organisational and institutional arrangements to implement the policies. Simultaneously, it proposed to promote development of country-wise action programmes to optimally utilise their water resources in a sustainable manner. A decision of ICID in its meeting held at Oxford in September 1997 to launch an annual Watsave award for recognising publicly the outstanding efforts in these directions by an individual or a group of individual and/or an Institution has now resulted in grant of an ICID Watsave Innovative Management Award.

Roving Watsave National Seminars and Regional Workshops to campaign for watsave worldwide are also proposed hopefully with the support and involvement of the international networks and mechanisms like the Global Water Partnership. Accordingly, the WatSave Team members of ICID will visit countries to focus on the needs for better water resource management as a prelude to holding of workshops.

To begin with, and as a part of the phased programme, seminars are proposed to be held in Africa and Asia. Eastern Europe, Mediterranean countries and the two Americas will be covered in subsequent phases. Various and themes for regional workshops will emerge from the country level seminars. About 20 seminars over next few years are in view. The seminars will identify project level provisions in physical and financial terms for effective water savings in the coming decades.

An international conference will be held in the end to deliberate on the generic issues that emerge from the series of workshops. Experts and specialists from different parts of the world on different topics crucial to WatSave programmes will be invited for evolving suitable long-term directions.

Looking to the experiences of the countries who have already taken strides in the watsave activities, there is not likely to be any ‘quick-fix’ as such for the countries that are to follow hereafter in the pursuit of various measures required for effecting water savings. It is going to be a long march. But, that is the one that will help the world to adjust to the realities of water shortages. ICID plans to play its modest role in actively supporting that process in the years to come.

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Responses to the Watsave questionnaire from ICID various member Committees:

	Communication dated
Australia	1st Feb. 1996
Austria	29 May 1996
Bangladesh	13 Apr. 1996
China	Feb. 1996
Cyprus	24 Nov. 1995
Chile	27 Jan. 1996
Chinese (Taipei)	9 July 1996
Egypt	19 June 1996
France	1 Aug 1996
Germany	15 Feb. 1996
India	9 June 1997
Indonesia	6 Feb. 1996
Israel	17 Dec. 1996
Italy	25 June 1996
Korea	10 June 1996
Malaysia	27 Jan. 1996
Mongolia	25 Jan. 1996
Nigeria	14 Feb. 1996
Pakistan	12 Dec. 1995
Slovenia	30 Jan 1996
South Africa	3 May 1996
Spain	8 Sept. 1997
Thailand	10 May 1996
Turkey	31 Jan. 1996
United States of America	14 Feb. 1996
United Kingdom	22 Apr. 1996
Zambia	5 June 1996

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Responding Countries

APPENDICES

ICID Participating Countries as on 31 December 1997