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MODULE THIRTEEN

AGRICULTURE AND IWRM

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MODULE 13 **AGRICULTURE AND IWRM**	
RATIONAL	Agricultural water requirements account for most of the water use, and rural development, agricultural production and food security represent dominant factors of the political economies of the generally water scarce countries in the arid and semi-arid ESCWA region. Agriculture includes forestry and fisheries and is closely linked to land resources and watershed management and the protection of fresh- and coastal water dependent ecosystems. As a consequence agriculture represents the important, primary key sector and is central to the establishment of IWRM. The agricultural sector, as a major water consumer relies on irrigation and rainfall. The average requirement per hectare for the Arab region, including the ESCWA member countries, is estimated at 11,500 m^3. However low water-use efficiency in the irrigation sector is contributing to the waste of the limited water resources and agriculture is also a main source of water pollution and continuation of the current agricultural practices in the ESCWA region will exert substantial pressure on the already limited water resources. The goal of self-sufficiency in food production and food security in the member countries will lead to increased agricultural water demands and expansion of irrigated land area. A main requirement is therefore to introduce improvements in irrigation efficiency, enhance the supplies with reuse of wastewater and drainage water, and to focus the cultivation on crops that consume little water but have high cash value. The other main option is to consider and optimize international food trade as a means of importing virtual water into water scarce countries and sub-regions.
OBJECTIVES	1. Discuss the issues of water security vs. food security and national development, including subsidized and protected agricultural production 2. Discuss the agricultural sector, including forestry and fisheries, in ESCWA countries. 3. Introduce Good Water Management including good governance concepts in agriculture 4. Identify and discuss the risks and management options for protection of ecosystems under threat from agricultural development, 5. Discuss the planning process for preparing and implementing water conservation plans in agricultural sector 6. Introduce a Catalog for Water Management Measures 7. Introduce and discuss the concept of virtual water, the scope for expanded food trade versus domestic agricultural production.
MAIN REFERENCES	- Bureau of Reclamation (2000) *Achieving Efficient Water Management: A Guidebook for Preparing Agricultural Water Conservation Plans, available at http://www.usbr.gov/waterconservation/publications.html accessed* August 15, 2003 - ESCWA (2003) *Updating the Assessment of Water Resources in ESCWA Members countries* UN - ESCWA (2003*) Sectoral water allocation policies in selected ESCWA member countries*, UN - FAO (1984) *Crop Water Requirements.* FAO Irrigation and Drainage Paper No. 24. Rome - FAO (1997) Irrigation potential in Africa. A basin Approach. FAO Land and Water Bulletin 4. Rome. - FAO (2002) *World Agriculture towards 2015/2030.* Rome - UNESCO/WWAP (2003)- World Water Assessment Programme; *The United Nations World Water Development Report;* Chapter 8 Securing Food for a Growing World Population; www.unesco/water/wwap, UNESCO/Berghan, Paris

	- UNESCO (2004), *ETHICS IN WATER; Chapter 5. Water for Agriculture*; Monograph; Paris - World Water Council (2000) *A Vision of Water for Food and Rural Development,* www.worldwatercouncil.org/Vision/Documents/WaterforFoodVisionDraft2.PDF
INTERNET LINKS	- www.worldwatercouncil.org/Vision/Documents/WaterforFoodVisionDraft2.PDF - http://www.fao.org/agl/aglw/aquastat/main/ - http://www.apps.fao.org/ - http://www.usbr.gov/waterconservation/publications.html - www.cgiar.org/iwmi/agriculture
DELIVERY OPTIONS	
DIRECTLY RELATED MODULES	5, 7 and 9

SESSION TOPIC SYNTHESIS	
QUESTIONS FOR DISCUSSION	1. Can food security be achieved in the ESCWA region without sacrificing water security? 2. How we can optimize water use in agricultural? 3. Agricultural water pricing – costs, in use and opportunity (scarcity) values 4. The concept of Virtual water and virtual water trade

Water for Food and Rural Development

World Water Council (2000) identified a Vision of water for food and rural development that can be adopted in the ESCWA countries. Three guiding principles give shape to their vision. The first of these is that all people have fundamental rights to sufficient water for drinking, food and sanitary purposes. This does not prelude that people may have to pay for or work for water and food, but that society would have to be organized in such a way that these are accessible to all. Society must focus particularly on ensuring this access to the most vulnerable user groups. The second principle is that each generation has the moral obligation to preserve the global heritage for its successors. Inter-generational equity requires that today's food production should not reduce the capacity for future generations to produce food, by over exploiting and degrading water and land resources. The third principle is that people should have a voice in making decisions on issues, which affect them, including those related to water allocation and management.

Water for Food

The human food supply comprises three principal sources – agricultural crops, livestock, and fisheries. The need for food depends on the number of people as well as on regional and local food traditions. As a result, demand for food will increase over this period due to the increase of population and with improved welfare. Growing more food and fibers requires more water whether production is rainfed or irrigated. Water supplies used in agriculture will have to be augmented by an additional 15 to 20% over the next 25 years, even under favorable assumptions regarding structural changes, and improvements in water management practices both on farms and in delivery systems, new technology, reforms in management institutions, more rational pricing policies and agronomic productivity to meet food requirements. The basic option to enhance supplies in arid and semi-arid zones is linked to reducing evaporation losses through e.g. improved watershed management and enhanced groundwater recharge, involving optimal agricultural land and forestry management and agricultural practices. The priority global challenge is to make food accessible and affordable to the poorest and undernourished populations of about 800 million in the world.

Agricultural Water Demand in ESCWA countries

Agricultural water requirements account for most of the water used in the ESCWA region. The agricultural sector, as a major water consumer, has relied on both irrigation and rainfall. Low water-use efficiency in the irrigation sector is contributing to the waste of limited water resources. The agricultural sector's contribution to gross domestic product (GDP) is relatively small; however the agricultural sector is, to a certain extent, the social and economic backbone of some countries for food production and rural employment. The continuation of current low-productivity agricultural practices in the ESCWA region will exert substantial pressure on the already limited water resources. The goal of self-sufficiency in food production and food security in the member countries will lead to increased agricultural water demand and the expansion of irrigated land. With finite water resources the focus need however to be on improved agricultural water use efficiency, reuse of wastewater and drainage water, improved groundwater recharge and the cultivation of crops that consume little water but have high cash value. On the other hand improved irrigation water efficiency and reuse are also linked to the risks of water quality degradation and salinization as well as reduced groundwater recharge and the loss of wetlands that depend on groundwater seepage and surface return flows.

What is Good Water Management?

To the farmer, good water management means getting the right amount and quality of water to the crops at the right time with minimum labor and expense and without compromising the risk of other impacts such as a build-up of salt in the soil. To the irrigation district, good water management means meeting the water needs

of its customers as efficiently as possible, with minimum waste or loss. Good water management is, therefore, fundamentally important to good overall district management. To society, good water management means having adequate and sustainable affordable supplies of good quality water for all municipal, industrial, agricultural, recreational, and environmental needs.

Fundamental Water Management Measures

- Water Measurement and Accounting Systems
- Water and Energy Pricing Structures
- Remove inappropriate irrigation subsidies
- Good Agricultural Practices: Crop Management and Plant Nutrition Management
- Educational Programs

Institutional Water Management Measures

- Clear and Sustainable Land and Water Tenures
- Participatory Irrigation Management: Water User Associations, Irrigation transfer
- Water Shortage Contingency and Drought mitigation Plans
- On-farm Water Conservation Incentives
- Water Transfers, Water Trading

Operational Water Management Measures

- Improved Operating Procedures
- Improved Distribution Control
- System-wide Irrigation Scheduling
- On-farm Irrigation Scheduling
- Conjunctive Use

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A. WATER FOR FOOD AND RURAL DEVELOPMENT

World Water Council (2000) identified a Vision of water for food and rural development that can be adopted in the ESCWA countries. Three guiding principles give shape to their vision. The first of these is that all people have fundamental rights to sufficient water for drinking, food and sanitary purposes. This does not prelude that people may have to pay for or work for water and food, but that society would have to be organized in such a way that these are accessible to all. Society must focus particularly on ensuring this access to the most vulnerable user groups. The second principle is that each generation has the moral obligation to preserve the global heritage for its successors. Inter-generational equity requires that today's food production should not reduce the capacity for future generations to produce food, by over exploiting and degrading water and land resources. The third principle is that people should have a voice in making decisions on issues, which affect them, including those related to water allocation and management. One perspective could be to identify and build upon the commonality between these principles and concepts of IWRM (Hofwegen, Svendsen,2000).

The United Nations medium growth projections indicate that global population will expand from the present 6 billion to nearly 8 billion in 2025. More than 80% of these people will live in developing countries. This implies that with nearly the same water and land resource base, we must grow enough food for 2 billion more people and create jobs for those not engaged directly in agriculture, while supplying expanding domestic and industrial water use needs. In 2025 about 84% of the population in industrialized countries and 56% of developing country residents will live in urban areas. Urbanization will encourage dietary shifts to preferred cereals (rice and wheat) and higher meat consumption. Agricultural productivity will tend to rise, along with yield per unit of land and per unit water, agricultural wages will go up, and farmers will rely more heavily on purchased inputs, better water management, and more mechanization. As agricultural water supplies, and agricultural land will be re-allocated to urban and industrial uses, there is need for regulation to reduce the risk of marginalizing rural populations.

The world will experience continued rapid developments in the fields of information, communications, remote sensing, and biotechnology. Biotechnology will likely furnish seeds with higher yield potential, better resistance to drought, tolerance of saline water, and better pest and disease resistance. Market, weather, and other information will become more widely available, enhancing producers' ability to make sound management decisions. Irrigation and drainage agency management capabilities will also improve as a result of these technologies, allowing better service provision at lower cost.

The real costs of energy are likely to drop over the medium-term. This development will make a variety of practices, such as pressurized water application, pumping of ground and surface water, and reclamation of brackish and polluted water more attractive. On the other hand, if not controlled it may encourage unplanned mining of groundwater reserves and other non-sustainable development.

The drive toward market-based economies will lead to continuing reductions in subsidies in some countries and reduced implicit taxation of agriculture in others, providing new opportunities for low-cost producers. Farmers will change crop mixes more readily in response to shifting prices and costs and adopt new technologies, especially for producing higher-value crops. Farm sizes will stabilize or expand as rural non-farm employment opportunities expand. Trading in water and water rights will expand significantly and global trade in agricultural commodities will continue to grow.

Regional trading blocks will strengthen, facilitating intra-regional trade. However, in areas of smallholder agriculture with uncompetitive farming systems, smallholders may fall back to subsistence agriculture or migrate to urban areas. To reduce the marginalisation there will be the need for intermediate and targeted measures to mitigate risks of rural poverty. The gradual warming of the earth, 1.0 °C in the past 50 years, is leading to glacial recession, declining snow cover, and rising sea levels. Some scientists claim that precipitation patterns will alter, reducing water availability especially in arid and semiarid regions, and increasing in others. Increased variability in precipitation patterns will accompany this shift with the impact

on both irrigated and non-irrigated agriculture. Precipitation patterns will include a greater proportion of extreme events, leading to higher and more frequent flooding, extended drought with lower dry season flows in rivers. More intense rainfall will lead to increased erosion and higher sedimentation rates in reservoirs and canals. The value of past investments in water control facilities will be reduced where reservoirs no longer fill and irrigation canals do not run full.

A.1. Food Demand to 2025

The human food supply comprises three principal sources – agricultural crops, livestock, and fisheries. In terms of total tonnage, crop agriculture accounts for more than three-quarters of food consumed (77.5%), with livestock (15.9%) and fishery products (6.6%) making up the balance. At its most basic level, the need for food depends on the number of people on the planet but also on regional and local menu traditions. Global population is expected to expand over the next 25 years, at a rate of 1.5% during 2005 - 2010 and be steadily decreasing thereafter. As a result, the demand for food will increase over this period, but at a slowing rate. The composition of the demand will also change. As incomes rise and urbanization advances, preferences will shift, first from maize and coarse grains to rice, and then from rice to wheat. There is an accompanying shift in growth from cereals to meat and fish as income levels rise. Increased demand for meat leads in turn to strong demand by producers for maize and other coarse grains as animal feed. Demand for food grows at 1.3% per year in response to population growth and rising incomes. Demand for animal products rises at a much more rapid rate. Composition of the cereal demand will shift to maize and wheat from the previous emphasis on wheat and rice. Cereal prices, with the exception of rice that is less widely traded and where the world price is more vulnerable, remain roughly stable in constant value terms. Other crops remain locally important.

During the coming quarter-century, rates of cereal yield increase are expected to decline further, averaging 1.0% for all cereals worldwide. Yield growth will provide almost all of the production increases, with global cereal area expanding at a rate of just 0.25% annually. More than half of the growth in area will be in Sub-Saharan Africa, where crop yields are very low.

A.2. Water for Food

Growing more food, whether production is rainfed or irrigated, requires more water. Even for optimistic assumptions regarding improvements in irrigation efficiency and agronomic potential to meet food requirements, global agricultural water supplies will have to be augmented by an additional 15 to 20% over the next 25 years. This amounts to an additional 0.6% to 0.7% of water supply per year. Some of this additional water can come from water harvesting, and development of small-scale water sources. These are preferred solutions in areas where poverty is extensive, water extremely scarce, and population growth rates high. Other options are related to additional groundwater development with artificial groundwater recharge and desalinization of brackish groundwater and expanded use of marginal quality water in agriculture. There is also the scope to reduce demand by introducing simple yield increasing, water-saving technologies such as manually operated pumps and bucket-drip systems. Better agronomic practices, such as mulching, can also save water, which can be used to improve productivity of rainfed areas and expand irrigated or partially irrigated area. One of the deciding and also limiting factors is access to low-cost energy.

There are limits though to how much additional water can be made available. The largest share of an increased water supply for agriculture must come from new practices and investments, which operate on a larger scale. These include improved water management practices both on farms and in delivery systems, comprising new technology, reforms in management institutions, and more rational pricing policies. The scope is not only ensuring food security, but also ensuring security of livelihoods through new and more responsive approaches to developing water resources. Water projects can bring many positive changes to the lives of poor people by reducing poverty, improving health and well being, and by empowering individuals and groups to act to improve their lives. Rural development requires that rural residents be empowered to manage and direct their own growth and development. This requires decision-making authority and at least a share of control over development resources to the local level. The pulling back by many state agencies from day-to-day water management will bring new roles for civil society. User associations are being formed to

run irrigation systems, and new multi-stakeholder catchment committees are increasingly influencing water management practices and water allocations. The new water institutions provide for wider participation of civil society to provide local conflict resolution mechanisms and protect the interests of poor producers and engage them in other collective actions to improve their livelihoods.

A.3. Implementation strategy

The proposed strategy for implementation focuses on improving food security and rural livelihoods by increasing the productivity of water (more crop and value per drop) and improving the access to food and water while reducing negative impacts of food production on the environment. These efforts are to be accompanied by supportive international trade arrangements, the development of adequate institutions and the necessary infrastructure. Choices will have to be made by Governments and many primary organizations and groups will be up to hard policy choices and the shared understanding of the problems and their consequences, the solutions, and the interconnections and tradeoffs among them is crucial for common actions and progress on common objectives.

A.4. Institutions and capacity building

In all the regional studies reforming and strengthening water institutions was called for to improve water management and to develop accurate, reliable, accessible water delivery systems and water use data for future planning and management. These institutions should be embedded in a system of integrated water resources management with empowered multi-stakeholder basin organizations managing surface and groundwater. This should be underpinned by water rights systems that recognize existing registered users, safeguard unregistered uses, enhance water access to the poor and disadvantaged groups, and allocate an appropriate flow to meet basic needs and development of small-scale irrigation. Reform of irrigation and drainage management institutions towards people and service orientated, and promote user-controlled and self-financing approaches, transparent decision making procedures and effective accountability mechanisms in place.

Sufficient numbers of qualified and skilled people are needed to develop and manage these organizations and institutions. Any envisaged institutional reform will require changes in attitudes and skills of staff and management processes for these reformed institutions to become service oriented.

Training and capacity building programs for individuals motivated staff and within the framework of human resources development plans should be an integral component of institutional reform and restructuring and supported with the necessary resources and time for training and capacity building. This involves development of local capacity on water and food production for professionals and researchers, facilitating the exchange of knowledge between local users, technicians and professional water managers and strengthening linkages between educational institutions and water research organizations.

Attractive career development programs are needed for water-related professionals to ensure and retain sufficient capacity and capability for planning, regulation and policing related to water resources use and management. Consideration is to be given to improve and balance gender representation in water management, at the different levels of governance and management

A.5 Investments in infrastructure and investments policies

Investment policies should be directed towards improvement of the productivity of water and sustainability of water resources based on participation of all stakeholders, including women and the poor. The investment programs should respond to the key principles of subsidiary, participation, accountability and transparency and foster the development of accountable, transparent and representative institutions within an integrated water resource development and management context. Considerations of ownership, collateral values and local credit securities and cost and credit recovery are essential for the mobilization of financially sustainable water investments especially at the local level.

Investments are needed to meet the demand for food, to improve the productivity and development of water and to improve the livelihood of rural people. These include the development of water resources to enable community based irrigated agriculture, modernization of irrigation and drainage systems in existing schemes and replacement and augmentation of water storage capacity in reservoirs and groundwater basins particularly in water scarce countries. Investments in new surface storage are required to replace lost storage (1%) and to add new capacity (0.5%), giving a net increase in storage for food production over 25 years of 13%. Groundwater recharge programs are to be initiated to help stem decline in groundwater tables. Additional supplies will be allocated to environment and for municipal withdrawals, with the remaining flows available to irrigated agriculture working towards an average annual increase in the irrigated area to match regional and local increases in food demands. Investments are needed in drainage and rehabilitation of degraded irrigated land, restoration of eroded lands and provision of flood protection and drainage of frequently inundated areas to improve rural livelihoods and secure or improve food production. Drainage reclamation needs to consider and respond to environmental requirements for protection and conservation of wetlands.

Investments in rural infrastructure and decentralized industrial development are needed to secure and enhance rural welfare including creation of rural jobs. In high-yielding agricultural areas, development will be focused on agro-processing to support enhanced productivity and larger agricultural production units. In low-yield agricultural areas, improved agricultural productivity balanced with off-farm job opportunities will increase farm household incomes to support grain import. The role of the private sector needs to be transitioned and expanded. The measures include stimulation of public-private partnerships to finance rural infrastructure, investments in labor-intensive industry in rural areas and the provision of agricultural support services. Reforms in water and energy pricing and irrigation management will lead to financially stable operation and maintenance and together with public capital cost-sharing, induce private sector interest in development and management of existing or new irrigation and drainage.

A.6. Trade

Global trade is a key element and to achieve adequate nutritional levels, food must be accessible and affordable. Therefore, trade arrangements should be developed to encourage water scarce regions to produce and export high-value crops and import water intensive staple crops. Trade regimes are also critical to building a food secure world, and must make special provisions for those countries not yet able to compete in world markets for their food supply. The economic implications of long-term imports of "virtual water", i.e. trade in food grains, in food deficit countries and regions should be carefully considered and assessed in its wider socio-economic and political perspectives. International trade regimes are to be further developed, which promote socially equitable production and distribution of food, and support agriculture-based rural development initiatives in low-income resource-poor countries. Some farmers in water-short regions will then be able to shift to higher value crops, enhancing value of output per unit water, and allowing purchase of imported cereals. Large areas under higher value crops will be able to shift to micro-irrigation, boosting yields and saving water.

A.7. Research

An increase in the overall research support is required for the development of new or situation adapted technologies focusing on the improvement of water productivity in irrigated and rainfed areas that maximize both water productivity and poverty alleviation impacts. This should be accompanied by research on further development of institutions for management, operation and maintenance. Biotechnology research is required to maintain or increase crop yield levels. Private sector genetic research supports growth in tradable cereal and horticultural crop yields. Public funding is required on locally important crops not likely to attract private sector interest such as coarse grains and tubers and improvement of drought resistance and salinity tolerance of major cereals. This would have to include the research on impact of development and use of genetically modified crops. The improvement of water quality of agricultural return flows requires the development of affordable and effective technologies including low-impact, short-life pesticides and herbicides (including biological agents) and feed for livestock. Strategies have to be developed to attain worldwide phase-outs of more persistent agricultural chemicals.

B. AGRICULTURAL WATER DEMAND IN ESCWA COUNTRIES

Agricultural water requirements account for most of the water used in the ESCWA region. Demand reached 123.2 BCM in 1990, increasing to 150.7 BCM in 2000. Countries in which the agricultural sector is the major water consumer include Egypt, Iraq, Saudi Arabia and the Syrian Arab Republic. Agricultural water demand in the ESCWA region is expected to reach 192.3 BCM in the year 2025.

*TABLE 1. CURRENT AND PROJECTED WATER ALLOCATION IN THE ESCWA REGION (*IN MILLION CUBIC METRES*)*

	1990			2000			2025		
Country	**Dom**	**Agric**	**Ind.**	**Dom**	**Agric**	**Ind**	**Dom**	**Agric**	**Ind**
Bahrain	112	120	17	132	124	26	169	271	169
Egypt	2,700	49,700	4,600	2,950	59,900	5,350	6,300	69,100	10,900
Iraq	3,800	45,200	1,450	4,300	52,000	9,700	8,000	76,000	10,000
Jordan	190	650	43	388	791	63	700	900	160
Kuwait	295	80	8	375	110	105	1,100	140	160
Lebanon	271	875	65	312	950	150	1,100	2,300	450
Oman	117	1,150	5	262	1,500	85	630	1,500	350
Palestine	78	140	7	260	217	18	800	420	70
Qatar	107	109	9	147	185	15	230	205	50
Saudi Arabia	1,508	14,600	192	2,350	15,000	415	6,450	16,300	1,450
Syrian Arab Republic	650	6,930	146	1,280	15,370	480	2,825	19,430	1,300
United Arab Emirates	513	950	27	750	1,400	30	1,100	2,050	50
Yemen	168	2,700	31	360	3,150	61	840	3,650	134
ESCWA	10,509	123,204	6,600	13,866	150,697	16,498	30,244	192,266	25,243

Sources: ESCWA,(2003) Sectoral Water allocation policies in Selected ESCWA member countries..

The agricultural sector, as a major water consumer, has relied on both irrigation and rainfall. The cultivated area of the ESCWA region was estimated at 20.2 million hectares in 1997; 44.6 per cent was irrigated from surface water and groundwater sources and the remainder from rainfall. The water required to irrigate one hectare of land ranges from 10,000 to 18,000 m^3 in Egypt, Iraq, Jordan and the Syrian Arab Republic, and from 5,000 to 10,000 m^3 in Lebanon, Oman, and Saudi Arabia, depending on the type of irrigation method and crop. The average requirement per hectare for the Arab region, including the ESCWA member countries, is estimated at 11,500 m^3. Low water-use efficiency in the irrigation sector is contributing to the waste of limited water resources. Egypt, Iraq and the Syrian Arab Republic have been relying mainly on surface irrigation, with 30-60 per cent efficiency. Other ESCWA member States, especially the GCC countries, have introduced modern sprinkler and drip irrigation systems that are recognized as being more water-efficient than surface methods (ESCWA 2003). The following economic factors should be taken into consideration when assessing the water consumption of the region's agricultural sector (ESCWA 2003):

(a) The agricultural sector's contribution to gross domestic product (GDP) is relatively small. In 1996, agriculture contributed US$ 54.9 billion to the economies of the ESCWA region (excluding the West Bank and Gaza Strip) and US$ 75 billion to those of the entire Arab region. The agricultural sector is, to a certain extent, the economic backbone of some countries for food production and employment. The contribution of agriculture to GDP in Egypt, Iraq, the Syrian Arab Republic and Yemen was estimated at 15.6, 34.4, 27.1 and 16.6 per cent, respectively, in 1996. Lower contributions of 4.5, 7.8, 3.0, 6.3 and 2.6 per cent were recorded for Jordan, Lebanon, Oman, Saudi Arabia and the United Arab Emirates, respectively. The region's average contribution in 1996 was 10.1 per cent. In the GCC countries, fisheries contribute a reasonable amount to GDP;

(b) Employment in the agricultural sector as a proportion of total employment in 1995 ranged from 1 per cent in Kuwait to 46 per cent in Yemen. A large percentage of the labour force, estimated at 33, 11, 14, 32

and 8 per cent, respectively, is employed in the agricultural sector in Egypt, Iraq, Saudi Arabia, the Syrian Arab Republic and the United Arab Emirates. Percentages of agricultural labour in the other ESCWA member countries, including Bahrain, Jordan, Lebanon and Qatar, are 2, 7, 4 and 3 per cent, respectively. The GCC countries rely mainly on foreign labour;

(c) In monetary terms, agricultural exports as a percentage of imports in 1995, including fisheries and forestry products, ranged from 0.75 per cent in Iraq to 91.4 per cent in the Syrian Arab Republic. Ratios for Jordan, Lebanon, Oman, Saudi Arabia, the United Arab Emirates and Yemen were 48.2, 9.5, 28.4, 11.1, 25.3 and 9.1 per cent respectively. In the other ESCWA member countries the ratios were quite low, ranging from 2.8 per cent in Kuwait to 5.2 per cent in Bahrain and Qatar. Average agricultural export trends during the period 1990-1995 for Egypt, Jordan, Lebanon, Saudi Arabia and the Syrian Arab Republic were +4.7, +31.1, -0.5, -11.1 and +2.8 per cent, respectively;

(d) The continuation of current agricultural practices in the ESCWA region will exert substantial pressure on the already limited water resources. The goal of self-sufficiency in food production and food security in the member countries will lead to increased agricultural water demand and expansion of irrigated land. The trend can be reduced through substantial improvements in irrigation efficiency, reuse of wastewater and drainage water, and change to crops that consume little water but have high cash value;

(e) Pricing schemes for irrigation water in the ESCWA region are almost non-existent, with the exceptions in a few countries States, where however water is extremely underpriced. With already low water prices for irrigation, water subsidies have been used as a means of supplementing low farmers' incomes , as a result of controlled agricultural pricing , compensating fixed exchange rates and encouraging the settlement of nomadic Bedouin populations. Irrigation water is provided free of charge in Egypt, Iraq, Yemen and the GCC countries, and at very low rates in Jordan and the Syrian Arab Republic. In Jordan, for example, the cost of irrigation water as a percentage of total agriculture production cost does not exceed 0.6 per cent for vegetables, 5 per cent for apples and grapes and 28 per cent for bananas of the total agricultural production cost.

During the past few decades, economic policies in several ESCWA member countries, including Jordan, Saudi Arabia, United Arab Emirates, Yemen, and the Syrian Arab Republic have given priority and support to the development and expansion of irrigated agriculture. National food security represents the major development goal and has resulted in expansion of grains and other water-intensive crops. Agricultural development policies in some countries have resulted in over-pumping of groundwater for irrigation use. Subsidized energy prices and credits for water pumps and irrigation equipment, exemptions of tariffs on imported fertilizers and equipment, subsidized prices of certain agricultural products, protection against foreign competition in the domestic markets, are all examples of the tools used to implement such agricultural-based economic polices. While there are important exceptions in the region, in general the impacts on the sustainability of water resources from protective policies and subsidized production have not been recognized and addressed in most countries of the region. .

In conclusion, the availability of water resources for agriculture in the ESCWA region conditional by the following factors:

- Agriculture is the dominant user of fresh water resources in all countries of the region except Kuwait and the agricultural share of water ranges from 70 per cent to over 90 per cent of the total demand
- The contribution of agriculture in the national economies and GDP is relatively low, although it absorbs substantial proportions of the labor force. Furthermore, its agro-based industries depend on agricultural products, especially in Egypt, the Syrian Arab Republic and Jordan
- The water efficiencies in distribution and use are generally low
- Agricultural expansion depends on irrigation from non-renewable groundwater sources, as in the GCC countries
- A large share of the available renewable and non-renewable water resources is shared between the countries within and outside the region.

C. WHAT IS GOOD AGRICULTURAL WATER MANAGEMENT?

To the farmer, good water management means getting the right amount of water to the crops at the right time with minimum labor and expense. If this can be accomplished without creating other problems, such as a build-up of salt in the soil or losing water to spills and seepage, so much the better. To the irrigation district, good water management means meeting the water needs of its customers as efficiently as possible, with minimum waste or loss. Good water management is, therefore, fundamentally important to good overall district management. To society, good water management means having adequate supplies of good quality water for all municipal, industrial, agricultural, recreational, and environmental needs. Those in charge of operating water supply and delivery systems bear the greatest burden of responsibility for promoting and achieving the good water management demanded by society (Bureau of Reclamation 2000). And on the global level good water management coincides with good global environmental governance to support sustainable socio-economic development, protect the ecosystems and minimize risk for regional and local water conflict. At all levels good water management builds on active involvement of civil society and on constructive and preventive conflict resolution mechanisms.

Benefits of Good Water Management Planning
The range of potential benefits includes:

- Improved water security
- Improved water service to customers
- More effective use of available water supply
- Improved agricultural productivity and rural welfare
- Improved water and economic efficiency
- Reduced operating costs and improved revenues to the district
- Improved crop yields and quality
- Reduced on-farm costs
- Development of additional water supply capabilities
- Education of customers and the public
- Improved system and water supply reliability
- Reduced drought impacts
- Protection of fresh water and water-dependent ecosystems

D. CAVEATS AND OPPORTUNITIES TO AGRICULTURAL WATER MANAGEMENT AND USE

The management and use of water for irrigation in the Arab region can be substantially improved provided resource constraints, external influences and recognition of political and economic realities are adequatly addressed within an IWRM framework.

D.1 Concurrent water and land constraints to expanded agriculture in the ESCWA Region

The conditions in the region deviate significantly from the global conditions for food security and water availability for sustainable agriculture. In the Near East and North Africa and in the ESCWA region, high portions of the available water and arable land resources are already used and the region is therefore, more than elsewhere, faced with rigid inter-linked water and land constraints to increased agricultural production. With limited unused arable land also the option to intensified production and irrigation is, constrained by high current utilization of the available water resources (FAO, 2002).

By 2030 irrigation will come much closer to its full potential in the Near East and North Africa using three-quarters of the irrigable land and 94 percent of its suitable cropland, with a remaining surplus of only 6 million ha. On the other hand water availability becomes a critical issue when 40 percent or more of the renewable water resources are used for irrigation and these countries are forced to make difficult choices between their agricultural and their urban water supply sectors. By 2030 the Near East and North Africa will be using no less than 58 percent.

D.2. Globalization and international agricultural trade

Trade reform has lowered the barriers, increased global economic integration, enhanced productivity and boosted incomes. Special measures are however needed to ensure that a greater share of the benefits of trade go to developing agricultural countries. Liberalized global trade is therefore generally seen as an important means for prosperity and the Uruguay Round's 1994 Agreement on Agriculture (AoA) provided special transitory conditions for agriculture. For most agricultural commodities, the AoA's impact on prices and levels of trade has however been negligible (FAO, 2002).

D.3 Groundwater development for agricultural productivity and rural welfare

One development option that has clearly, over many decades demonstrated its effectiveness and efficiency for intensive agriculture production gains is the accelerated groundwater irrigation development with energised borehole pumping, particularly when associated with private control over the application of groundwater. Much of this has been accidental as an indirect result of expansion of irrigated agriculture through surface command areas. The Indus basin large schemes, Loukkos in Morocco and many large commands in India and China have seen the proliferation of public and private investment in groundwater abstraction where it has conferred specific water security to producers who would otherwise have to rely on intermittent surface irrigation services.

D.4. Towards economic viability and mobilizing political support

In many irrigation development planning, land and water are perceived as resources, which can be fully exploited without due parallel analysis of economic, financial, institutional and environmental constraints and without any realistic market analysis. Supply-led approaches and large-scale irrigation infrastructure continue to dominate, reflecting government's determination to play a leading role in operation, construction and management of public infrastructure for the supply of irrigation services. The scale of the asset base and vested interests in such projects are so significant that they will continue to hinder the transfer of these irrigation management projects. Irrigation development should be integrated with plans to improve the productivity of the agricultural systems and their responsiveness to agricultural markets. Thus irrigated agriculture has to make a solid case for mobilizing the required investment. This should be supported with progressive reform and innovation for the organization, financing and operation of irrigation.

The notion of integration and linkages across sectors embedded in an IWRM perspective has particular significance for agriculture development as stability in the social, economic and political environments are essential for the sustainable management of land, forestry, fisheries and water resources. IWRM is by definition a complex concept; its success relies on its ability to accommodate the political dimension of integration and institutional realities with the social capacity to establish consensus and change public behavior, and to grasp a wider socio-economic integration. Furthermore, the effective application of IWRM is affected by political determinants which are locally specific and not always adapted to generalization (Allan, Motadullah, Hall, in UNESCO 2000).

D.5. The right to food

Access to food is one of fundamental pillars of human rights (as highlighted in the 1948 Universal Declaration of Human Rights and the 1966 International Covenant on Economic, Social and Cultural Rights) and there is growing agreement that no nation has the right to starve its people. However, judging from increasing and aggravating poverty conditions in many parts of the world, fewer economic rights are violated as much as food and nutrition rights. **(**UNESCO/WWAP, 2003).

D.6. Planning process for preparing and implementation water conservation plans in agricultural sector

There are nine planning steps for preparing and implementation water conservation plans in agricultural sector, each of them is discussed in Table 1.

TABLE 2: THE PLANNING PROCESS FOR PREPARING AND IMPLEMENTING WATER MANAGEMENT (CONSERVATION) PLANS

Step	Activity	Tasks	Responsible Party(s)
1	Gathering data	1. Collect information on the general description and setting of the district 2. Collect information on water rights and water resources 3. Develop a water budget 4. Identify legal, institutional, and environmental constraints and requirements 5. Define or describe the current water management program	Plan preparer[1] with input from district staff and management; Reclamation; other federal, state, or local water agencies; local stakeholders
2	Identifying and prioritizing issues	1. Identify issues A. Study available information (see Step 1 above) B. Conduct on-site tours C. Interview individual stakeholders D. Conduct brainstorming sessions with stakeholders 2. Prioritize issues	1. Plan preparer with input from district staff and management; Reclamation; other federal, state, or local water agencies; local stakeholders 2. District governing board and management with input from plan preparer, district staff, and local stakeholders
3	Setting Goals	Set one or more concise, quantifiable, and measurable goals for each issue determined to be relevant (see Step 2, Task 2 above)	District governing board and management with input from plan preparer, district staff, and local stakeholders

[1]The plan preparer might be a district employee, a consultant hired by the district, or a Reclamation or another agency' s technical specialist providing assistance.

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Source: Bureau of reclamation 2000.

Step	Activity	Tasks	Responsible Party(s)
4	Identifying candidate water management measures and activities	List all water management measures or activities that might contribute to the accomplishment of each goal	Plan preparer with input from district staff and management; Reclamation; other federal, state, or local water agencies, local stakeholders
5	Evaluating candidate measures	Evaluate and compare the candidate measures identified in Step 4 considering the following factors: • Benefits provided by each measure • Cost of implementing each measure • Acceptability of each measure to stakeholders • Ease of implementing each measure • Legal or institutional constraints associated with each measure • Environmental impacts associated with each measure	Plan preparer with input from district staff and management; Reclamation; other federal, state, or local water agencies; local stakeholders
6	Developing water management program	1. Select measures and activities to be included in the water management program 2. Establish a schedule for implementing each individual measure 3. Determine resources (staff time, money, facilities, and equipment) to be committed to implementing each individual measure 4. Identify monitoring parameters and establish monitoring schedule 5. Prepare written water management plan documenting process followed, information considered, and adopted plan	1-4. District governing board and management with input from plan preparer, district staff, technical specialists, and local stakeholders 5. Plan preparer with input from other sources as needed

Step	Activity	Tasks	Responsible Party(s)
7	Implementing water management program	Employ appropriate resources to accomplish the water management program following the schedule developed above	District governing board, management and staff with possible assistance from technical specialists
8	Monitoring implementation progress	Follow the monitoring schedule developed above to collect the data to evaluate implementation progress	District management and staff with possible assistance from other technical specialists
9	Evaluating progress and updating plan	1. Evaluate progress being made in implementing the water management program to determine if goals are being met as planned 2. Review the plan annually to refine issues or goals, add or delete measures, adjust schedule, or refine budget. The complete plan should be updated and resubmitted every 5 years	1. District management and staff with possible assistance from other technical specialists 2. District governing board with input from district management and staff, local stakeholders, and other technical specialists

E. PROTOTYPE CATALOG FOR WATER MANAGEMENT MEASURES[1]

This section contains descriptions of common agricultural water management measures and practices. This information will help participants to identify measures for achieving specific sets of goals for water management improvements to determine which measures will be best for achieving you're the set goals.

E.1. Fundamental Water Management Measures

There are three fundamental water management measures that should be considered in any water management program. These are:

1- Water Measurement and Accounting Systems
Effective water measurement and accounting is necessary for developing a sound water management program. A district's measurement and accounting systems should be capable of tracking the amount of water delivered to individual water users. These systems are effective water management tools because they help inform both the water users and the district about the quantity, timing, and location of water use. From the district's perspective, water measurement will help with: assembling information needed for a detailed water budget, identifying areas where additional efficiency can be achieved and implementing a billing system based on deliveries. At the farm level, water measurement will help with application of the proper amount of water to meet crop requirements and therefore may help to: improve crop yield and quality, and reduce erosion, fertilizer leaching and drainage problems.

2- Water Pricing Structure
To encourage efficient water use, a district's pricing and billing procedures should be based, at least in part, on the quantity of water delivered. Quantity-based charges can be incorporated into various existing pricing structures to provide some degree of economic incentive for efficient water use. Fairness in water billing is an additional benefit of quantity-based pricing structures. (See module 5)

3- Educational Programs
An important component of any water management program is providing information to farmers about efficient water use and water management services available through the district or other organizations. Educational programs can be effective because many water users are unaware of potential benefits from improvements in water use efficiency. Examples of educational programs include irrigation system improvement programs, on-farm irrigation scheduling programs, real-time agricultural evapotranspiration (ET) information, school and community educational programs, and technical and financial assistance programs. (See module 4)

E.2 Institutional Water Management Measures

These measures include:
- **Water Shortage Contingency and Drought mitigation Plan:** This can be accomplished through a combination of water development, water conservation programs and a drought preparedness or contingency plan. The basic objectives of a plan would include: hydrologic forecasting to predict water supply, definition of water allocation procedures to be used during drought periods and identification of alternative or supplemental water supplies.
- **On-farm Conservation Incentives:** For some farmers, the ability to implement efficient on-farm management practices and install modern water application equipment is hampered by the lack of capital. On-farm water management measures might include ditch lining, development of water reuse systems, installation of surge valves and gated pipes, sprinkler systems, field leveling, and soil

[1] *Extracted from Bureau of Reclamation (2000) Achieving Efficient Water Management: A Guidebook for Preparing Agricultural Water Conservation Plans, available at http://www.usbr.gov/waterconservation/publications.html accessed August 15, 2003*

treatments. Farmers may be willing to improve their irrigation efficiencies if long-term financing or other assistance is available from the district or other sources. Programs to provide incentives for on-farm water management may include financing incentives, in-kind services, and educational programs.

- **Water Transfers:** This generally involves moving water from areas of surplus to areas of shortage. These may be an effective technique for meeting water demands and for managing the impacts of drought. A permanent transfer involves the acquisition and change in ownership of water rights or allotments.

E.3. Operational Water Management Measures

These measures include:

- **Improved Operating Procedures:** changes to a district's operating procedures may provide for increased delivery and storage flexibility. Some operating procedures, which might be useful for improving water management ordering and delivery, canal/lateral operating practices, reservoir operations and integrated system operation.
- **Improved Distribution Control:** distribution control refers to the ability of the district to control delivery rates and amounts of water. Of particular interest are the physical capacities of the system (diversion structures, canals and laterals), control mechanisms (gates, checks, and weirs), and the ability of the district to operate these facilities in response to changes in water demands and hydrologic conditions. Limitations on physical features of the distribution system or difficulties in responding to changes in hydrology and water demands may result in over-delivery to farm turnouts and system spills, or under-deliveries, water shortages, crop stress and lower crop yields.
- **System-wide Irrigation Scheduling:** it attempts to schedule water deliveries to match irrigation requirements.
- **On-farm Irrigation Scheduling***:* when to irrigate and how much water to apply are the two basic questions each farmer must answer during the irrigation season. The answers will change throughout the irrigation season and will depend on crop type, climate conditions, soil types, application efficiencies, and previous water applications. Improving on-farm scheduling to better match actual crop needs, thereby reducing over-application of water, may be a very effective water management measure. On-farm irrigation scheduling can be based on the following methods: crop and soil appearance and feel, water availability (often a fixed frequency, theoretical ET calculations and allowable soil moisture depletion. The method chosen is usually a function of crop type and sensitivity to the timing of water application, availability of data, time constraints of the farmer, and system-wide water delivery flexibility.

- **Conjunctive Use:** it is the coordinated operation of surface water and groundwater resources to meet water requirements.

E.4. Facilities-Related Water Management Measures

There are some water management improvements achieved by constructing or modifying water delivery facilities like:

1. Construction of Regulatory Reservoirs
2. Lining of Canals and Reservoirs
3. Development of Water Re-use Systems

F. EXERCISE

The trainees can discuss the case studies in Box 1 and try to analyze similar cases from their counties.

BOX 1: CASE STUDY TUNISIA: REFORM OF IRRIGATION POLICY AND WATER CONSERVATION

This case describes the introduction of a new irrigation strategy in Tunisia, designed to address growing water shortages and to introduce reforms applicable to both modern large-scale and traditional smaller-scale irrigation systems.

Main IWRM Tools

- A2. LEGISLATIVE FRAMEWORK - Water policy translated into law
- A2.3 Reform of existing legislation
- B2. BUILDING INSTITUTIONAL CAPACITY - Developing human resources
- B2.1 Participatory capacity and empowerment in civil society
- B2.2 Training to build capacity in water professionals
- C7. ECONOMIC INSTRUMENTS - Using value and prices for efficiency and equity
- C7.1 Pricing of water and water services
- C7.4 Subsidies and incentives

Description

An arid country with limited water resources, Tunisia depends heavily on irrigated agriculture. The sector contributes 30-40% of the value of agricultural production, and is highly important in some regions. However, abstraction for irrigation accounts for 83% of the available water resources, competing with other uses. To conserve water resources and encourage demand management in the irrigation sector, a national water saving strategy was implemented. As part of the strategy, a number of reforms were introduced in the past few years, including the promotion of water users' associations, an increase in the price of irrigation water, and the use of incentives to adopt technologies at field level. The strategy also introduced a number of supporting actions such as applied research, improved agricultural marketing and capacity building in the irrigation sector. The integrated strategy has resulted in a marked increase in national awareness of water scarcity, and the value of water in the country's economic development. Specific measures introduced by the new strategy included:

- Creation of a legislative framework to promote water users' associations and financial incentives for water saving
- Strengthening capacity in all water management sectors, including the management and supervision of water users' association, training of trainers, and improving farmers' awareness of the need to improve the irrigation practice
- An increase in water tariffs to reinforce users' participation in cost management and to provide incentives for the adoption of water saving techniques.

Lessons learned

- Integrated reforms that take into account the technical, economical and institutional aspects of water demand can make a significant impact on water management and conservation
- To gain the support of farmers, reforms must seek to improve farmers' incomes
- Financial incentives accelerate the adoption and use of efficient irrigation techniques.

Importance of case for IWRM

The irrigated sector in Tunisia is similar to that of other countries of North Africa and the Middle East. Overall, the sector is characterized by high consumption and production of waste water, socio-economical constraints, and competition between users. In addition, the importance of agriculture to the social and economic life of the country makes the introduction of any irrigation management reform risky. The Tunisian experience can enrich the debate on the costs and benefits of establishing water demand management in agriculture.

Source: GWP ToolBox - Case study No. 19, 2003

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