

# ***Country Water Resources Assistance Strategy (CWRAS)***

**(DRAFT REPORT)**

## **Irrigation Thematic Group**

*Prepared by:*

*DR. Abdul Wahed Othman Mukred, Facilitator*

**February 2004**

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## **Introduction:**

Irrigation Sector in Agriculture is the major consumer of water. Irrigation efficiency does not exceed 35%. The sector is responsible for mining of the majority of water basins along with deterioration of water quality. Irrigation poses serious threats to many water basins, which might have dangerous demographic impact on economic and social development on rural population.

The continuation of this grave situation will definitely affect the economic and sustainable use of water. On the other hand, it will be virtually impossible to maintain equilibrium between available water resources and the continuously increasing demand for water.

Another factor complicating the situation is the fact that productivity of irrigated crops is still low and with inferior competitive qualities. This leads to major losses in food security in general.

The agriculture sector contribution to the Gross Domestic Production (GDP) is totaling 17% and accommodates 54% of the total labor force. Agriculture activities in rural areas are sources for settlement of rural population, which decreases the internal migration to cities and urban centers.

The Government of Yemen (GoY) through the Ministry of Agriculture and Irrigation (MAI) has been engaged (since the mid-nineties) in preparation of several strategic visions reflected in "Aden Agenda" and "Agriculture 21 Agenda" "The Irrigation Policies" which created a solid platform for launching a reform program of the agriculture sector. The strategic documents aimed at redefining the roles of the different stakeholders in the agriculture sector and restructuring the administrative, financial and personnel set-up of agriculture institutions.

As of the mid nineties MAI has accumulated several experiences in dealing with the continuously increasing irrigation water management challenges in particular and the agriculture sector reform program in general.

Since the launching of the reform program in the agriculture in the mid nineties several developments took place, such as: the establishment of National Water Resource Authority (NwRA), The issuing of Water Law and the creation of a new Ministry of Water and Environment (MWE). These developments must have their impact on the roles and responsibilities of different parties dealing with water resources.

In order to speed up the reform program in water resource sector, the MWE approached the World Bank and other Donor Agencies (DAs) to assist in the developing of the Country Water Resource Assistance Strategy (CWRAS) that would describe a rolling five-year plan for sector development. The CWRAS document is an important tool introduced under economy-wide impacts of water resources management and therefore the need for a cross – sectoral strategy for the WB and other donor agencies that integrates the range of financed programs impacting ,and impacted by, water resources.

The objectives of CWRAS exercise are:

- Spell out sector development objectives for the medium (five years) and long term (2015);
- Identify what are the important problems in the sector that will make it difficult to reach sector development objectives;
- Propose strategies that are feasible in the Yemeni context, even if sub-optimal, to address the critical situation; and
- Prepare a plan of action over five years, with a sequence and with priorities assigned.

The process of CWRAS preparation will have four phases envisaged in the following manner.

- 1- An analysis phase to be conducted by a core group and four thematic groups<sup>1</sup>: setting objectives, reviewing existing strategies, programs and recent experiences; identify problems; and potential solutions, a prioritized plan of action and investment program.
- 2- A consultation phase to be conducted through workshops with a wider audience for informing the public
- 3- A consolidation phase to bring together the output of the five thematic groups with a draft strategy and action plan.
- 4- A validation stage to obtain the approval of Government ( and where relevant of other donor agencies such as donors)

The Irrigation thematic group comprised of representatives from MAI, AREA, farmers Union, FAO, Council of Ministers, Ministry of Planning and International Cooperation and Presidential Office (for details see annex 1)

The Thematic group held six meetings. The seventh meeting was organized jointly with MAI Minister and senior HQ management. (annex 2)  
During the first meeting, the thematic group reviewed the issues to be discussed and divided the different topics into three major subjects:

- 1- Institutional and legislative aspects in irrigation
- 2- Management and uses of irrigation water
- 3- Research and Extension in irrigation

In the same meeting the agriculture and irrigation sector objectives were spelled out

Discussions of every subject covered identification of major problems, analysis of causes and listing of potential solutions on a priority basis. The potential solutions were compared to current strategies and policies to understand reasons for delay in implementation and lessons learned. A logical framework was designed and filled by the group in every meeting. The framework included strategies for implementation, plan of action and required investment plan.

The results of work of the irrigation thematic group are presented in this report and the annexes.

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<sup>1</sup> The thematic Groups are : Rural water supply and sanitation; Urban water supply and sanitation; Irrigation; Human and Environment. The core group : Water Resources, policy and institution.

## **1. Water Resource Sector Objectives:**

### **1.1 The water resources sector objectives<sup>2</sup> are:**

- Protection of water resources from over pumping and pollution
- Rational use of water resources to secure highest value from these resources.
- Secure the nation's needs for water for different purposes.

### **1.2. The Agriculture Sector Objectives in Irrigation<sup>3</sup> are:**

- Improve water use efficiency in the agriculture sector (more crop per drop)
- Improve institutional capacities in irrigation water management
- Increase the participation of local communities and farmers groups in irrigation water management.
- Improve water harvesting techniques in rainfed agriculture
- Develop and adopt techniques aimed at optimization the use of non traditional sources of water for irrigation( Treated Waste water , brackish water, saline water).

## **2. Institutional and legislative Aspects in irrigation.**

### **2.1. The role of Ministry of Agriculture and Irrigation (MAI) and its branches in irrigation water management.**

The problem of water in Yemen is not only related to the irrigation sub sector but it is related to the agriculture sector as a whole and is a function of several institution setups at the national, regional and local levels. Agriculture stakeholders in water are the Government public sector, the cooperative sector, the private sector and individual farmers.

The Agricultural strategy documents<sup>4</sup> established clear visions for required reforms in the agriculture sector in institutions, service delivery and the sustainable management of resources.

According to these strategies and the irrigation policy statements, the current and future challenges faced by the agriculture sector are:

- Deterioration of natural resources which agriculture depends on.
- Decreased status of agriculture economy
- Increased poverty and hunger among the majority of agriculture population.

To face the above mentioned challenges it was deemed necessary to adopt and implement without delay the implementation programs pertinent to ensure the presence of a strong and dynamic institution capable of responding to the changing environment. This can be achieved only if the tasks

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<sup>2</sup> National water sector strategy document

<sup>3</sup> The Irrigation water policies document prepared by MAI and approved by the council of Ministers as per the council's decision No. 38 (March 1999)

<sup>4</sup> "Aden agenda" and "Agriculture 21 Agenda"

and roles of MAI are clearly defined in line with the strategy documents at the national and local levels.

Discussions in the irrigation thematic group revealed that there is an urgent need to adopt an integrated approach in implementation of the reform program in order to address the major components of change: Strong and dynamic institution capable of change, enabling environment, laws, regulations and legislations supporting reforms.

It must be noted that MAI started a program for revival of the reform program. This is evident by the activation of the "Agenda Committee" meetings for review of the strategic documents to ensure accommodation of changes and developments since their preparation, and the formulation of a revised implementation program. A request has been submitted by MAI to donor agencies<sup>5</sup> to help implementing the reform program.

The key issue in implementation of the institutional reform program is the adoption of a decentralized policy in MAI and in the irrigation department which will serve as a tool for identification of roles at the national level (steering) and the local level (implementation).

The rationalization of staff has to rely on clear job description and clear definition of Terms of Reference for the different levels of the administrative structure. Job description has to go in line with the efforts of the Ministry of Civil Service and Administrative Reform to ensure harmony.

Human resource development is essential to improve capacities of staff in irrigation planning, monitoring and water management at the national and local levels.

### **2.3 Role of Ministry of Agriculture and National Water Resource Authority (NWRA) in irrigation monitoring.**

The water Law clearly defined the roles and responsibilities of both NWRA and MAI in monitoring of water .

Paragraph "21" In the Water Law stats that NWRA is responsible for determining the water equations , assessment of water demand for water and amounts that can be used by different sectors engaged in water use, through monitoring and assessment of water use in different basins and further development of these resources. The monitoring should be based on an intensive network of water monitoring in each basin. NWRA should adopt necessary measures to ensure equity in water use and protect these resources from mining.

Paragrah"25" in the Law states that MAI and the development agencies under it should manage its own structures and manager water use in irrigation as per the water master plan and in line with the strategies and policies of the agriculture sector.

MAI should prepare irrigation policies and plans which ensure maximum use of the sectors share from water.

MAI should conduct research and extension on rationalization of water and promote modern methods of irrigation

Construct, manage and maintain water constructions to ensure optimal use of rainfall, floods

In the light of the water paln, water equations for basins,

Prepare indications for water demand in the short, medium and long terms. This should include projects water requirements of the private sector.

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<sup>5</sup> FAO has positively responded to MAI request. Both parties are now formulating a Technical Cooperation Program for approval. The FAO program will review MAI reform program and will test scenarios of institutional structures and service deliveries in pilot areas for possible adjustments under the local Yemeni conditions.

The WB is currently engaged in formulation of a Rainfed and Livestock Development Project for possible funding.

Despite the statement in the water law, the delay in issuing the by-laws and new the developments of the creation of the MWE have delayed the actual implementation of the law.

On the hand, the weak institutional set-up of both NWRA and MAI has affected on the mechanism of implementation of monitoring of water resources and on water management at the field level. The monitoring functions of both institutions are still on paper as a result.

To facilitate the role of both institutions in monitoring as per the tasks reflected in the water law, it will important to restructure and strengthen the institutional capacities of NWRA and MAI. At the same time there is a need to revise the water law to accommodate the new developments and simultaneously prepare the by-laws in order to speed the process of implementation to ensure equity of water distribution and sustainability of the resource.

#### **2.4. Role of National Water Resources Authority in assessment and management of water resources.**

The recent creation of NWRA and its limited staff as well as its limited branches at the water basins level has negatively affected the implementation capacity of the institution. This has forced NWRA to limit its activities to areas were there are available data on water basis. The presence of more than one institution dealing with water resources had complicated the role of NWRA in assessment and management of water resources.

The grave situation of water resources puts on the Government additional commitments in supporting and strengthening NWRA financially and administratively to enable this institution perform its duties in an efficient manner.

The strengthening of NWRA will ensure the completion of studies of the outstanding water basins and will facilitate the creation of a solid data base on ground water in an interactive manner through the creation of the long awaited water communication center.

#### **2.5. Role of Non-Governmental Organization in irrigation management ( Participatory Irrigation (PIM) and Water Users Associations (WUAs)**

There is a wealth of traditions and water rights, which used to regulate the use of surface water and springs to ensure equity without any interference from outside the local communities. However, developments, which took place during the past forty years, have affected the power of these traditions and water rights and in some cases had negative effects on equity of surface water distribution. Following are some examples:

- The construction of diversion dams in major wadis in Tihama, Abyan and Tuban delats led to the continuous diversion of floods to land owners in the upper part of the wadi. This is mainly as a result of a traditional water right which gives the fields located up-stream priority in irrigation in every single flood throughout the season.
- This principle was valid when traditional earth water diversions used to be constructed for diversion of floods. These diversion never used to prevent floods from going downstream . However, the concrete diversions can withstand the biggest floods and prevent water from flowing downstream.
- Land owners located in the middle and in the lower parts of the wadis started getting less floods and were forced to drill wells for irrigation. The intensive drilling of wells and the limited recharge of underground water led to mining of underground water and quality deterioration. Many wells were abandoned because of salinity problems.
- The construction of water diversion dams and irrigation canals was not associated with direct involvement of local communities. This led to the spread of a wrong perception that the construction, management and maintenance of these dams is the responsibility of the Government.
- Agriculture in the highlands was subjected to drastic shift from subsistence to growing cash crop for marketing. This shift weakened the role of local communities in monitoring of traditional water rights and terrace rehabilitation. Subsequently the maintenance of these terraces and water harvesting structures gradually fade out with subsequent deterioration of these man made interventions.
- The random drilling of tube wells in the seventies and eighties either by individual farmers or as a result of heavy subsidies by the Government led to a wrong belief that these wells are private property of individual owners or managed by shared ownership. As a result have the right to extract underground water without any consideration to the capacity of the basin and sustainability of the resource.
- Lack of incentives to rationalize the use of underground water promoted the concept of underground mining of water.
- The spread of shared ownership of tube wells led to dividing water use by days among owners not by actual needs of crops grown.

Current strategies and irrigation policy statements highlighted the importance of revising the level and type of government interventions in service delivery in irrigation. Gradual withdrawal of government from management and maintenance of water constructions became a must. At the same time there is a need to empower local communities to take over this role in a gradual manner and through the creation of water users Associations and Participatory Irrigation Management.

This strategic direction was reflected in the water management project. Two pilot sites were selected for the implementation of this project ( Wadi Zabid in Tihama and Wadi tuban in Lahej governortaes.) In these sites the participatory rehabilitation of main and secondary canals is underway and the creation of WUAs is being launched.

It will be of vital importance to closely monitor these developments and ensure successful function of the newly established WUAs before disseminating these interventions to other areas in the country.

It must be noted that the creation of WUAs is not an objective by itself and might not be enough for rational use of water resources. There is a need for additional measures with the aim of lifting incentives for irrational use of surface and underground water.

Government support for rationalization of water in irrigation has been in the promotion of modern irrigation methods<sup>6</sup> and improvement of surface irrigation<sup>7</sup> through improvement of water conveyance systems in farmers' fields.

## **2.6 Traditional Water Rights in Irrigation Management:**

Government intervention in construction of concrete water diversions in major wadis in the coastal plains led to negative impacts on the equity of traditional water rights. This requires thorough review of the level of impact and required alterations to ensure equity in flood water distribution.

This revision has to be supported by intensive extension and awareness campaigns with active participation of beneficiaries. At the same time there is a need to formulate rules and regulations supporting the equal distribution of flood water among beneficiaries.

## **3. Management and Uses of Irrigation Water:**

### **3.1. Ground Water Mining:**

The intensive drilling of tube wells and the irrational use of irrigation water as well as the growing of low value crops under irrigation without consideration to the resources available led to sharp drop of underground water levels in most water basins coupled with deterioration of underground water quality. The deterioration in both quantity and quality of underground water is taking place at accelerating and alarming rates, which could pose a threat on most water basins.

The partial or total collapse of terrace farming in some areas have also led to deterioration of the water harvesting systems in hill slopes and wadi beds. This in its turn has contributed to the sharp drop of underground water levels as a result of low recharge.

Addressing the problem of water mining requires an integrated approach which embarks on creation of strong institutions (Government and NGOs) capable to respond to challenges in an efficient manner, an enabling environment in which subsidies for mining of underground water are lifted and laws and regulations which support efforts for more rational use of underground water resources.

There is still a big scope for improvement of irrigation practices at the field level. Results of trials carried out by national scientists in AREA under farmers' conditions gave promising results in this regard<sup>8</sup>.

Current strategies on water mining are reflected in the irrigation policy statements. According to these statements, pumping of underground water

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<sup>6</sup> Results of experiments carried out in potato cultivation using drip irrigation combined with application of fertilizers (fertigation) clearly demonstrated that drip irrigation saved up to 40% of irrigation water and the yield was similar in quantity and superior in quality when compared to surface irrigation in Dhamar area.

<sup>7</sup> Calculations made under farmers conditions in both Lahej and Abyan Governorates in the context of on-farm water management project indicated that the % of irrigation water lost in earth canals ranged between 20-40% depending on the location of the well and the distance to the field. Water loss was a result of leaching, evaporation and weeds competition in the canals.

<sup>8</sup> Results of studies and measurements of farmers irrigation practices clearly demonstrated the farmers irrigate when soil moisture is about 83-85 % of field capacity. Irrigation should be applied when soil moisture is about 70- 75 % of field capacity. This means that farmers are wasting about 13-15% of water applied because of early water application to their crops.

should be measured both in quantity and quality. Legislations and regulations should be issued and gradually implemented to ensure rationing of water according to economic use and by means of water saving irrigation techniques. The maximum return per unit area and water should always be maintained.

To minimize the danger of underground water mining it will be essential to adopt an integrated approach, which must incorporate strengthening the institutional capacities of MAI and Irrigation Department at both national and local levels, lifting the subsidies for underground water pumping and speeding the implementation of water law and irrigation policies. The integrated approach should also include promotion and dissemination of modern irrigation techniques.

Intensive extension programs on the impact of irrational water use on the sustainability of resources should also be launched to raise awareness among local communities in rural areas.

### **3.2. The rationale of dams and water structures.**

Huge efforts were exerted by the Government and donor agencies in construction of dams and water structures for recharge of underground water and for irrigation. Statistics show that the total number of dams and water structures constructed by projects and promotional funds exceed 500.

Despite these efforts, the efficiency of these constructions in recharging underground water and in irrigation is still low<sup>9</sup>. Reasons for this can be summarized as follows:

- Unsuitability of some locations where dams were constructed
- Limited hydrological and hydro-geological studies of some sites.
- Limited experience of some contractors involved in the construction of dams.
- Absence of independent supervision of dams' construction.
- Limited involvement of local communities in the whole process of dams' construction, management and maintenance.

To ensure that dams serve the purpose of their construction, there is a need to assess the experience in dams' construction accumulated so far. The

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<sup>9</sup> Results of a recent study carried out by scientists in the National Natural Resources Center in AREA on five randomly selected small to medium dams in Sana'a Governorate indicated that : Sites of some dams were not properly selected, the capacities of two dams were far below the amount of annual floods.

There was a defect in the construction of at least one dam. This was evident by water leakage from the sides of the dam.

Most dams positively affected the recharge of surface water in the surrounding area only, this forced farmers to dig open wells in the area surrounding the dams for water extraction.

Farmers located downstream are suffering from water depletion in open wells. Some of these farmers purchased land upstream and dug open wells for irrigation of their lands located downstream.

Irrigation practices applied are still traditional; earth canals are still major method of water conveyance to the fields.

Nearly all dams surveyed suffer from sedimentation and there seems to be no efforts by local communities for regular removal of these sediments.

Some members of local communities in the surveyed areas are expecting the government to manage these dams.

results of this analysis will serve as lessons learned and will help planning better for the future.

A national plan for dam construction should be carried on the basis of clear objectives and scientific studies carried out by independent and professional bodies covering all watersheds. Ad-hoc construction of dams will only complicate the situation.

The construction of dams should be carried out in a participatory manner. Local communities should be made aware of their roles and responsibilities right from the beginning.

Promotion of the use of modern techniques in irrigation is important issue in rational use of water for irrigation from dams.

The effect of dams on recharging underground water is still not assessed under local conditions. Therefore, it will be advisable to include this parameter in the assessment of constructed dams.

### **3.3. Operation and Maintenance of Irrigation Structures:**

The construction of irrigation structures in major wadis is considered one of the most important development interventions carried out in the early years of agriculture development. These irrigation structures were sponsored from loans or donations through development projects. The projects provided for operation and regular maintenance of these constructions in total absence of the contribution of local communities in management and maintenance..

The termination of development projects led to shortage of funds provided by the government for operation and maintenance, which led to gradual deterioration of these diversion structures and affiliated main and secondary canals. This led to a partial or total collapse of main and secondary canals. There is evidence that deterioration is accelerating at a fast rate and unless measures are taken to remedy the situation, the total collapse of these structures might be inevitable.

Analysis of this problem clearly indicated that development efforts concentrated more on the construction of structures and overlooked operation and maintenance. The limited funds provided by the government and the passive role of local communities in management of irrigation structures further aggravated the situation.

Recently, the government launched a program for rehabilitation of irrigation structures in two pilot areas ( wadi Zabid and wadi Tuban). The rehabilitation was accompanied by creation of water WUAs as a first step in empowering local communities to manage and maintain these irrigation structures in a sustainable manner.

The process of handing over will be gradual. In the medium term, the role of government will continue to manage and maintain the diversion structures and the WUAs will take over the management and maintenance of the main and secondary canals. In the long term however, the responsibilities of Local communities will take over the whole network of irrigation structures.

To ensure that local communities take over these responsibilities, several steps had to be carried out such as: analysis of socio-economic factors affecting local communities benefiting from irrigation structures; revise traditional water rights to ensure equity in water distribution among beneficiaries; strengthen capacities of WUAs to enable them understand their potential roles in improvement of their livelihoods. Therefore the close monitoring of WUAs performance and elimination of obstacles affecting performance of their roles are essential elements in ensuring success and further dissemination of these interventions to other areas.

### **3.4. Water Shed Management and Terrace Rehabilitation:**

Natural Resources were subjected to a rapid deterioration during the past few decades. The rate of this deterioration has dramatically accelerated during the recent years to the extent that they reached irreversible stage in some places. Water shed and terraces were most affected were the most to be affected as a result of this deterioration.

The deterioration started upstream in the watershed followed by terrace deterioration in the hill slopes and wadi beds located downstream towards the coastal plains.

The collapse of community roles and traditional management systems and the mass migration to urban centers and cities accelerated the process of deterioration as a result of lack of labor and regular maintenance of watersheds.

Development efforts concentrated on irrigated areas and overlooked rainfed areas. This was a major reason for depriving rainfed areas from basic services and essential needs for a decent livelihood.

Current Irrigation policies stated that there is a need to control floods and management of water sheds and rehabilitate terraces in order to reduce soil erosion and increase the utilization of rainfall to recharge the underground water as well as improve the vegetative cover and reduce floodwater flow to the sea.

A comprehensive and integrated approach is required to solve problems of watersheds management and terrace rehabilitation. In this approach the role of government and local communities are integrated and complement each other. On the other hand, there is a need for a set of procedures to ensure sustainable development of watersheds and terrace rehabilitation. These can be summarized as follows:

- Improve productivity of rainfed crops (High yielding varieties, Drought resistant, Early maturing, Sound crop management and effective resource management practices)
- Participatory range improvement
- Promote gas use to reduce reliance on firewood
- Diversify income of farmers from agriculture and non agriculture activities
- Promote farmers skills and handicrafts and home economics
- Integrate gender in all aspects of watershed management.
- Introduce environmental concepts in development interventions
- Introduce new crops with comparative advantage such as potato growing and Protected agriculture by using water harvesting and drip irrigation techniques.
- Promote environmental awareness among local communities
- Create a national institution to coordinate efforts in water shed management in line with Agriculture 21 Agenda vision and implementation program.
- Enforce laws and regulations on the integrated management of watersheds.

To implement the above procedures it will be essential to design participatory development interventions and test them in pilot areas to gather lessons from implementation before dissemination of these development approaches into other areas.

### **3.5. Qat:**

Qat cultivation is expanding rapidly. Areas under qat f increased from 8000 ha in 1970 to 110000 ha in 2001. The reasons for this increase in area

are related to the high returns from qat cultivation and the ever expanding markets and the increasing number of new categories of people adopting the habit of chewing qat ( women, youth, Arab and Foreign tourists)

Among other reasons for expansion of qat growing is the fact that qat return is not only high per unit area but also per unit of water used in irrigation. Thus exceeding any other crop so far.

Current strategies dealing with qat are reflected in the proceeding of the qat conference held in 2001 and are summarized as follows:

- Minimize the risk of random use of chemicals in qat cultivation to reduce its effect on human health and the environment by suggesting alternative measures for integrated production and protection management practices.
- Study qat water requirements and introduce modern techniques to reduce water use in qat cultivation.
- Launch campaigns on the effect of qat chewing on health and family income.
- Suggest alternative crops that can compete with qat.
- Establish recreation clubs and sport clubs to attract younger generation spend their time more efficiently.

The irrigation policy statement stressed the need for discouraging water markets for qat cultivation.

Addressing the qat problem requires patience and persistence in implementing integrated efforts aimed at improving water use efficiency in qat cultivation and reducing the danger of qat chewing on health as a result of random use of chemicals in its cultivation. Equally important is the introduction of alternative crops<sup>10</sup> and techniques with high returns per unit area and water used.

Raising the awareness of consumers and provision of alternative recreation facilities for people to spend their time are complementary measures in the overall campaigns against qat.

### **3.6. The use of Treated waste Water, Brackish water and Salty Water in Irrigation.**

Despite the increasing number of sewage water treatment facilities, the treated wastewater (TWW) is still a marginal source in water resources. TWW is still not utilized properly. In best cases TWW is used for forage production. In coastal areas TWW is left to pour into the sea.

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<sup>10</sup> Results of three consecutive years in protected agriculture cultivation of cucumber and tomatoes under terrace conditions in Al-Mahweet, Yareem and Taz using water harvesting and drip irrigation were encouraging and led farmers to expand construction of plastic houses particularly in Al-Mahweet. The average total income per plastic house (30m x 8m) ranged from 150.000 YR to 170.000YR per season (4 -5 months) in the case of cucumber.

The cultivation of cucumber in plastic houses in terraces was based on the adoption of an integrated production and protection management approach (IPPM). As a result of this approach the use of chemicals was reduced to only 1-3 sprays throughout the growing season.

The cost of erection of one plastic house with the drip irrigation network ranged from 190.000 YR to 250.000 YR.

The level of wastewater treatment adopted locally restricts the use of TWW to only irrigate forestry belts and perennial forage species. Objective assessment of the quality of TWW to determine uses of this source in irrigation has not been done so far. A preliminary study carried out in Al-Shaab Treatment facility revealed that TWW under current circumstances is not suitable for irrigation of forages<sup>11</sup>.

Current strategies are spelled out in the irrigation policy statements. According to these statements there is a need to utilize TWW and brackish water in irrigated agriculture without jeopardizing human and animal health and without any pollution of water basins and as per the standards applied to secondary sources of water.

The secondary level of treatment of sewage water is not enough for safer use of TWW for irrigation of field crops or perennial crops. There is a need therefore, for upgrading treatment into tertiary treatment which will involve the introduction of additional measures to the treatment facilities to ensure safe use of TWW for irrigation without the risk on human, animal health and the without pollution of the environment.

The use of brackish water and saline water is a challenge in the utilization of secondary sources of water for irrigation. Research institutions should become actively involved in adopting measures and techniques for proper utilization of these sources of water. In this regard it will of vital importance to rely heavily on experiences generated elsewhere and avoid starting from scratch in this respect.

### **3.7. Virtual Water and Food Policy:**

Poverty is an essential element in food security. Statistics show that there an increase in % poverty in rural areas which has an impact on waste of human power which otherwise could have diverted to or used in agriculture production and development activities. There is also evidence of deteriorating living standards in rural areas required for simple and decent life (electricity, roads, transport means, health care, education, social care ) The increase in % of poverty is a challenge that cannot be overlooked in the agriculture sector.

The low productivity in agriculture production is a cutting across factor in the low levels of food security in both rainfed and irrigated agriculture.

Production of food crops per unit area in irrigated areas is still low when compared to cash crops under the same production system and when compared to similar production systems in neighboring countries and in the Middle East Region. Similarly returns per unit area are still low in cultivation of food crops in rainfed production systems, which led to migration of members of communities to cities and urban centers.

The above challenges require solutions in which the national research system (NARS) plays a vital role, through applied and adoptive research programs in genetic enhancement, resource management and crop management. These activities should aim at development of suitable varieties

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<sup>11</sup> Analysis of affluent and effluent water qualities in Al-Shaab Treatment Facility revealed that the capacity of the facility is less than it the amount of affluent received per day. This is mainly because the design of the facility did not take into account the rapid expansion of the Al-Shaab district in Aden. As a result sewage water does not remain in the ponds for the required time. The result is quick discharging of treated waste water with high contamination of bacteria and salinity levels. The study suggested construction of additional ponds for proper treatment of sewage in this district.

and recommend interventions which help increase returns from growing food crops under rainfed and irrigated production systems.

The interventions should include, but not restricted to, land preparation, crop husbandry, integrated pest management (IPM), application of organic and mineral fertilizers under different levels of rainfall, post harvest treatments for minimizing losses during in the field and during storage.

Improvement of food security expands to cover livestock improvement, and honey production through improved practices of animal feeding and preparation of balanced feed rations and improvement of range production and range management in a sustainable manner.

The research agenda should be formulated on the basis of careful assessment of prevailing production systems in the targeted areas. The agenda should also ensure participation of target groups in identification and priority setting of problems and potential solutions for these problems.

Needless to say that NARS should have the human , financial means, strong and dynamic institution and an enabling environment to launch these activities in a professional manner.

### **3.8. Pricing and Cost Recovery in Irrigation:**

Agriculture development in the seventies and eighties was based on total or partial subsidies of agriculture services. The services include diversion of floods for irrigation. The cost of water in irrigation was overlooked in the process of cost recovery and maintenance of irrigation structures. The situation was further complicated when traditional tariff systems in which farmers pay cash or in kind for flood irrigation were cancelled after the construction of irrigation structures in coastal plains.

The situation was not better under irrigated production systems. Here subsidies covered the cost of drilling of wells and provision of pumps. These subsidies were provided in a form of free services or through subsidizing the cost of drilling machines and import of engines as well as cheap diesel required for running the pumps of tube wells. The subsidies covered water transportation by diesel trucks. These subsidies drastically affected groundwater extraction, which was reflected in lavish irrigation of low value crops and growing of crops that are known for their high demand for water without consideration to the capacity of water basins.

The acute problems of water shortages became more evident in the recent years and require an integrated approach not only in legislations but also in launching economic measures, which should give value to the water used in irrigation.

Current policies in irrigation provide the following directions:

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| <ul style="list-style-type: none"><li>- There is a need to apply a cost and tariff for water use to cover the cost management and maintenance of irrigation structures under spate irrigation conditions as a first step</li><li>- Subsidies of underground water extraction should be lifted in a gradual manner.</li><li>- Study the possibility of costing of underground water for rational use of this resource.</li></ul> |
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The implementation of the above measures require the presence of a strong institution and a conducive environment supported by strong public awareness campaigns to generate consensus among communities on the

importance of these measures and should be applied in a gradual and persistent manner.

#### **4. Research and Extension in Irrigation:**

##### **4.1. Research**

Research and extension in water resources and irrigation are considered the weakest points in technology development and dissemination. Research efforts during the past three decades were devoted to irrigated agriculture. During this time priorities were not on rationalization of water in irrigation but rather screening for the highest yield per unit area under irrigated production systems.

Research under flood irrigation was on screening varieties and expanding the list of crops that could be grown under flood irrigation.

The low irrigation efficiency is the major problem in the mining of underground water in most water basins. The reasons of this problems are: the dominance of traditional irrigation methods (surface irrigation); water losses resulting from weak management of water at the field level; limited information on crop water requirement under the rainfed and irrigated production systems.

On the other hand, lack of incentives for rational use of water in irrigation complicated the matter and contributed to mining of underground water resources. The shared ownership of tube wells led to sharing of water on the basis of equal duration not as per crop requirements and cropping patterns.

It must be noted that fragmentation of land ownership and the scattered nature of fields in most households contributed to losses of irrigation water in traditional earth canals connecting fields located far apart.

The irrigation policy statements indicated the following priority issues in irrigation research and extension:

- Conduct research in crop water requirements; Irrigation scheduling; irrigation efficiency; modern irrigation methods and techniques; economics of irrigation
- Conduct research in genetic engineering; tissue culture techniques to develop resistant varieties to insect/pests and high yielding varieties per unit area and per unit water use.
- Strengthen linkages with International Institutions as well as local universities to benefit from their experiences in solving irrigation water problems.  
Develop joint programs with regional and international institutions in the field of increasing water use efficiency in irrigation water.

Discussion in the irrigation thematic group highlighted the following priority issues:

- Conduct research and socio- economic studies on cropping patterns, which might lead to reducing water use in irrigation.
- Conduct research on increasing soil water holding capacity under rainfed conditions.
- Study the effect of supplementary irrigation in increasing yield under flood and rainfed production systems.
- Introduce techniques, which help coping with salinity of irrigation water.

The above-mentioned priority issues are important in improvement of techniques applied in irrigation. They are also important in improvement of surface irrigation. The testing and dissemination of the technologies require a

strong, transparent research institution capable of responding to the changing circumstances and lifting incentives for underground water mining and increase the demand for improved technologies in irrigation. Equally important is the application of a tariff system in flood irrigation to ensure sustainability of irrigation structures maintenance.

The increased demand for improved technologies to economize water use will put pressure on NARS and other stakeholders for speedy introduction and adaptation of these technologies to the local conditions.

#### **4.2. Extension in Irrigation**

Despite the huge investments by the government and donor agencies in the establishment of extension agencies, the issues of water and irrigation remained marginal in extension activities. Extension recommendations in water and irrigation relied on farmers' experiences in irrigation scheduling. On the other hand, there was no information generated locally either by the research institutions or by the extension experts (working in development projects) on water and irrigation techniques to rationalize water use in irrigation.

The undermining of the importance of Irrigation Subject Matter Specialists in the structure of extension agencies is a clear example of ignorance of water in extension. It must be noted that SMSs in extension agencies covered most of agriculture production aspects except water and irrigation.

The overall environment in the early days of development and the dominance of subsidies for mining of underground water were not in favor of neither rationalization of water, nor the introduction of new technologies for water saving.

The termination of development projects and the limited funds provided by the government led to deterioration of government extension services to the extent of total or partial collapse of many extension agencies.

The revival of extension services in agriculture general and in irrigation and water mining in particular should be built on understanding recent developments in service provision in the agriculture sector. It must be acknowledged that, the list of extension service providers has expanded to include: the private companies in agriculture; individual extension agents who provide paid extension service (cash or in kind); retailers in the input supply outlets as well as farmers organizations<sup>12</sup>.

The presence of a wide range of extension service providers requires attention from MAI and AREA. Contacts with these categories of service providers should be strengthened. Problems affecting provision of sound services should be taken into consideration. Plans for support in capacity building and training should be launched to ensure sound advice provided to farmers by the different categories of service providers.

Government extension should be revived in line with the reform program and the outputs of "Agriculture 21 Agenda" in these respects, efforts should be exerted to create a strong and transparent national extension

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<sup>12</sup> Results of surveys carried out in Tihama, the Central Highlands and Seiyun in Hadramout indicated that the majority of farmers growing cash crops rely on retailers and private companies for advice followed by neighboring farmers. Farmers growing food crops rely on neighbors and elderly people in the village for advice. Extension came third and fourth in the sources of information for farmers.

institution to coordinate efforts of service providers and adopt extension problems at the national and local levels.

The role of extension in irrigation and rationalization of water use in agriculture will only be effective if beneficiaries spell out the demand for this service. This could happen only if subsidies for mining of underground water are lifted and farmers felt the high cost of pumping underground water.

The revival of the role of government extension should rely heavily on experiences generated and new approaches applied successfully under the Yemeni context. These approaches are based on the principles of participation and cost sharing. On farm testing of technologies in irrigation should be jointly implements and assessed by both researchers and farmers.

The Rapid Impact Program (RIP) proved to be a genuine approach in speeding up on farm testing and dissemination of technologies in a record time. This approach should be adopted dissemination of irrigation techniques and irrigation recommendations.

To speed up the technology transfer in irrigation it will advisable to benefit from the mass media network in order to reach a wider audience in a record time and complement on farm extension activities. This is very important in the case of dissemination of technologies and techniques in isolated and scattered locations in rainfed areas.

There is a big responsibility on AREA in assessment of current developments in extension, designing interventions and adopting practical approaches in technology dissemination. AREA should take a leading role in revising the extension strategy and in providing technical backstopping to different extension service providers in irrigation.

Annex (1) List of participants in the Irrigation Thematic Group

Annex (2) List of participants in the meeting with Minister (MAI)

Annex (3) Logical frame work for analysis of problems and potential solutions

Annex (4) Plan of action

Annex (5) Investment plan

Annex (6) Literature cited

***All annexes are being translated or under preparation***