ASSESSING CROP WATER PRODUCTIVITY FROM FIELD LEVEL TO NATIONAL SCALE, WITHIN IWRM FRAMEWORK

CASE STUDY IN JAHRAN AREA

[1]**Eng. Abdullah A. Ibrahim, Prof.Dr. Abdullah Babaqi, Dr. Abdulrhman Al-Eriani**
Prof.Dr. Wim Bastiaansseen

ASSESSING CROP WATER PRODUCTIVITY FROM FIELD LEVEL TO NATIONAL SCALE, WITHIN IWRM FRAMEWORK

CASE STUDY IN JAHRAN AREA

Background

Agriculture is a key sector in the Yemeni economy, it provides a main source of employment for 54% of the population. Agriculture produced 17.5% of Yemen's GDP in 2010 , according to the Central Statistics Office. Agriculture also plays an important role in food security, in improving the trade balance, and in efforts towards integrated rural development. In addition, the agricultural sector helps to stabilize the population by reducing internal migration and its related social and economic problems. The agricultural sector is also the key factor in natural resources management, it consume up to 90% of available water in Yemen annually.

Very reliant on food imports, which account for 62% of cereals consumption (2008), Yemen is also very vulnerable to external shocks. The global food crisis of 2007-8 led to steep rises in the cost of food and placed stress on the balance of payments. With the average Yemeni only 300 calories above hunger, domestic price rises pushed many more Yemenis into food insecurity. In 2000, Yemen used 10% of its export earnings to import food, by 2007 it was using 25%, representing a significant deterioration in its macro-level food security.

Increasing water scarcity and competition on the same amount of water from non-agricultural sectors drive the need to improve crop water productivity (ICWP) (more crop - per drop) to ensure adequate food for future generations with the less or same amount water than is presently available to agriculture. This must be achieved because there is a wide gap between actual and attainable crop water productivity, especially in rain-fed environments.

State of Groundwater Basins of Yemen

With the exciting water shortage that represent 26% and the need to provide irrigation water required to cultivated crops a huge number of illegal wells drilled every year all around Yemen out of governmental regulations. This disturbing of wells drilling and excessive groundwater extracting caused rapid annual groundwater level drawdown (figure 1) as in Sana'a (6-8 m), Tehama (1-3 m), Saddah (5-6 m), Amran (3 m), Taiz (1.75-2 m) and Abien (0.2-1 m)…et. (Bamaga and Weshali, 2011)

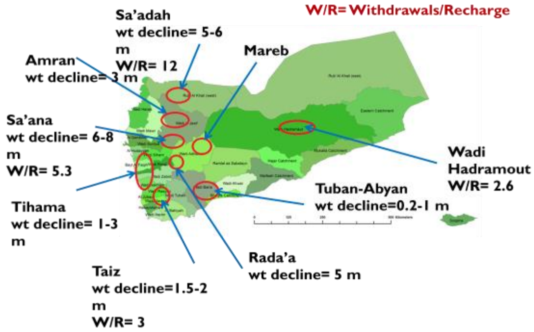

Figure 1 State of Groundwater Basins of Yemen

Agricultural production uses 93 percent of all water in Yemen, often in an unsustainable way

The remaining 7 percent of water is used by households (6 percent) and industry (1 percent). About half the agricultural land in Yemen is rain fed and an additional 10 percent of land is directly dependent on rainfall through flood irrigation. The remaining 40 percent of agricultural land is irrigated

Eng. Abdullah A. Ibrahim, Prof.Dr. Abdullah Babaqi, Dr. Abdulrhman Al-Eriani

from different sources, mainly groundwater wells (Figure 2).

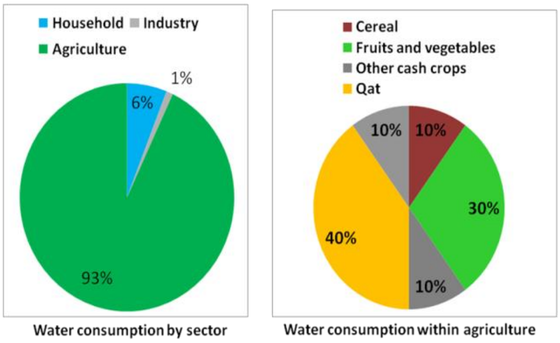

Figure 2 Water use and consumption by sector and agricultural subsector

Irrigation, and crop production

According to the HBS 2005–2006, the total annual cereal consumption of the Yemeni population is 3.2 million tons, of which only about 600,000 tons are locally produced. Fig. 3. Cereal consumption and production by governorate (in thousand tons) In other words, only about 27 percent of cereal consumption is met by local production. In all governorates cereal consumption is higher than production, so all governorates are net cereal importers. Even the population in the governorate with the highest cereal production, which is Al-Hodeida, consumes more than 2.5 times more cereal than it produces. Moreover, the high food insecurity means the demand for cereals is not met. For example, to supply the current Yemeni population with enough calories from wheat flour to meet its physiological requirements, the country would have to import 4.9 million tons of wheat every year, or about 13 times the total cereal production today.

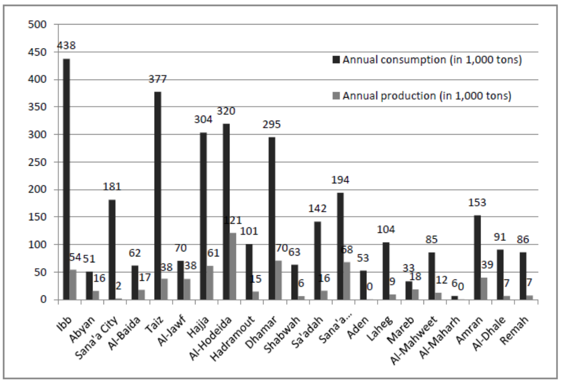

Figure 3 Cereal consumption and production by governorate (in thousand tons)

Water Productivity Concept

According to Molden (1997), identify the water Productivity in general terms, as a ratio between a unit of output and a unit of input. Water productivity broadly denotes the outputs (goods or services) derived from a unit volume of water.

Water productivity is the physical mass of production or the economic value of production measured against gross inflows, net inflows, depleted water, process depleted water or available water, whereas at basin level, water productivity spans multiple uses and sectors: crop production, livestock production, tree production, fisheries production, ecosystem services, domestic, industrial, power generation, tourism and recreational, and he added that there is no definition that suits all situations .

Results and Discussion

1. Physical water productivity

Fig. 4 shows the results of CWP for some different crops of cereals such as wheat, maize , and vegetables such as potatoes and tomatoes in irrigated farming conditions of the study area under traditional open channels conveyance system compared to the improved pipes conveyance system, where the study results show that in general the CWP in improved pipes conveyance system is better than CWP in open channel conveyance system. Where found that (1m^3) of water given (0.6kg) wheat, (0.59kg) maize, (3.1kg) potatoes and (2.9kg) tomatoes , under improved pipes conveyance system. While (1m3) of water given (0.4kg) wheat, (0.4kg) maize, (2kg) potatoes and (2.2kg) tomatoes, under open channel irrigation system as shown in the following figure:

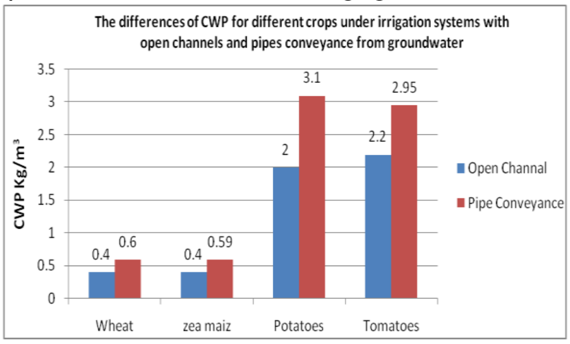

Figure 4 The differences of CWP for different crops under irrigation systems with open channels and pipes conveyance from groundwater in the studied area.

Table 1 shows that the increase percentage in the CWP for various crops under pipes conveyance system are 33% of wheat, 32% of maize, 35.5% of the potatoes, and 25% of the tomatoes, with an average estimation of 31.6% for the piped conveyance system, compared to traditional soil unlined open channel conveyance system.

Table 1 The differences of CWP under studied irrigation methods in Qa Jahran

Cropping pattern	CWP (kg/m3) under different irrigation methods		CWP gains %
	Open channel	Pipes conveyance	
Wheat	0.4	0.6	33.3
Maize	0.4	0.59	32.2
Potatoes	2	3.1	35.5
Tomatoes	2.2	2.95	25.4
Mean			31.6

2. Irrigation water saving

Figure 5 show the irrigation water saving results that obtained for various crops in Qa'a Jahran in irrigated agriculture conditions, under piped conveyance system and Traditional open channels system. Where found that percentage of irrigation water saving under piped system vary between (23.2% and 30.8%), with average saving (26.3%) compared to open channels as is evident in the following figure

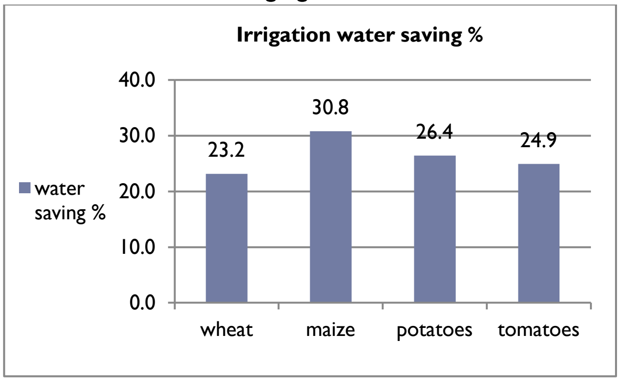

Figure 5Irrigation water saving under irrigated agriculture with pipes conveyance system use %

3. Economic Water Productivity under different irrigation systems

Figure 6 clear that the economic values of water productivity in irrigated agriculture conditions, under pipes conveyance give higher values than economic values for WP in open channels with increase percentage 32%, 23%, 36%, 25% for wheat, Maize, Potatoes and Tomatoes respectively, with an average estimation of 29%.

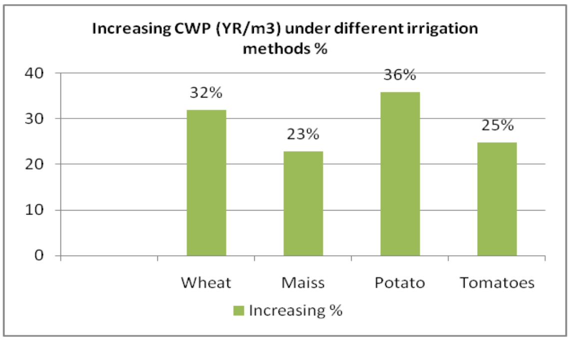

Figure 6 Increasing CWP (YR/m^3) under different irrigation methods %

4. Another economic benefits of pipes conveyance system use

Savings in diesel consumption and pumping hours: One of the important economic benefits to the farmers adopting improved irrigation systems was in saving diesel use with percentage 18% comparison with traditional open channels systems. The saving in diesel use is come as a result for reduce the pumping hours operation.

Savings in labor hours: The interviewed farmers in the study have indicated that there is saving in labor hours as a result of improving the irrigation water management on field level. According to water saving report (GSCP, 2011), mentioned that the saving in labor hours is 15% in the improved irrigation system. The labor savings come partly from the reduced time at the pump but even more in reducing the time which takes to fill and maintenance the soil channels.

Improve in income : The interviews results clarify with all farmers which adopting improved irrigation system that there is clear improving in their income, resultant to increase CWP, reduce the production costs and increase the return, the improve in income was 38.6% such as clear in table 2.

Economic benefits of pipes conveyance system use

Economic benefits	Ave. Percentage %
Increase in crop yield	8
Saving in irrigation water	26.3
Saving in pumping hours	26.3
Saving in labor hours*	15
Saving in diesel consumption	26.3
Improve in income	38.6

Recommendations

Crop water productivity depends on several factors these factors have to be managed properly for increasing of the CWP through:

Irrigation Water-management improvement

-Use of modern water management technologies lead to improving the irrigation efficiencies and ICWP.

-Adding water harvest and storage facilities (reservoirs, small tanks, ponds on farmers' fields, and soil moisture storage) so that more water is available when it can be more productively used.

-Supplemental irrigation with a limited amount of water, if applied to rain-fed crops during critical stages, can result in substantial improvement in yield and WP. Application of water to satisfy less than the full water requirement of crops was found to increase WP and spare water for irrigating new lands. But this require to high experience availability for farmers.

-Using deficit, or precision irrigation to achieve higher yields per unit of water, and spare water for irrigating new lands especially when combined with other management practices

-Lessening nonproductive evaporation by mulching, enhancing soil infiltration and storage properties, enhancing canopy cover, subsurface drip irrigation, matching planting dates with periods of less evaporative demand, and reducing evaporation from fallow land and high water tables by decreasing areas of exposed water surface and decreasing vegetation (weed control).

Soil management improvement

Optimizing soil characteristic with agricultural practices that promote soil fertility and reduce salinity such as dependence on organic fertilizers.

Crop management improvement

-The orientation towards using both Mendelian breeding techniques and modern genetic engineering, new crop varieties that can increase water-use efficiency.

-Drought-tolerant crops varieties will help save water under irrigated conditions and reduce the need for supplemental irrigation under rainfed conditions. And varieties that tolerate water shortage will reduce the negative impact of on yields.

The agricultural processes and Inputs

-Optimizing agricultural practices and inputs, such as pests and diseases control, weed control, improved seeds, and fertilization, can increase WP.

Activation of the participatory management principle:

-Participation of all concerned in the management of scarce water resources is the key to successfully implementing more effective measures of water management. Players include the public and private sectors but, most importantly, representatives of the water users, particularly farmers, should be involved in the decision-making on water-management issues. Without appropriate policies, users cannot achieve the objectives of effective water management, but the inadequacy of current policies is the main constraint on improved water use in the region.

-However, more work is needed to integrate all the above-mentioned approaches in practical packages to achieve the largest return from the limited water available.