Mainstreaming gender dimension in water management for food security and food safety, country paper: Egypt

Aboul-Fotoh N.Z., Abdin A.E., Salem S.A.

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MAINSTREAMING GENDER DIMENSION IN WATER MANAGEMENT FOR FOOD SECURITY AND FOOD SAFETY, COUNTRY PAPER: EGYPT

N. Aboul-Fotoh*, A. E. Abdin and S. A. Salem*****
* Director, Strategic Research Unit, National Water Research Center, Egypt.
Email: n_abouelfotouh@nwrc_eg.org
** Research Association Professor, Strategic Research Unit, National Water Research Center, Egypt.
*** Research Association Professor, Research Institute for Agriculture Economy

Abstract - Water scarcity is currently threatening any country's development worldwide and its national food security and food safety, including Egypt. Therefore, Integrated Water Resources Management (IWRM) is considered a must towards national development. Successful implementation of IWRM requires full cooperation among all social categories (men and women). Therefore, lot of attention should be paid to involving men and women as gender dimension in the water management process for food security and food safety.

The current study investigates the important role of women in water management from different perspectives towards food security and food safety. Specifically, this role is analyzed through women's participation in food consumption and production in relation to irrigation water management. In addition, women's role in food distribution and processing is also presented through their responsibility for food waste. On the other hand, the current constraints of rural women to participate more actively in water management towards food security and food safety are profoundly identified.

The results of the current study showed that women are currently participating in water management through various activities, although they are currently facing some social, political, educational, economical, cultural, health, and institutional obstacles. Therefore, the current study has listed some recommendations to improve women's water management capabilities and capacities towards better and sustainable food security and food safety.

INTRODUCTION

Successful implementation of the Integrated Water Resources Management (IWRM) concept is the only available path to face the current and future water scarcity challenges. Water scarcity is not only affecting national development projects but also national food security and food safety. Therefore, all the categories of the society should cooperate and combine their efforts towards its successful implementation. Consequently, women's full participation into water management and food security can be considered as an urgent need. Several previous studies have been conducted to identify women's role and responsibility in the Egyptian society in general, and specifically in the water sector towards better food security.

WOMEN'S ROLE AND RESPONSIBILITY IN THE EGYPTIAN SOCIETY

Several studies have investigated women's role and capacities in the Egyptian society from different perspectives and not only in relation to water management. Sadek and Tolba (2005) examined the socio-economic factors that affect the role of rural women in human development in Fayoum governorate. The authors conducted their study through field questionnaire with a sample of 100 women responsible for their families. The results of their study showed that there was a quality gap in women's capacities in certain fields such as labor force, education, and health. Therefore, this study recommended the development of comprehensive plans and programs intended to decrease the above-mentioned quality gap. Zakaria and Ahmed (2004) presented a study aiming at measuring the impacts of the most important socio-economic factors on the family income of which women are the sole providers in Behaira governorate. This study has been conducted through field data collection among a sample of women from the pilot area. Some key elements were identified such as the age categories, educational status, number of children, children's educational level and contribution to family income, family income source, the reasons why women are the sole family providers,

agricultural land size, the type of work carried out by women, and their social participation and cultural level. The results of the study revealed that there is a significant relationship between the family income and age categories, women's and children's educational level, source of income, and the type of work taken on by women. Thereafter, the authors presented certain recommendations to improve women's family income such as providing women with different types of credit, involving and supporting them with different types of small projects, and updating their structured database towards identifying their basic needs. Fayek (2004) investigated the impact of women's education on their health and status. He used various data on women collected from published human development reports at national level. In addition, the author developed statistical analysis techniques for the different collected data in order to achieve the study's objective. The results of this study showed that the educational level had an impact on the percentage of women in scientific and technical professions, management and organization activities, and in the government and public sector. In addition, the results showed that there was a powerful correlation between women's educational level on one side and their health and status on the other side in 2001 compared to the 1990s. Shareef et al (2004) conducted a study to identify some social factors affecting the degree of political participation of rural women in Qalubia governorate. The study adopted the methodology of field data collection through an interview questionnaire during the period between December 2003 and March 2004 with a total sample of 310 women. The study results revealed that most of the interviewees fell in the lowest category with reference to the political participation scale (87.4%), and the most important social factors affecting this situation were age, education, marital status, political socialization, ….etc. The main obstacles hindering women's participation in the political sphere were the lack of women's political awareness and of sufficient time due to the nature of their work, and finally the lack of interest in politics. El-Bana (2000) examined the analytical economic aspects of the role of rural women in the Egyptian agricultural production. The study was conducted in 70 villages in 7 governorates, and adopted the methodology of field data collection through a questionnaire from 350 agricultural families. The study revealed that women's contribution to land preparation and irrigation reached 100%, while their contribution to crop harvesting only 33%. This was more noticeable in the small-size farms than in the large ones.

In the light of the previous literature review it is quite clear that gender equality in all social activities, especially in agriculture and irrigation, is very important and should be promoted, formalized, regulated, and directed towards better water management. Successful implementation of IWRM guarantees food security and food safety and consequently ensures national development all over Egypt.

Food Security

Within the context of the current research, it is very important to highlight the exact definition of food security. According to the 1996 World Food Summit, food security at the individual, household, national, regional, and global levels is achieved when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preference for an active healthy life.

Food Safety

According to FAO (2003), food safety is obtained through the protection of human life and health from food-borne risks arising from additives, contaminants, toxins, or disease-causing organisms in foods and beverages.

These definitions highlight the vital importance of safe and high quality agricultural production and rational food consumption behavior towards achieving the main pillars for food security and food safety. These two issues are mainly dependent on the management level of different water resources. Achieving high level of food security in Egypt requires the full participation of both men and women.

Therefore, the study presented in this paper investigates, in a detailed fashion, the current women's participation level and role in water management in food consumption and production towards improving food security and safety status. In addition, the obstacles hindering the improvement of women's participation in water management from different perspectives are presented. On the other

hand, several recommendations to improve women's capabilities and capacities towards better and sustainable water management and food consumption are also illustrated.

METHODOLOGY

The following technical methodology is adopted, as shown in figure 1, to successfully examine women's participatory role in water management towards the improvement of Egypt's national food security and food safety,. Women deal with water through different aspects in the agricultural and food sectors as described in figure 1:

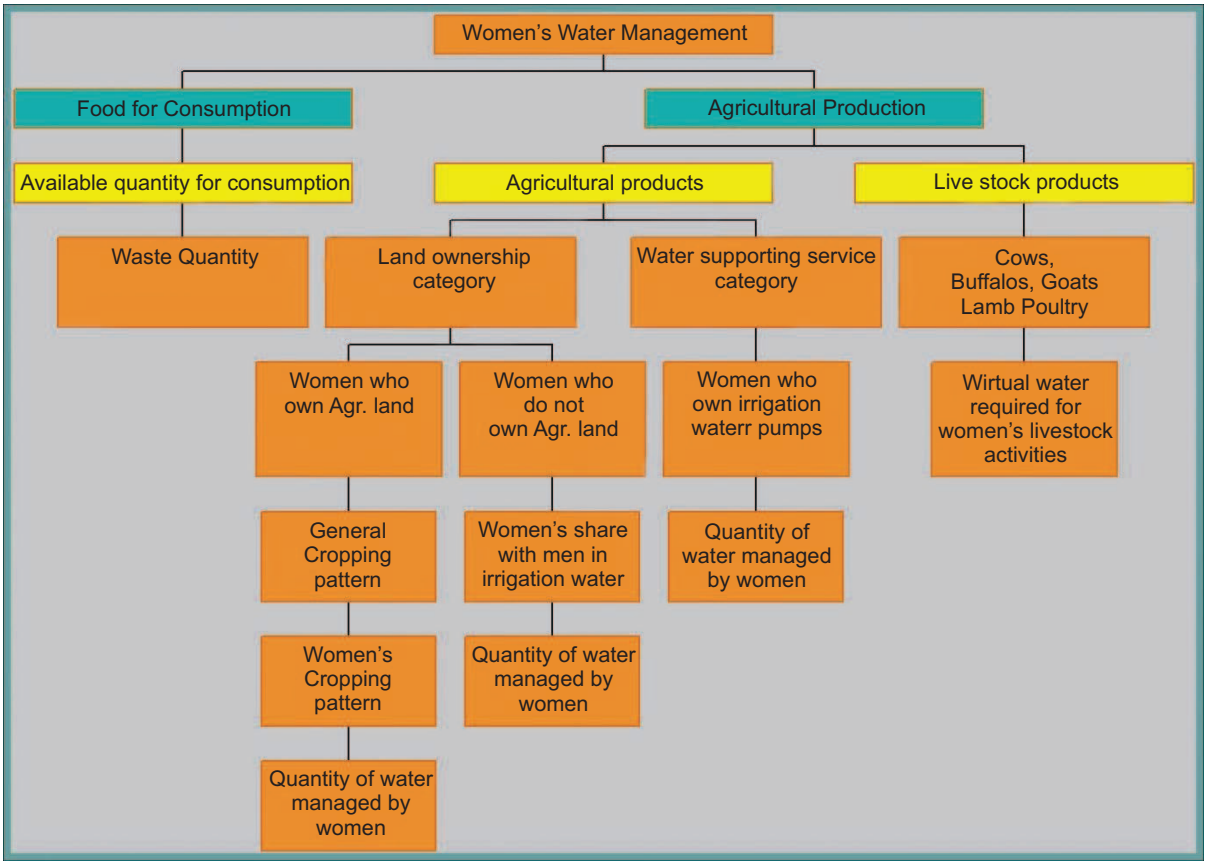

Fig. 1. Schematic diagram for women's role in water management in food consumption and agricultural production

Food Consumption

To examine women's participatory role in food consumption, the current study uses the available water quantity for food consumption and waste to evaluate first the wasted virtual water at the national level as presented in Eq. (1) :

$$WVW = \sum_{i=1}^{n} \frac{W_i}{Y_i} * WR_i \quad (1)$$

where:
WVW = Wasted Virtual Water at the national level for all crops,
W_i = Waste from crop i at the national level,
Y_i = Yield per feddan of crop i,
WR_i = Water Requirement per feddan of crop i and
n = Number of investigated crops.

It is probably worth mentioning that W_i represents the waste from crop i women are responsible for according to the information presented in the results and discussion section.

Agricultural Production

Women's participation in water management through agricultural production is determined through the following sub-aspects: agricultural and livestock products.

Agricultural Products

Women deal with water in the context of land ownership and irrigation water support services. The first category (land ownership) includes women who own agricultural land and women who do not own and share the responsibilities with their husbands. The second category (irrigation water support services) includes women who own irrigation pumps and participate in the irrigation processes.

1. Land ownership category

The current study deals with each of these two sub-categories differently since their degree of participation in water management is different.

- Women who own agricultural land

As regards this sub-category, the current study uses the general cropping pattern for each governorate in order to estimate the relative importance of each crop which is estimated using Eq. (2) as follows:

$$RI_i = A_i * 100 / TA \quad (2)$$

where:
RI_i = Relative Importance of crop i in each governorate,
A_i = Area cultivated with crop i in each governorate and
TA = Total cultivated Area in each governorate.

Women's cropping pattern in each governorate is evaluated using Eq. (3) as follows:

$$WA_i = RI_i * WOA \quad (3)$$

where:
WA_i = Women Cultivated Area with crop i in each governorate and
WOA = Women Ownership Area in each governorate.

The water requirement for women who own agricultural land can thereafter be evaluated using Eq. (4) as follows:

$$WWR_i = WA_i * WR_i \quad (4)$$

where:
WWR_i = Women Water Requirement for crop i in each governorate and
WR_i = Water Requirement to cultivate one feddan of crop i in each governorate.

The total water requirement for women who own agricultural land at the national level is evaluated using Eq. (5) as follows:

$$TWWR = \sum_{i=1}^{n} \sum_{j=1}^{k} WWR_{i,j} \quad (5)$$

where:
TWWR = Total Women Water Requirement at the national level and
$WWR_{i,j}$ = Women Water Requirement for crop i and governorate j.

- Women who do not own agricultural land

Women's participation is evaluated through the percentage of their participatory share in irrigation activities. Therefore, Eqs (3) and (4) are applied for the men category to evaluate what is called MWR_i which refers to men's water requirement for crop i. Thereafter, the collected data on the percentage of

women's participatory share in irrigation activities, from Mansour (1994), is utilized to evaluate their participatory water share at the national level:

$$WPW = \sum_{i=1}^{n} PWS_i * MWR_i \quad (6)$$

where:
WPW = Women's Participatory Water share for all crops,
PWS_i = Percentage of Women's Share in irrigation activities for crop i and
MWR_i = Men Water Requirement for crop i.

Here, it is probably worth mentioning that Mansour (1994) is the latest publication that addressed this issue.

2. Water support service category

Within this category, women participate in water management through their irrigation pumps that support the different irrigation activities. To evaluate women's participatory water share, the number of pumps owned by them was utilized as follows:

$$TWWSS = \sum_{i=1}^{N} NP_i * APC * NWH * NWD \quad (7)$$

where:
TWWSS = Total amount of Women's Water within the Support Services category,
NP_i = Number of Pumps owned by women in each governorate i,
APC = Average Pump Capacity all over the country (assumed to be 50 m^3/hr for 7 horsepower pumps),
NWH = Number of Working Hours per day (assumed to be 8 hours per day) and
NWD = Number of Working Days (assumed to be 200 days per year).

Livestock Products

It is very important to evaluate women's virtual water share for the livestock products according to figure 1. The mathematical procedures for this estimation can be presented as follows:

1. Evaluate the percentage of women who own different types of animals with respect to the total number of these animals at the national level:

$$PW_i = \frac{NA_i}{TN_i} * 100 \quad (8)$$

where:
PW_i = Percentage of Women who own animal i,
NA_i = Number of Animals i owned by women at the national level,
TN_i = Total Number of animals i at the national level and
i = Type of animal according to figure 1. (Caws, Buffalos, Goats, Lambs, and Poultry).

2. Evaluate the total virtual water for the total number of slaughtered animals at the national level:

$$TVW_i = TP_i * VW_i \quad (9)$$

where:
TVW_i = Total Virtual Water from slaughtered animals i,
TP_i = Total meat Production from the slaughtered animal i and
VW_i = Virtual Water required to produce one ton of meat from the slaughtered animal i.

3. Evaluate women's share in the total livestock virtual water by multiplying results of Eq. (8) by results of Eq. (9):

$$WVW_i = TVW_i * PW_i \quad (10)$$

where:
WVW_i = Women's Virtual Water.

Collected Data Types

Throughout the implementation of the methodology presented in figure 1, the following types of data are collected:

- Winter and summer cropping patterns in each governorate;
- Agricultural areas owned by women in each governorate;
- Livestock owned by women in each governorate;
- Irrigation pumps owned by women in each governorate;
- Available food consumption at the national level;
- Estimates of food waste at the national level;
- Virtual water requirement for food production;
- Women's employment at governorate level according to age categories and educational level;
- Percentage of women's participatory share in irrigation activities;
- Water requirement for agricultural production.

RESULTS AND DISCUSSION

The methodology described in the previous section is implemented in the same sequence described in figure 1 to evaluate women's participatory water share in all irrigation and agricultural practices in Egypt. This identification is considered a prerequisite process towards gender mainstreaming in integrated water resources management (IWRM) and a better status for food security.

Food Consumption

In this section, wheat and maize crops are given as examples in order to examine women's role in food consumption and their responsibilities for the food waste and associated virtual water at the national level. This section was included due to the following several factors:

1. According to Egyptian food balance sheet, wheat represents 25% of total daily food and 55% of total coarse grain consumption.
2. According to el-Khateib (2006), wheat represents 37% of total calories per capita.
3. According to the Egyptian government policy, Maize comprises 20% of total flour produced to subsidize bread.

Actual availability of wheat and maize flour in egypt

El-khateib (2006) stated that the actual Egyptian consumption of wheat and maize is 12 and 0.5 million tons respectively. Among these quantities, 5 and 0.5 million tons of wheat and maize respectively, are utilized to provide subsidy for bread. On the other hand, 4 and 3 million tons of wheat are directed towards producing unsubsidized bread and macaroni respectively. The current study is focused on food consumption and waste computations on the subsidy share from wheat and maize.

Waste estimates for wheat and maize crops

Several studies have been carried out to determine the percentage of waste within the food consumption of wheat and maize used for producing subsidized bread,. Aisawy (1985) stated that the bread waste was 6.4% and 7.8% for urban and rural areas respectively. However, El-Gundy (1995) stated that the wheat waste was 35% for the local wheat and 4% for the imported one. On the other hand, El-khateib (1996) stated that the bread waste as a result of bad industries was between 16% and 20%. Two scenarios are adopted in the current study: the first one assumes that wheat and maize wastes are 20% while the second assumes that these wastes are 5%. These assumptions were selected to determine the maximum and minimum level of virtual water derived from waste.

Waste estimate for virtual water

To determine the wasted virtual water, Eq. (1) is applied to the collected data using the two scenarios described in the previous section. The results are presented in table 1 as follows:

Table 1.Total virtual water waste as a result of Wheat and Maize consumption

	Production(tons)	Waste percentage from consumption	Consumed quantity (tons)	Waste quantity (tons)	Ton/fed	No. of wasted feddan	Water req./fed (m^3)	Total wasted virtual water (m^3)
Scenario 1								
Wheat	5000000	0.2	4000000	1000000	2.67	374531.8	1698	6.36E+08
Maize	500000	0.2	400000	100000	3.36	29761.9	2912	86666667
Total								722621723
Scenario 2								
Wheat	5000000	0.05	4750000	250000	2.67	93632.96	1698	1.59E+08
Maize	500000	0.05	475000	25000	3.36	7440.476	2919	21666667
Total								180655431

The different columns in table 1 show the different steps in applying Eq. (1) for the computation of the total wasted virtual water. Figure 2 shows the results of the two scenarios. The total wasted virtual water of the Wheat and Maize waste from bread consumption, is 0.7 and 0.18 billion m^3 respectively for the two identified scenarios (maximum and minimum). Generally, many factors contribute to the waste from industries, transportation, handling, and home manufacturing. Therefore, it can be correctly assumed that the minimum scenario for wasted water (0.18 billion m^3) is the one produced from home manufacturing and is consequently the responsibility of women. This result shows the urgent need for improving women's home manufacturing and handling of bread to save this amount of wasted water.

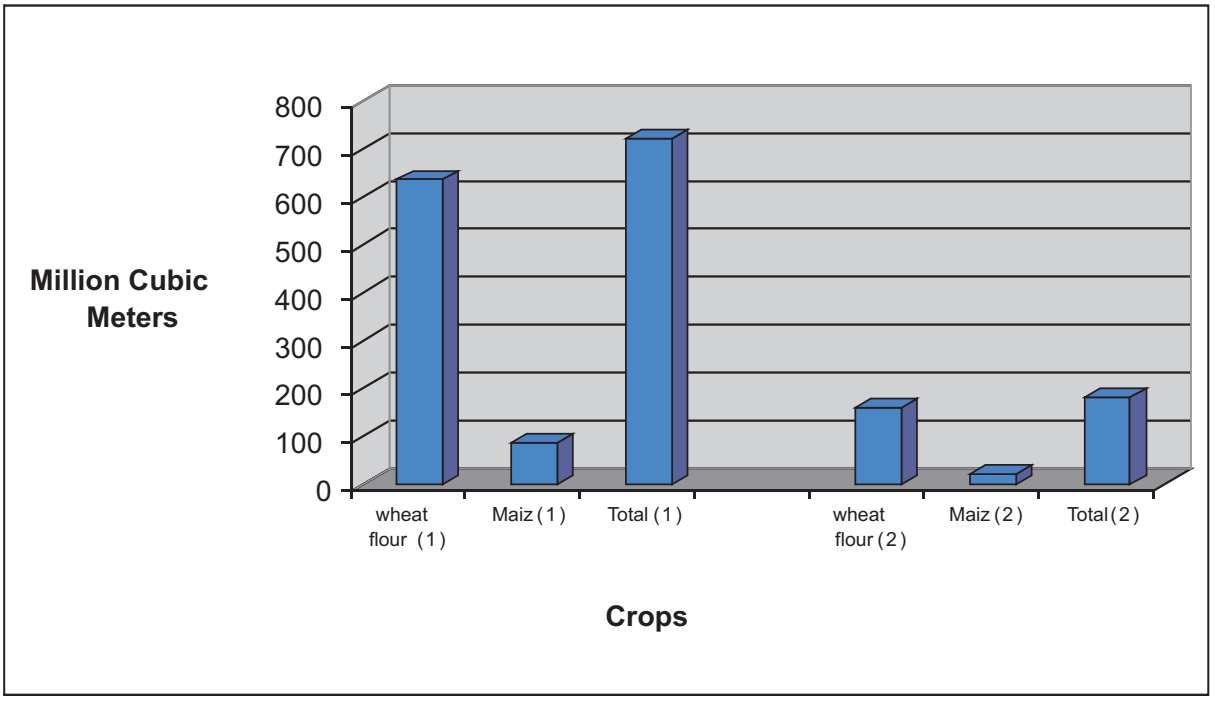

Fig. 2. Waste virtual water estimates from wheat and maize consumption for the two scenarios maximum (1) and minimum (2)

Agricultural Production

Women's role and participation in water management is evaluated at the national level as follows:

Agricultural Products

As described previously, there are two main areas of water management, land ownership and water support service, where women participate. The mathematical formulation is described as follows:

1. Land ownership category

Within this category, women participate in water management in two main areas, namely, women who own agricultural land and women who do not own any land.

- *Women who own agricultural land*

Equations from (2) to (5) are applied for the various collected data regarding all cultivated crops in the different seasons: Nili, Summer, and Winter seasons at governorate level to cover the entire nation of Egypt. Results of women's participation in water management in the winter season are presented in table 2 and figure 3 spatially distributed over Lower, Middle, Upper, and New Egyptian Lands for all the crops cultivated by women.

Table 2. Average water managed by women who own agricultural lands in the winter season between 2001-2004 (m^3)

	Location				
Crop	Lower Egypt	Middle Egypt	Upper Egypt	New Lands	Total
Long Clover	302	71	32	1	407
Wheat	167	54	43	6	270
Barely	3	1	1	9	13
Broad Bean	28	2	2	1	32
Fenu-greak	0	1	0	0	2
Check Peas	0	0	1	0	1
Winter Potato	10	1	0	0	11
Winter Tomato	9	7	6	1	23
Garlic	0	2	0	0	2
Sugar Beat	17	1	0	0	19
Flax	2	0	0	0	2
Onion	5	3	1	0	8

Source: MALR, Economic Affairs Sector, Central administrative of Agricultural Economics, Agricultural Economic Bulletin, 2004

Table 2 shows that women manage the largest water quantity for Long Clover and Wheat crops that is equal to 407 and 270 million cubic meters respectively in the winter season. In addition, women manage water in Lower Egypt more than in any other locations. This fact can be justified according to the successful implementation of the inherited system in the Lower Egypt area that allowed them to own agricultural lands.

On the other hand, Long Clover and Wheat are the main dominant crops cultivated in the winter season; therefore, their cultivated areas are much higher than other crops. As regards women water management in New Lands, it is clear that their participation in water management is very minimal in most of the crops. This is mainly due to the fact that women are usually not capable of moving to New Lands due to family constraints.

Table 3 shows the results of women's participation in water management during summer spatially distributed over Lower, Middle, Upper, and New Lands for all the crops cultivated by women.

Table 3. Average amount of water managed by women who own agricultural lands in the summer season between 2001-2004 (m^3)

	Location				
Crop	Lower Egypt	Middle Egypt	Upper Egypt	New Lands	Total
Maize	255	126	45	3	429
Sorghum	0	17	33	1	50
Rice	731	9	0	7	748
Peanut	10	6	2	3	20
Sesame	2	4	8	0	14
Soya bean	0	3	0	0	3
Onion	2	2	0	0	4
Sun Flower	1	5	1	0	7
Yellow maize	11	0	10	0	21
Summer Potato	13	3	0	0	16
Summer Tomatoes	20	8	1	7	37
Cotton	134	26	5	0	164

Source: MALR, Economic Affairs Sector, Central administrative of Agricultural Economics, Agricultural Economic Bulletin, 2004

By examining table 3 and, it is clear that Rice, Maize and Cotton are considered the main crops cultivated by women in the summer season. As to the amount of water managed by women, Rice crop represents the highest crop cultivated by women (more than 50% of water managed by women). Specifically, women manage 731 million cubic meters of water in Lower Egypt for Rice crops compared to 9 and 7 million cubic meters in Middle and New Lands respectively. This can be due to the fact that Rice is not heavily cultivated in locations other than Lower Egypt. In addition, the high quantity of water for Rice is not only due to its cultivation by women but also to its high water consumption value.

With regard to the Nili season, table 4 and shows the results of women's participation in water management spatially distributed over Lower, Middle, Upper, and New Lands for all the crops cultivated by women.

Table 4. Average water managed by women who own agricultural lands in the nili season between 2001-2004 (m^3)

	Location				
Crop	Lower Egypt	Middle Egypt	Upper Egypt	New Lands	Total
Maize	309	62	43	4	418
Sorghum	0	5	0	0	5
Rice	1	0	0	0	1
Onion	0	16	23	0	39
Yellow maize	63	0	6	0	70
Nili Potato	67	46	11	1	125
Nili Tomatoes	31	19	10	6	66

Source: MALR, Economic Affairs Sector, Central administrative of Agricultural Economics, Agricultural Economic Bulletin, 2004

It is clear that women managed the largest quantity of water during the cultivation of Maize. This is due to the fact that Maize is very common to be cultivated in the nili season due to its short cultivation period besides its comprehensive usage in feeding animals and poultry.

- *Women who do not own agricultural land*

Eq. (6) is applied for the collected data concerning all crops in the different seasons: nili, summer, and winter seasons at governorate level to cover the entire nation of Egypt. Results of women's participation in water management in winter irrigation activities are presented in table 5 spatially distributed over Lower, Middle, Upper, and New Lands.

Table 5. Average water managed by women through their participatory role in winter activities between 2001-2004 (m^3)

	Location				
Crop	Lower Egypt	Middle Egypt	Upper Egypt	New Lands	Total
Long Clover	1360	414	326	15	2116
Wheat	827	325	461	74	1687
Barely	18	5	4	125	152
Broad Bean	74	5	10	4	93
Winter Potato	18	3	0	0	22
Winter Tomato	14	12	15	4	46
Suger Beat	31	2	0	0	33
Onion	6	5	3	0	14

Source: MALR, Economic Affairs Sector, Central administrative of Agricultural Economics, Agricultural Economic Bulletin, 2004

Table 5 reveals that Long Clover and Wheat are considered by men the best crops to cultivate during winter and consequently women's participatory water share is the highest in these two crops compared with the other crops cultivated in winter. The results also show that women manage about

3.8 billion m³ of water for only Long Clover and Wheat as a result of their participatory involvement in irrigation activities.

As regards the summer season, the amount of water that women manage as a result of their participatory involvement in irrigation activities according to men's cropping pattern spatially distributed over Lower, Middle, Upper, and New Lands is shown in table 6.

Table 6. Average water manageg by women through their participatory role in the summer activities between 2001-2004 (m^3)

	Location				
Crop	Lower Egypt	Middle Egypt	Upper Egypt	New Lands	Total
Maize	849	527	350	37	1763
Sorghum	0	82	284	4	371
Rice	6131	112	0	153	6396
Peanut	13	7	4	8	33
Sesame	4	7	20	1	32
Soya bean	0	5	0	0	5
Onion	12	15	0	0	27
Sun Flower	3	9	4	1	17
Yellow maize	22	0	68	0	91
Summer Potato	18	6	0	0	25
Summer Tomatoes	37	16	0	28	81
Cotton	437	97	0	1	535

Source: MALR, Economic Affairs Sector, Central administrative of Agricultural Economics, Agricultural Economic Bulletin, 2004

The results presented in table 6 show that women managed 9.4 billion m³ of water through their participatory role in irrigation activities during summer. It can be observed that women's share of managed water is the largest for the Rice crop (6.4 billion m³), since Rice is heavily cultivated during the summer season and it is the most preferred crop by men due to its high profitability. In addition, it is intensively cultivated in the Lower Egypt area due to its high water requirement that is needed to balance the salt water intrusion from the Mediterranean Sea. On the other hand, women manage 1.763 billion m³ of Maize crop. This crop is also preferred by farmers since it is used in bread industries, oil manufacturing, and feeding animals and poultry. On the contrary, water managed by women for Maize is distributed all over the country with little amounts in New Lands. Women's contribution to the other crops presented in table 6 is smaller because of their limited cultivation areas.

With respect to the nili season, the amount of water that women manage as a result of their participatory role in irrigation activities according to men's cropping pattern spatially distributed over Lower, Middle, Upper, and New Lands is presented in table 7.

Table 7. Average water managed by women through their participatory role in the nili season activities between 2001-2004 (m^3)

	Location				
Crop	Lower Egypt	Middle Egypt	Upper Egypt	New Lands	Total
Maize	981	293	292	36	1603
Sorghum	0	22	1	0	23
Rice	14	1	0	0	15
Onion	0	80	285	0	365
Yellow maize	331	0	40	0	371
Nili Potato	105	84	54	4	246
Nili Tomatoes	50	36	27	22	135

Source: MALR, Economic Affairs Sector, Central administrative of Agricultural Economics, Agricultural Economic Bulletin, 2004

Table 7 shows that women manage 2.8 billion m³ of water in the nili season through their participatory role in the irrigation activities. Specifically, women manage most of the water for the cultivation of Maize and yellow Maize crops (1.97 billion m³). This is particularly due to the intensive cultivation of these two crops in the nili season which is normally considered as a late summer season. As regards the spatial distribution, women manage the most quantity of water in the Lower Egypt area. This is due to the large cultivated area in this region and the prevailing culture that allows women to perform different types of activities. As regards the participation of women in water management in Upper Egypt, it can be observed from the results presented in table 7 that Onion crop is ranked the second after Maize for the amount of water that women manage, since it is intensively cultivated in Upper Egypt as compared to other locations. Therefore, in that area women are found to manage 0.3 billion m³ of water for Onion crop.

2. Water support service category

Within this category, women participate in water management since they own irrigation pumps to support the different irrigation activities. Eq. (7) has been applied to the different collected data in order to evaluate the quantity of water managed by women. The results of the amount of water managed by women spatially distributed all over the different regions in Egypt are presented in Fig. 3.

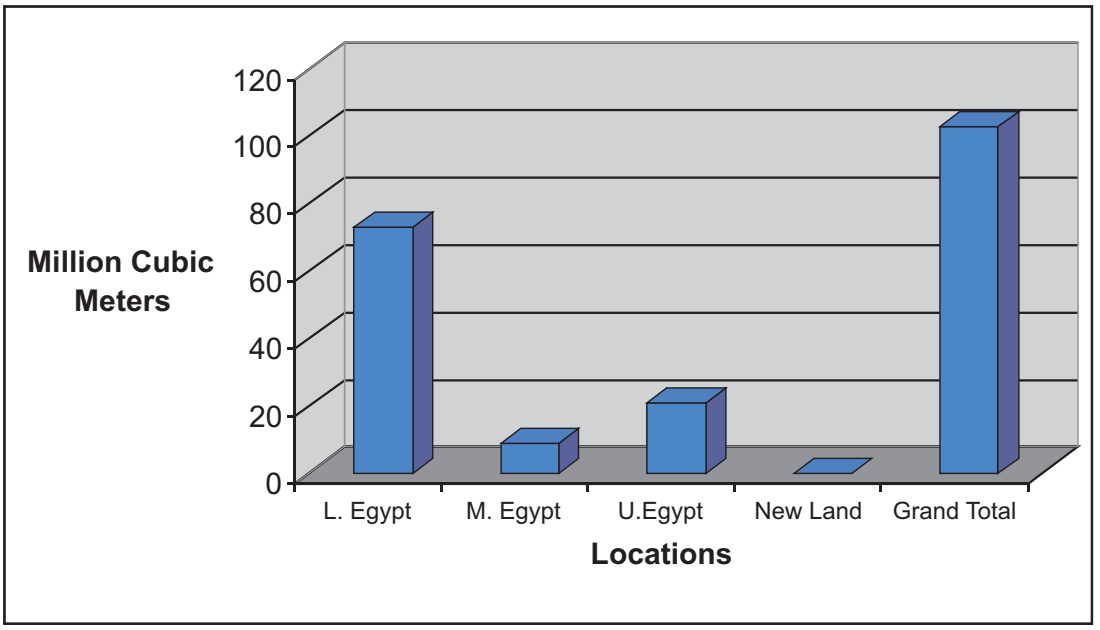

Fig. 3. Water quantity managed by women through their own irrigation pumps

It was found that women manage a total of 103 million m³ of water through their own irrigation pumps. Figure 3 indicates that Lower Egypt is ranked the first among the different regions in Egypt where women can participate in water management since the culture allows them to own irrigation pumps and use them as a source of income.

Livestock Products

In this case, Eqs. (8-10) are applied to the collected data to evaluate women's water share. The results of the amount of water managed by women for the livestock production spatially distributed over the different regions in Egypt are presented in Fig. 4.

Figure 4 shows that women manage a total of 485 million cubic meters of water through their activities within the different types of livestock production. This water is mainly consumed by Buffalos, Cows, and Poultry because they constitute the main common source of meat for the entire Egyptian population. It is probably worth mentioning that the main animal breeding activity for rural women is

Poultry. However, the virtual water managed by women for Poultry is less than that for Buffalos and Cows. This is due to the fact that the virtual water for poultry is 3809 cubic meters per ton compared to 16726 cubic meters per ton for Buffalos and Cows.

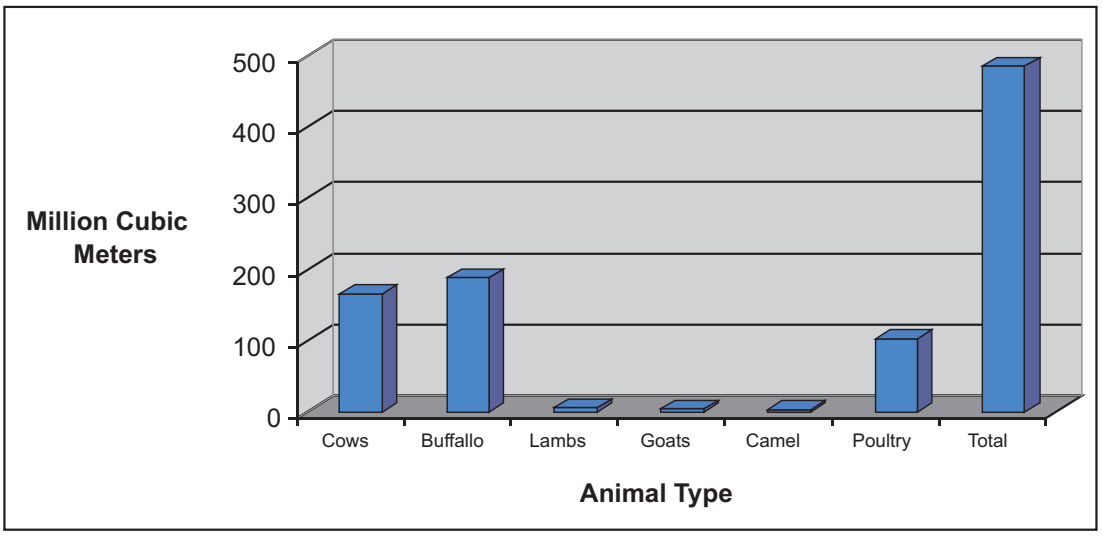

Fig. 4. Amount of virtual water managed by women through the Livestock production

Total Water Managed by Rural Women in the Agricultural and Irrigation Sectors for Agricultural Production

Data analysis in figure 5 shows the total amount of water managed by women in their different categories in the agricultural and irrigation sectors.

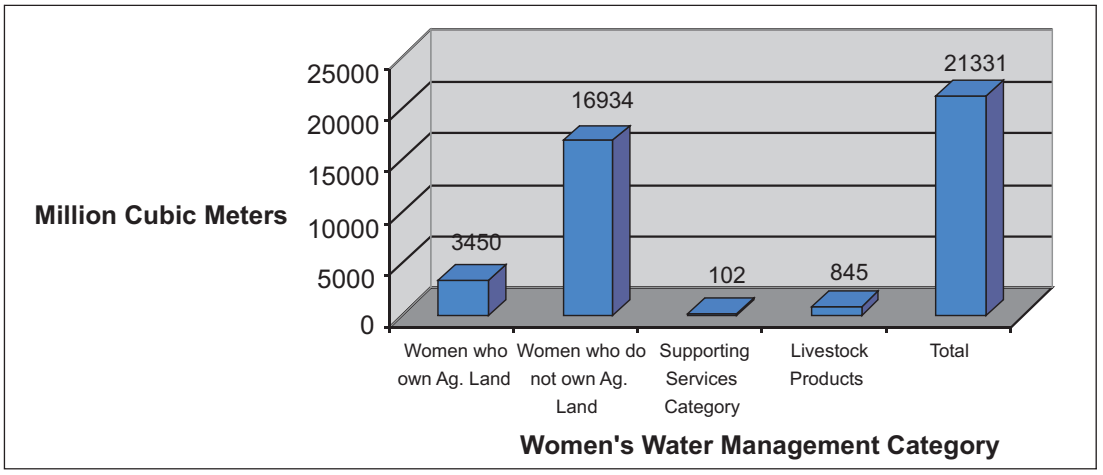

Fig. 5. Total amount of water managed by women in the different categories

The total amount of water managed by women is 21.331 billion cubic meters which represents 38% of the total Egypt's share of Nile water (55.5 billion cubic meters) as it is considered the main source of water for the country. In addition, most of these 21.331 billion cubic meters is managed by women within the category where they share irrigation activities with men and do not own agricultural lands by themselves (16.934 billion cubic meters). This water quantity represents 79% of the total amount of water managed by women. On the other hand, women who own agricultural lands manage 3.45 billion cubic meters of water which represents 16% of the total amount of water managed by women. The other two categories, Support services (women who own irrigation pumps) and Livestock production, represent the minimum water categories managed by women (102 and 845 million cubic meters respectively) compared with the landownership category.

OBSTACLES TO THE IMPROVEMENT OF WOMEN'S PARTICIPATION IN WATER MANAGEMENT

Throughout the comprehensive investigation presented in the current study it was clear that rural women's role in the water management sector and the huge amount of water they manage is extremely important. Therefore, it was very essential to investigate the various obstacles to the role of rural women in water management activities. These obstacles can be divided into the following different categories according to the degree of involvement of rural women in the Egyptian society:

1. Educational category:
   - High illiteracy ratio. This ratio was very high in the 1970s (71%) and dropped to 51% at the end of the 1990s (Women's National Council, 2003) but this percentage was still high as compared to men (29%).
   - Girls' unenrollment at different educational levels.

2. Social and cultural categories:
   - Decrease in women's opportunities to receive their inherited share of land.
   - Limited women's role in family decision-making.
   - Limited equitable participation in the different social and water entities.
   - Lack of appreciation for women's responsibilities within the family. Their household work is still considered not productive.
   - Bad habits and traditions towards women.

3. Economic category:
   - Women's role within the family is not considered an economic benefit by men.
   - Slow development of the customary agricultural practices in old lands.
   - Limited financial resources for women since they don't receive their inherited share of land.

4. Health category:
   - Un-tested relative marriages. This type of marriage is forced in certain regions and causes lots of health problems without prior tests.
   - Lack of standard precautions when dealing with animals and poultry. This causes lots of unexpected infections such as Birds' Flue.

5. Political category:
   - Lack of political knowledge.
   - Decrease in women's political participation. Only 38% of women are officially listed in the government voting documents.

6. Environmental and institutional category:
   - Urbanization has switched rural women's role from productive to consumptive.
   - Weakness of the existing social institutions.
   - Lack of sanitation services in certain regions has degraded the different water vessels.
   - Lack of coordination among non-governmental organizations.

RECOMMENDATIONS

The detailed analysis, previously presented, revealed the importance of women's role in water management and the several categorized obstacles they face in this activity. Therefore, several recommendations are considered vital for improving women's capabilities and capacities in the various aspects of their life towards better and sustainable water management for food security and food safety. These recommendations can be categorized and listed as below.

Food Consumption

The bread example shows the amount of water wasted in manufacturing it, therefore, certain recommendations are extremely necessary to efficiently improve women's behavior in food consumption towards better water conservation and management:

- Encourage women to produce their own bread at home.
- Encourage the private industrial sector to manufacture small unexpensive bakery units that meet rural women's needs.

- Reduce the size of the subsidized bread as well as its price in order to decrease its waste.
- Improve the quality of the subsidized bread.
- Organize specific awareness programs for rural women to efficiently manage their family food consumption through non-governmental organizations and other social institutions.

Agricultural Production

The analyses previously presented addressed women's role in water management and agricultural production through two main categories: agricultural products and livestock products. To improve their role to achieve better and sustainable food security and food safety, it is worth considering the following recommendations:

Agricultural products

- Develop an authentic and real database for women who share irrigation activities with men according to their land size category, ownership of irrigation pumps, and family circumstances. Based on this database different specific awareness programs can be organized and efficiently fulfilled.
- Involve women who own irrigation pumps in the Water Users Associations (WUAs) so that the use of these pumps is properly regulated and managed.
- Improve women's skills in operation and maintenance of these pumps to stabilize their financial income thus motivating the regulation of the pumps' working days according to the irrigation scheduling without the need to work extra days to cover up the missing income in the non-operating days.
- Organize specific awareness programs on the water management issue that meet women's needs.
- Encourage the equitable participation of men and women in all water social associations.
- Adopt the Right Based Approach (RBA) for all farmers (men and women) through specific awareness programs formulated for water management.
- Encourage gender equality in water management decision-making.

Livestock Products

Despite the fact that the amount of water managed by women in livestock products represents only 15% of the total amount of water managed by women in all kind of agricultural production, it is considered the main issue for food safety especially after the random wide spread of diseases such as Birds' Flue. Therefore, certain recommendations are considered of vital importance to improve women's water management within this category:

- Improve women's capacity and knowledge on the importance and severe impacts of the quality of water on the different types of animals and poultry through specific awareness programs.
- Develop standard breeding procedures for all types of animals and poultry specifically directed to rural women.
- Develop standard safe milking procedures for Cows and Buffalos specifically directed to rural women.
- Develop an information dissemination strategy specifically directed to rural women regarding animals and poultry breeding, and animals' milking.
- Improve women's knowledge on the severe danger of throwing dead poultry in the different water ways and its impacts on several health issues.
- Develop a national rural system for collecting dead poultry.

SUMMARY AND CONCLUSION

Due to water scarcity, successful implementation of the Integrated Water Resources Management (IWRM) concept has been currently given lots of attention by decision makers and scientific communities worldwide and specifically in Egypt. This implementation involves lots of technical, social, environmental, and financial dimensions. The current study addressed a cross-cutting issue within the Egyptian society: the gender mainstreaming in IWRM towards food security and food safety. A technical methodology was adopted to first identify, precisely, women's role and responsibilities in the water management sector, especially in food consumption and agricultural production as they are

considered the main pillars for food security and food safety. The main conclusion is that women are highly involved in managing huge amounts of water (38% of the total Egypt's share of Nile water), that are directly related to food consumption and agricultural production. However, women's role and responsibilities in water management have to be improved, formalized, and regulated in order to guarantee a better and sustainable food security and safety status. Prior to this action, the various obstacles to the improvement of rural women's participation in the water management process were clearly identified and various recommendations were suggested in order to overcome these barriers towards improving women's skills in water management in food consumption and agricultural production and consequently obtain a better and sustainable food security and safety status in the Egyptian society.

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