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Research Article
Efficiency of Water Resources in Small and Medium-sized Dairy Factories in Egypt

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Abstract

Background and Objective: The dairy industry consumes great amounts of water and generates large quantities of wastewater. The study problem is the lack of available water resources which reflected in decreased average per capita water. The main objective of this study was to study the efficiency of water use in the production units, estimate the cash yield of the water unit and finally study the factors that affect them. **Materials and Methods:** Data were analyzed using Statistical Package for Social Sciences (SPSS) version 16. Quantitative data were presented as Means±SD. The independent sample- ANOVA was used with two-way analysis of variance, with *Post-hoc* (LSD) test was used to analyze mean difference. Probability values (P) of less than 0.05 were regarded as statistically significant. **Results:** The most important results of the study suggested to the low average per capita average annual attrition rate of about 1.29% and rising share of water resources industry with a growth rate of approximately 15.1% during the study period have been measuring the significance differences between the sample in the water-use efficiency, proven statistical model significant at level $p<0.05$. Also, suggest the disparity in the percentage of the cost of employing and run water to an average of about 5% of total operating costs, as well as indicate low efficiency rate. **Conclusion:** The study concluded that a clear plan Inspection Department on how to deal with these facilities over the long term and anaerobic biological treatment in processing the high organic content industrial pollutants.

Key words: Dairy factories, efficiency of water use, dairy industry, manufacturing process, statistical analysis of water consumption

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Water is a precious resource. There are a number of strategies to achieve a sustainable water security[1]. Also, water has a key role in the development process, which is the main source of food security. So, the states is caring about water development, good governance and economic optimization. This problem became scarce resources according to World Bank estimates by 2035 (http://worldbank.org/ida) and per capita is expected to arrive in the next generation in developing countries of fresh water to a 3rd of what it is now.

All countries seeking to secure water resources in order to achieve its national security and hence food security. In this regard, the Egyptian State seeks to reorient and streamline the various water uses to achieve maximum satisfaction is possible in light of the scarcity of water resources and those resources are about 65.55 Billion m^3, while some uses 76.25 billion m^3 water gap amounting to 10.75 billion m^3 for the year 2016[2-4]. Per capita has dropped water from 1672 m^3 in 1970 to about 828 m^3 a year by 2016 down 50.66%, affecting the population increase dramatically on average per capita water to low water scarcity phase is called[2].

Milk processing industry consumes large quantities of energy and water, each milk industry step is accompanied by formation of by-products, waste, pollutants and a potential impact on the environment. In milk industry, the biggest quantities of water are used in equipment washing processes, as well as in sanitation, cooling, pumps, package processing, utilities and auxiliary wants[5,6].

The Arab Organization for Industrial Development (AOAD) has studied the rationalization of water use in the dairy industry of some countries, including India and Saudi Arabia[7]. India is one of the world's largest producers of milk and its products in the world, with a production of 135 million tons. The Indian experience in water supply has been supported by the government. The exemption of different rates of taxes according to the amount of water being rationalized, as well as the provision of facilities to obtain the necessary funding to improve the efficiency of water use in factories, the provision of programs that help improve the efficiency of dairy products. The use of resources, including water resources and the improvement of the quality of dairy products, especially for export and to achieve greater competitiveness in the global markets.

In dairy factories in Saudi Arabia[7] during the season 2007/2008 daily production reached about 400,000 L of milk pasteurized daily. But the company was suffering from the rising cost of providing water crisis to manufacturing process which was up daily for about 2000 m^3 daily spends about 1.4,00 m^3 per day. The most important results are that the amount of water savings is about 160,000 m^3 per year and financial savings about 153,000 dollars. The most important methods used to reduce and reuse and rationalization of washing water using equipment and machine guns equipped. The most important factors of success are experience, management support in the factory, worker's awareness and involvement and effective control.

The problem of this study is the lack of available water resources from different sources, with the inability to meet the increasing water needs and the demands of the population increase in Egypt until we are below the level of the water poverty line[1]. In view of the repercussions of the Nile water resource shortage in Egypt's share of that resource To establish the Ethiopian dam, especially because the Nile water resource is the lifeblood, which requires the Egyptian state to adopt rational methods to bridge the current and future water gap associated with the construction of the dam, necessitating the need to follow mechanisms to rationalize available water[8].

To achieve the primary objective of the study, several sub-objectives should be studied: First, assessing the relative distribution of water uses. Second, estimation of water per capita compared to some countries in the world. Third, water use efficiency in production units, estimate water unit cash used in the productive process and measure the percentage of operating costs and the use of water for total costs.

MATERIALS AND METHODS

Sources of data: The study relies on two sources of data, the first source is published and unpublished secondary data issued by the stakeholders represented in each of the Central Department of Agricultural Economics, Ministry of Agriculture, Central Agency for Public Mobilization and Statistics, Ministry Resources Irrigation and Water. The second source was the initial data obtained through the questionnaire prepared for this purpose represented a random sample was collected from some dairy factories in some provinces lower Egypt and Upper Egypt and Grater Cairo in 2017. To learn how efficient water use in dairy factories in Egypt, as some research was adopted universal data indicative of average water use efficiency in dairy factories and compare it with the sample vocabulary research.

Sample study: it was necessary to identify the water use efficiency in dairy factories in Egypt, to provide the necessary data to conduct this research through a questionnaire

Table 1: Geographical distribution for the sample of the study throughout the republic

Regions	Governorate	No. of sample	Percentage
Lower Egypt	Damietta	8	24.2
	Sharkia	5	15.2
Total lower Egypt		13	39.4
Upper Egypt	Fayoum	5	15.2
	Asyut	5	15.2
Total upper Egypt		10	30.3
Greater Cairo	Giza	4	12.1
	Kaliobeya	6	18.2
Total great Cairo		10	30.3
Total		33	100.0

Source: Compiled and calculated from the research questionnaire

specially prepared for this purpose dairy and especially soft cheese in various regions of the Republic. With regard to the sample used in the research sample was intentional method when selecting small and micro production units producing soft cheese for a 33 unit spread over various regions of the Republic and the preview process them through a personal interview and was described in the Table 1, the maritime provinces face (in the provinces of Damietta, Eastern) by 39.4% of the study sample and the provinces of upper Egypt (in the provinces of Fayoum and Asuit) by 30.3% of the study sample and Grater Cairo (in the provinces of Giza and Qaliubiya) by 30.3% of the sample, where the dairy plants in those provinces combined about 77.2% of total dairy factories registered with the authorities in Egypt within the framework of small and medium-sized enterprises data in Egypt as an average for the period (2007-2016)[9].

Sample key indicators: Through the results of a study it was drawn a set of conclusions on the use of water in the production process in small dairy factories producing soft cheese. Those results can be summarized as follows:

- About 67% of the sample vocabulary not using water filters and about 33% use these filters, indicating a lack of adequate awareness among producers. The importance of specifications and requirements which should be available in the water used in the manufacturing process
- About 39.4% of the study sample gets water through without using Government counters and a codified form, while it gets about 60.4% of sample water legally through Government connections. Therefore, implicitly refers to increasing the size of the informal sector in making products dairy
- About 63.4% of the study sample drains the resulting from the manufacturing process directly into the drain without treatment and increased levels of salinity resulting from the production of soft cheese

Analysis of sample's data: Data were analyzed using Statistical Package for Social Sciences (SPSS) version 16. Quantitative data were presented as Means±SD. The independent sample- ANOVA was used with Two-way analysis of variance, with *Post-hoc* (LSD) test was used to analyze mean difference. Probability values (P) of less than 0.05 were regarded as statistically significant. Research on using descriptive analysis and quantitative methods to achieve the objectives of the research and the research method is as follows[10].

- Calculate cash yield water unit used in the manufacture of soft cheese:

$$CRW = \frac{SP}{LWM}$$

Where:

CRW = Cash dividend on unit water used in the manufacture of soft cheese (Pound L^{-1})
SP = Sales volume (Pound t^{-1})
LWM = Liters of water involved in the manufacturing process

- The efficiency of water use in the manufacture of soft cheese in particular units of study:

$$WE_{CH} = \frac{TWS}{NLM} \times 100$$

Where:

WE_{CH} = Water use efficiency in soft cheese
TWS = Total water used in the plant during the manufacturing process
NLM = Liters of milk within the manufacturing process

- Contribution to the cost of employing and run water for total costs at the factory:

$$PCUW = \frac{COW}{TCP} \times 100$$

Where:

PCUW = Contribution to the costs of using and running water

COW = Cost of employing and run water during production

TCP = Total costs of the production process

Factors that determine the efficiency of water use: To identify the most important factors that contribute to determining how efficient water use in dairy factories in Egypt has been tested multiple regression analysis. Where, it is assumed that, the most important independent factors affecting water use efficiency of dairy factories in Egypt as the dependent variable is the amount of dairy production in tons (x_1) and a way to get water from the original sources (x_2), the educational and cultural level of the owner of the facility and its staff (x_3), the total cost of water in dairy factories (x_4) and the number of workers in the factory (x_5), as independent variables.

RESULTS

Relative distribution of water uses in Egypt: Table 2 showed that the water used include the needs of agricultural resources available, as well as losses to evaporation from the Nile and canals, drinking water and health and industrial uses and power generation those uses approximately 81.5, 3.29, 13.64 and 1.58%, respectively of the total shown and uses about 76.25 billion m^3 represents the total available resources[2-4] of 2015/2016.

Evolution of water per capita in Egypt: By estimating the parameters of the estimated per capita directivity in Egypt of total available water resources during the study period, Table 3 shows that the linear image was best images to estimate the equation of yearly general time trend for per capita. Where, the average trend was decreasing and informed 11.95 m^3/year, showed that it decline by a statistical significant annual amount at 0.01 level, an annual decline rate of about 1.29% of the annual average of about 922.97 m^3/year and an operand (R^{-2}) indicated that approximately 93% of the changes in total per capita available water resources time interpreted:

$$\text{Annual rate of change} = \frac{\text{Ammount of change}}{\text{Average of the dependent variable}} \times 100$$

Current state of water use in the industrial sector in Egypt and the percentage of food industries including: The industrial sector had seen an increase in water use during the period 2010-2016, reflecting data Table 4 high water use in Egyptian industry in 2016 by approximately 4.9 billion m^3 compared to about 1.7 billion m^3 in 2010 with a growth rate of approximately 15.1% and an average of about 3 billion m^3 during that period. Regarding the food industry showed that according to some food industries accounted for field studies of water used in the industrial sector in 2010 about 33.2% of total water for the industrial sector, while the same for about 44.5% in 2016, a growth rate about 4.2% average during that period was approximately 39.2%.

Efficiency of water use in the dairy industry in Egypt: The statistical significance level 0.05 as the calculated F-value was approximately 18.3, which referred to the

Table 2: Proportional distribution of water uses (2015/2016) (Unit: billion m^3)

Water uses	Uses (Billion m^3)	Total (%)	Uses after the construction of the Renaissance Dam (Billion m^3)	Amount of loss after the construction of the dam of Renaissance* (Billion m^3)
Agriculture	62.15	81.50	53.74	8.41
Loss by evaporation from the Nile and canals	2.50	3.28	2.15	0.35
Household use	10.40	13.64	8.58	1.82
Industry, electricity generation and others	1.20	1.58	1.03	0.17
Total	76.25	100.00	65.50	10.75

*Calculated result of Egypt share expectations of the Nile in the Ethiopian Dam Lake filled about 10.75 billion m^3 $year^{-1}$, Source: Central Agency for Public Mobilization and Statistics (CAPMAS)[2], Ministry of water Resources and irrigation, Egypt[4]

Table 3: Estimated directional trends of Egypt's average per capita water resources during the period (2002/2003-2015/2016)

Equation	Average dependent variable (m^3 $year^{-1}$)	R^{-2}	"F" calculated	Amount of change	Annual rate of change (%)
$\hat{y}i = 1023.576–11.95\hat{x}i$ (-13.895)**	922.973	0.93	193.079**	-11.95	-1.29

Where: $\hat{y}i$: Estimated value of the dependent variable per annum. $\hat{x}i$: Factors linked to the time period, years 1, 2, 3... 16. **Level of significance (0.01%). -: A declining annual change. Source: Compiled and calculated from Table 4

Table 4: Water use in the industrial sector and food industries in Egypt during the period (2010-2016)

Statements	2010	2011	2012	2013	2014	2015	2016	Average	Growth rate
Water use in the industrial sector (Billion m^3)	1.70	1.80	1.96	2.86	3.24	4.20	4.90	3.00	15.10
Percentage of water allocated to the most important food industries for the total industrial sector (%)	33.20	36.90	37.20	39.30	40.20	43.40	44.50	39.20	4.20
Growth rate in the food industry (%)	8.20	5.10	4.90	3.20	6.10	9.20	11.20	6.80	4.50

Source: Ministry of Irrigation and Water Resources, Council of Industry and Innovation Technology, Technological Council for Food Industries, Field Studies Central Agency for Public Mobilization and Statistics (CAPMAS)[11]

Table 5: Statistical analysis of water consumption indicators in dairy plants

	Descriptive statistics				
Factors	N	Minimum	Maximum	Mean	Std. deviation
Maintenance costs	33	400.00	600.00	516.67	56.826
Water consumption per liter of milk (m^3)	33	1.50	3.60	2.091	0.315
Return of liter of water (pounds)	33	19.40	70.00	37.312	10.206
Coast of water is attributed to the total costs	33	3.00	8.00	4.970	0.951

Source: Compiled and calculated from the research questionnaire

differences between the three regions of the Republic in the efficient use of water in the amount of water used in the manufacture of every liter of milk productive process.

Economic indicators of water use in the dairy factories: Cash yield water unit used in the manufacture of soft cheese: Through data of the study sample the return on a liter of water used in production processes for sample was calculated as shown in Table 5. As the yield was about 19 pounds per liter as a minimum and 70 pounds per liter as upper limit, averaging about 37 pounds per liter water.

Efficiency of water use in the manufacture of soft cheese production units in the study sample: Through the questionnaire data turns out sample factories focused on soft cheese industry. So, the results of the study showed that the rate of consumption of water per liter of milk goes into the production process of soft cheese in the study sample ranges between minimum reached 1.5 L of water, a higher limit 3.6 L of water, averaging approximately 2.1 L of water Table 5.

Contribution to the cost of employing and run water for total costs at the factory: Table 5 showed that the contribution use and costs of running water in the samples were ranging from 3-8% of the total operating costs, with an average of about 5% in the study sample, which demonstrates the disparity in the efficient use of water as a resource economically between sample.

Factors that determine the efficiency of water use in dairy factories in Egypt: The following general formula was applied to describe water consumption per unit of final productized groups of dairy plants in view of various factors:

- Production quantity:

$$\hat{y}i = 20.144+1.476\hat{x}_1$$
$$(13.418)^{**}\ R^{-2} = 0.85\ F = 180.04^{**}$$

- Educational level of the factory with the production quantity

$$\hat{y}i = -13.484+1.523\ \hat{x}_1+26.77\ \hat{x}_3$$
$$(14.627)^{**}\ (2.418)^{*}\ R^{-2} = 0.86\ F = 107.02^{**}$$

- Number of workers in addition to, the production quantity and level of education

$$\hat{y}i = -42.98-1.276\hat{x}_1+27.166\ \hat{x}_3+9.33\ \hat{x}_5$$
$$(9.722)^{**}\ (2.677)^{*}\ (2.578)^{*}\ R^{-2} = 0.89\ F = 86.99^{**}$$

Through the review of the results showed that the statistical model ICH statistical significance level at 0.01 and 0.05, averaging 85% coefficient of determination about any to those factors that the study assumed responsible for about 85% efficient use. While, the factors of costs of obtaining water (X2) and obtained from main sources (X4), there is no moral impact on water use efficiency in dairy plants in the study sample.

Water conservation in the dairy industry in Egypt

Importance of saving water in dairy factories in Egypt: Limiting environmental impacts of poor water use in dairy factories is one of the most important reasons for the conservation at the national level. Where, the wastewater from industrial processes often contaminated due to the presence of solid component in milk and as a result of salting activities

during the production of soft cheese may increase salinity levels in wastewater[12]. It can explain the most important environmental effects resulting from the misuse of water in dairy factories[13] in the Table 6.

DISCUSSION

Relative distribution of water uses in Egypt: Aweida and Abdel Rahman[3] mentioned that in the fallout from a Renaissance dam and its effect on Egypt's share of Nile waters will go down as a result of about 10.75 billion m^3. This lack has been divided among different uses according to the proportions of representation in total uses before building the dam, then the amount of loss in some uses 8.41 billion m^3 in agriculture, 0.35 billion m^3 as unconscious evaporation from the Nile and canals, 1.82 billion m^3 of drinking and health uses 0.17 billion m^3 for industry and electricity generation boil respectively. Therefore, appreciates the amount of water available for use after construction of the dam about 53.74, 2.15, 8.58 and 1.03 billion m^3, respectively of total uses of about 65.5 billion m^3 excluding Egypt share inferiority of the Nile after construction of the dam.

Evolution of water per capita in Egypt: Table 7 showed the evolution of per capita in Egypt of the Nile and of total available water resources during the period[7] 2002-2016, with an average per capita per year of Nile waters approximately in total 817.38 m in 2002, below about 603.5 m^3 in 2016. As an average share some 703.36 m^3 on average for the period, judging from a study the same table that the per capita water resources total available culminated about 1005.3 m^3 in 2002 and reached below about 828.8 m^3 in 2016, as approximately 922.97 m^3 on average for the period, notes from the table for Nile water per capita represents about 76.21% of the total share of total available water resources from different sources.

The study of AFED[1] provides that, if the average per capita water availability of less than 500 m^3/year, it reflects the situation of shortage of water in those States. While, if that average is less than 1000 m^3/year, water is a constraint on economic and social development (there are Eight Arab countries, Bahrain, Djibouti, Jordan, Kuwait, Qatar, Saudi Arabia, UAE, Yemen "facing water shortages as water per capita less than 500 m^3/year. Whereas, four other Arab countries, Algeria, Egypt, Somalia, Tunisia, suffering from water shortage as a constraint on Economic development with an estimated per capita water with less than 1000 m/year).

Table 6: Production processes in dairy plants and the field of impact of pollutants in water used in manufacturing processes

Production process	Input process productivity	Outputs of the production process	Pollution indicators	Area of influence
Examination of raw milk	Raw milk	Returned dairy	Absorbed biological oxygen, Suspended solids, pH	Water
Ultra filtration	Dairy products	Water and lactose	Absorbed biological oxygen	Water
Coagulation	Pasteurized milk+rinse+salt	Whey	Biological oxygen, suspended solids, pH	Water
Facilitators	Water	Water treatment, reverse osmosis	Soluble solids and suspended solids	Water
Boilers	Water treatment+steam condenser	Waste water	Soluble solids and suspended solids	Water
Cooling towers	Water	Waste water	Soluble solids and suspended solids	Water

Source: Ministry of Environment, Self-Monitoring Manual for the Dairy Industry[15]

Table 7: Evolution of per capita income in Egypt of Nile water and the total available water resources during the period (2002-2016)

				Average per capita (m^3/year)	
Years	Population (million)	Nile water (Billion m^3)	Total water quantity of different resources	Nile water	Total quantity of water resources available
2002	67.9	55.5	68.26	817.3785	1005.302
2003	69.3	55.5	68.67	800.8658	990.9091
2004	70.7	55.5	69.16	785.0071	978.2178
2005	72.2	55.5	69.56	768.6981	963.4349
2006	73.6	55.5	69.96	754.0761	950.5435
2007	74.4	55.5	72.36	745.9677	972.5806
2008	76.1	55.5	73.6	729.3035	967.1485
2009	77.8	55.5	73.35	713.3676	942.8021
2010	79.6	55.5	73.35	697.2362	921.4824
2011	81.6	55.5	74.16	680.1471	908.8235
2012	83.7	55.5	75.5	663.0824	902.0311
2013	85.6	55.5	76	648.3645	887.8505
2014	89.1	55.5	76	622.8956	852.9742
2015	90	55.5	76.25	616.6667	847.2222
2016	92	55.5	76.25	603.2609	828.8043
Average	78.91	55.5	72.834	703.362	922.973

Source: Central Agency for Public Mobilization and Statistics (CAPMAS)[9]

A study of AFED[1] has shown that, most of the Middle East and North Africa suffer from acute water scarcity and half the population lives in the area under water stress conditions. The water demand rises, combined with increasing population and changing lifestyles and economic development. As well as, it is consistent with the study conducted by the World Bank[14], with an expected decrease the amount of renewable fresh water in half by 2050 compared with 2007.

Current state of water use in the industrial sector in Egypt and the percentage of food industries including: Water uses are many and vary in general of the Egyptian industry between use as production requirements or cleaning and waste collection problem and other various uses. Often these showed increase in water usage rates in the food industry in particular, it is not compatible with growth rates in the food industry, where increasing water use in the food processing industry growth volatility nutrients as indicated in the Table 5, which showed that the increase in water use is not accompanied by growth in the production. This is indicative of the inefficient use of this resource and gives an indication of poor water use efficiency as a production requirement in Egypt during the study. This proves that the use of the preparation industry by 70-80% of the treated water (water in the product), cleaning activities represent about 70% of water use in the dairy sector[15].

Efficiency of water use in the dairy industry in Egypt: Water efficiency indicator for the relationship between the amounts of water needed for a particular purpose and the amount of water provided[16]. It is necessary that the water used in the production process is valid and in accordance with the environmental and operational requirements approved by the General Authority for Standardization and Quality of Egypt[14,17].

Before examining the efficient use of water in a sample study measuring the significant differences between the sample in water use efficiency and impact of divergence in the geographical territory. As well as, the existence of modern machines to rationalize water use in production units as independent variables on the quantity consumed water per liter of milk in the production process as a dependent variable, using the analysis of variance test in two directions (Two-way analysis of variance), which aims to determine the effect of the independent variable dependent variable, also known as the interactive effect is the result of the interaction of variables and there is an interaction between them if the differential impact of any of them varies depending on the other levels. Statistical analysis of the results shows the significant differences between the upper and lower Egypt and Greater Cairo by another, where the lack of efficiency in the use of water in upper compared and Cairo, as showing lack of moral differences between the efficient use water and Cairo.

Economic indicators of water use in the dairy factories:

- **Cash yield water unit used in the manufacture of soft cheese:** This point is to the importance of water as a production input in the manufacture of dairy products and refers to the great disparity between the samples in the efficient use of water as an economic resource
- **Efficiency of water use in the manufacture of soft cheese production units in the study sample:** The global average and the guiding for manufacturing soft cheese ranges between 1.4-2 L of water per liter of milk. The results of some previous studies have shown that the milk industry uses the largest quantities of water in production. It was determined that 2.0-2.5 L of sewage are located on average on 1 L milk production[5,6]. According to published research results, most dairy plants consume from 1 to 10 m^3 of water per every cubic meter of milk production. Water is used in various areas of business and industry; with regard to the industry, the food sector has one of the highest water consumption and is one of the biggest producers of effluent per unit of production[17]. Vickers[16] and Daufin *et al.*[18] reported that water consumption in Europe has been reported to range from 0.2-11 L L^{-1} milk, with effluent volumes per raw milk intake in the same range, while ratios for Australian processors producing any combination of white milk, cheese, powders or yoghurts range from 0.07-2.90 L L^{-1} milk, with the average being around 1.5 L L^{-1} milk[19], an increase in milk processing output in summer by 1000 L could increase daily water consumption (WD) by around 2.62 m^3 in summer and around 4.54 m^3 in winter[12,19]. Ajiero and Campbell[20] mentioned that the average water consumption rates for dairy products against their corresponding best practice values, the average water use for skimmed milk is 3.6 m^3 t^{-1}; whereas, the best practice water consumption is 2.1 m^3 t^{-1}. Also, in butter production, typical water use ranges from 1.5–6.7 m^3 t^{-1}, while the benchmark or best practice value is 1.3 m^3 t^{-1}, comparing these values clearly reveals great potentials for water savings in each milk process

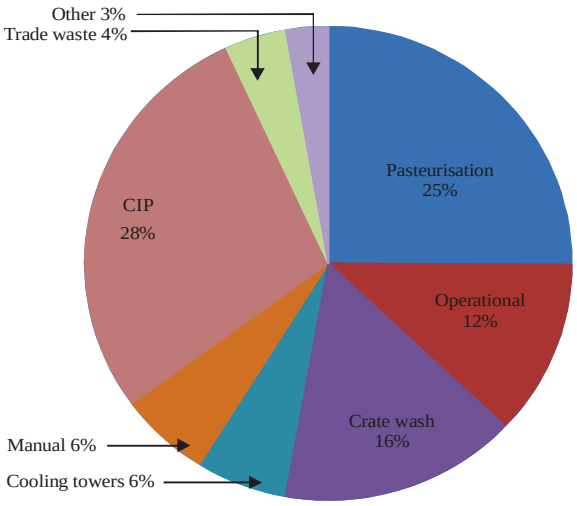

Fig. 1: Breakdown of water use of a market milk processor

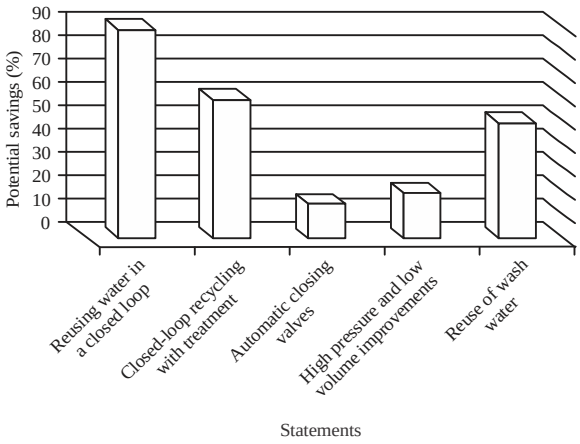

Fig. 2: Providing water in the food industry according to some experiences in different countries of the world

Figure 1 showed the range of ratios for factories producing white or flavored milks[20], cheese and whey products and powdered products. For factories that produce powdered products. The range in water to milk intake ratios indicates there is potential for some dairy processing plants to decrease water consumption significantly. This confirms the study undertaken by Arab Organization for Industrial Development[7]. Arabic industrial development which shows that high rates of efficiency of water resource used globally in the field of food industry through various actions to rationalize often leads to significant percentages of consumption reduction ranging between 15-90% as shown in Fig. 2.

- **Contribution to the cost of employing and run water for total costs at the factory:** A (T) test is in the direction of one of the most important statistical tests designed to detect statistical differences between the moral and the sample mean and the overall average of society, through a (T) test and described in Appendix a statistical research to see how much of a moral difference between the average global water use efficiency in production of soft cheese production units, between the average sample shows that (F) value intangible moral level statistical 0.05%, which suggested a moral difference between the pilot and the global average water consumption in Egypt. These results indicated clearly to low water use efficiency mode in Egypt about global rate, as well as lack of awareness of producers the importance of saving water and the importance to educate stakeholders interested in this issue to rationalize the use of water as an important economic resource in the productive process. Al-Ashmawi[21] illustrated that the cost of desalination of cubic meter of sea water can reach approximately 3.34 Egyptian pounds. Growing water scarcity and higher cost obtained from conventional sources on the one hand and the progress of science to discover non-traditional sources of cheap energy and technological methods, on the other hand, since the cost of desalination depends on the type of energy and the technology used and the size of the project but even with cheaper cost available currently keep desalination process very expensive. This consistent is agreement with Wojdalski, *et al.*[12]. Which proved that it could not determine indicators of water consumption per unit of final product

Factors that determine the efficiency of water use in dairy factories in Egypt: Coefficient (r) can also be used to determine the analyzed factors' influence (described as coefficient of determination (R^{-2})) on water consumption per unit of final product (WU). Stepwise regression equations were developed in the statistical analysis process. A multiple regression model was used due to a high number of factors of varied significance. This results agreement with Wojdalski *et al.*[12] who reported that water consumption was most highly correlated (r>0.868) with equipment profiles. The indicators of water consumption per unit of the final product were correlated (at 0.820>|r|>0.663) with equipment profiles, the degree of process automation and employment. Variations in water consumption per unit of the final product were best explained in small plants supplying several products. The presented equations can be used to optimize water demand of

various types of equipment and to determine the correlations with energy consumption for wastewater treatment.

Water conservation in the dairy industry in Egypt

Importance of saving water in dairy factories in Egypt: The sweet whey form the most polluting effluent by its biochemical composition rich in organic matter (lactose, protein, phosphorus, nitrates, nitrogen) and is from 60-80 times more polluting than domestic sewage[5,6]. The environmental impact of wastewater depends on the quality of the receiving media; Ministry of Irrigation (MOI) has set maximum pollution loads in the drainage water, canals and drains, the River Nile (Ministerial Decree 8 of 1983), because of its harmful effects on agriculture. With respect to the dairy industry, the most important indicators of pollution are biotic and chemical oxygen. Contaminated water causes high percentages of oxygen on lakes and seas on the phenomenon of water bodies and Egon negatively affects biodiversity[13]. Based on the idea that dairy products can cause negative impacts on the environment, it is appropriate to use techniques to avoid and minimize these impacts, propitiate production efficiency, economic gains and a better working environment. Thus, the application of preventive techniques such as Cleaner Production (CP) may be appropriate to achieve these objectives[22]. In order to successfully reduce the waste load in the wastewater stream[23].

Proposal for mechanisms to improve the efficiency of water use in dairy factories in Egypt

At the Government level: The governmental role in rationalizing the use of water in industry in the dairy industry in is particularly pivotal. Where the US Environmental Protection Agency reports that any Government role for water rationing should be based on several pillars is an effective system for determining the amount of water entering the plant, compare the water consumption in fact estimates the plant and water losses, cost estimation and educating factory owners the importance of rationalization. The matrix of key policies and governmental mechanisms to rationalize the use of water in dairy factories as shown in Table 8.

At the private sector level: The private sector contributes to the rational use of water in dairy factories to achieve many benefits for both of the economic level or social level, where it is expected when the factory to rationalize the use of water to achieve many of the benefits is the most important in reducing cost of water consumption and disposal of industrial wastewater from manufacturing processes. As well as, achieving a better of water use in the factory and then improve the reputation of the factory as a result of better environmental performance, can put an indicative guide to the private sector about the steps to improve the efficiency water use in dairy factories in Egypt in Table 9.

Finally, desalination is one of the options being formulated to address water scarcity expected their uses in the drinking water sector, the ministry of water resources water

Table 8: Proposing policies and government mechanisms that can be followed to rationalize the use of water in dairy plants

Policies	Mechanisms	Stakeholders
Update national policies to increase the interdependence between water and energy	A fair framework for water and energy pricing in accordance with actual needs	Ministry of irrigation and water resources, the Ministry of electricity
Policies to rationalize consumption and increase the efficiency of water use in dairy factories	To encourage the recycling of water in dairy factories. Using the definition of consumption of water upward	Ministry of trade and industry, Ministry of irrigation and water resources, Ministry of the environment
Activation procedures, laws and legislation governing water use optimally in Egypt	Not to grant licenses for industrial dairy plants only after ensuring safe disposal of industrial wastewater	Ministry of trade and industry, Ministry of the environment
Increase awareness of producers the importance of water conservation	Seminars and informational programs	Chamber of food industries, Ministry of irrigation and water resources
Cooperation with international bodies in preparing optimal water databases in the industry	Training courses and workshops with professionals in this field	
Benefit from the international experience and global dairy factories in rationalizing the use of water	Transfer to manufacturers fit the situation	Industrial modernization Centre
Facilitate the financing of the modernization of production lines, purchase of machinery and equipment that help rationalize the use of water in dairy factories	Encourage financial institutions to grant loans. Sufficient guarantees for loans	Central Bank of Egypt, the Ministry of trade and industry

Source: Setting research team

Table 9: Guidance proposal about steps to improve water use efficiency in dairy factories in Egypt

Action to be implemented	Policies and mechanisms for implementation	Operators work
Assess the current state of water use in the factory	Identifying sources and costs of obtaining water. The amount of water entering through the meter reading energy costs and maintenance of equipment. Select equipment and machines that enters the water run like boilers, chillers, scrubbers and other	
Prepare an outline of the sequence of water use in the factory	By the beginning of entry into leaving, taking into account the amount of water used in production processes	
Prepare a detailed report on the areas of water uses in the plant water consumption rates includes for each area and the nature and cost of hydrotherapy	Uses such as: water entering in the production process, purification filters, cooling and heating, drainage costs workers uses	Factory management consultant or specialist
Prepare a report on the technical aspects related to water flow in the factory	With water meters or indirect accounts such as experienced workers, manufacturing processes and productivity	
Calculate the total costs of water use in the factory	Calculate the total cost of water production units during a specified period	
Develop an action plan to benefit from improved water operations and implementation	Identify the needs of development and improvement, such as performing maintenance or even replacement of machinery and equipment. Define achievable objectives be measurable, technical information collected. Time frame for implementation	
Monitoring and evaluation processes for implementing plan	To determine the most successful procedures and address deficiencies	

Source: Setting research team

deficit forecast of about 7.4 billion m^3/year, will rise to 11.59 m^3/year in 2050, according to a study of National Specialized Councils[24].

CONCLUSION

Based on the findings of this study, it is recommended that the dairy sector adopt more water efficient systems and processes and annually conduct bench marking exercises, with the intention of helping know how they are performing, inclusion of factories in the formal sector, which leads to the rationalization of water use in all levels of productivity, reduce as far as possible from water consumed in the production process using automatic taps closing or high pressure water reusing water cooling and heating in the stages of production. Also, the inspection department has to have a clear plan on how to deal with these facilities over the long term, as well as recommends to have anaerobic biological treatment in dealing with high organic content industrial pollutants, where contaminants probably milk plants organic origin where many Recent research into success.

SIGNIFICANCE STATEMENT

This study focused on the efficiency of the use of water resources in small and medium-sized dairy factories in some governorates of Egypt during the various stages of production and the costs of water use and operation and studies the factors that affect them. It also directed officials to rationalize water consumption and wastewater treatment and reuse. It also explained the role of the Inspection Department in dealing with these factories in the long term and follow up the quantities of water consumed and training the workers on the modern mechanisms to rationalize water consumption. This study will also help researchers and workers in the dairy sector to discover the most important causes of water loss and methods of conservation and rationalization of consumption and especially in the coming years after the construction of the dam and the decline of Egypt's share of water and thus the per capita water.

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