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UNIT COST FOR PUMPING IRRIGATION WATER IN EGYPT

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Abstract

The increasing dependence on irrigation for food supply needed by an expanding world population will coincide with accelerating competition for water and rising concern about the environmental effects of irrigation. This will lead to the most fundamental precept of conventional irrigation practice; that crop water demands should be satisfied in order to achieve maximum crop yields per unit of land. Ultimately, irrigated agriculture will need to adopt a new management pattern based on an economic objective, the maximization of net benefits, rather than the objective of maximizing yields. Irrigation to meet crop water demand is a relatively simple and clearly defined problem with a singular objective. Irrigation to maximize benefits is a substantially more complex and challenging problem. Identifying optimum irrigation strategies will require more detailed models of the relationships between applied water, crop production, and irrigation efficiency. Economic factors, particularly the opportunity costs of water, will need to be explicitly incorporated into the analysis. Traditional irrigation systems have the common that water has to be lifted before being applied to the irrigated lands. Pumping stations are then required. The cost criteria for such pumping stations include fundamentally the initial cost, and the annual operating and maintenance cost. This paper studies and estimates the unit cost of lifting irrigation water, that is the cost per feddan (commonly used unit for area served), taking into consideration the two items of cost, the initial cost, and the annual operating and maintenance cost. The data of thirteen irrigation pumping stations in Egypt are collected, and are classified into two groups according to the area served. The first group is for small areas served, while the second group is for larger areas. These data are studied and analyzed, using the common spreadsheet software "Microsoft Excel", in order to estimate the unit cost of pumping irrigation water (per feddan). Equations are obtained for estimating the cost of pumping irrigation water per feddan, specifically the initial cost per feddan and the annual operating and maintenance cost per feddan. These equations are good and easy tools for decision makers involved in economic and environmental studies for agricultural projects. It can be recommended to investigate these equations against recent projects of pumping irrigation water with various areas served.

Keywords: Irrigation, Water, Cost, Pumping Stations.

1 IRRIGATION PUMPING STATIONS IN EGYPT

Data are collected for thirteen pumping stations lifting irrigation water in different locations in Egypt. These stations are classified into two groups according to the areas served. The first group of pumping stations is characterized by small areas served, not larger than 1000 feddan (commonly used unit for area served). It includes eight pumping stations. The second group of pumping stations is characterized by large areas served, from 140000 to 340000 feddan. It includes five pumping stations. All costs are in Egyptian Pounds (LE).

It can be logically that the costs for operating and maintenance may vary from a year to another. In this study, these costs are assumed to be constant for convenient. However, it is not easy to get all the desired data.

2 ANALYSES OF THE DATA

First of all, it is obvious that the collected costs are of different years. To analyze these data, a datum year is fixed for all costs. That is the year 2011. All costs are recalculated at the year 2011 assuming two rates of interest, e and e'. The first rate e is assumed to be 9 % for the years before 1980. The second rate e' is assumed to be 12 % for the years after 1980. These assumed rates are considered due to the economic point of view.

2.1 The Initial Cost (I C)
2.1.1 The First Group of Pumping Stations (Small Areas Served)

For all eight pumping stations, the initial costs for the year 2011 (I C2011) are obtained using the following simple equation:

$$I\ C\ 2011 = I\ C * (1 + e')^{n'}$$

………………………………..…………………………..………
(1)

Where: e' = 12 %, and n' = 26 years.

Then, employing the regression model at the Microsoft excel software, the following equation is got to estimate the initial cost per feddan:

Estimated I C / feddan = - 27.579 (Area Served, feddan) + 44560.68   ……………… Equation (A)
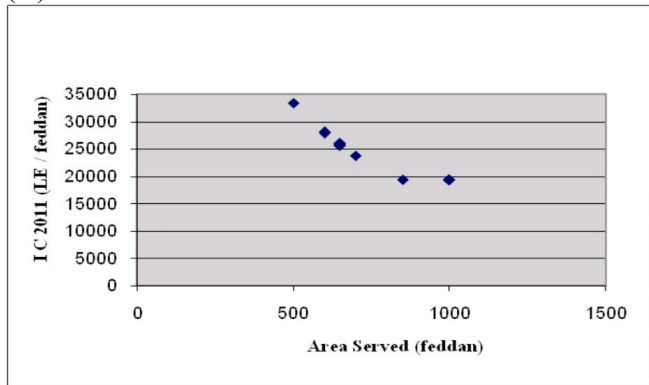

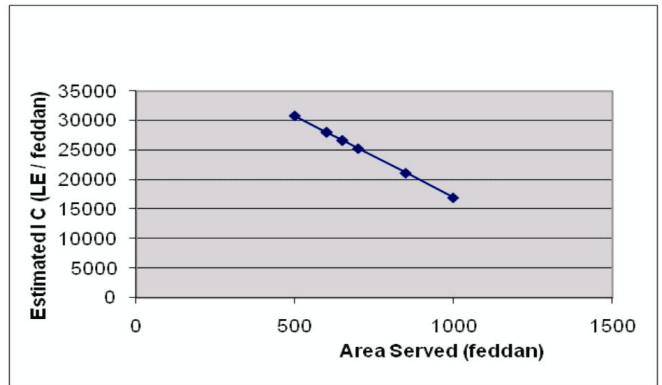**Figure 1. I C 2011 / feddan vs areas served.**   **Figure 2. Estimated I C / feddan vs areas served.**

2.1.2 The Second Group of Pumping Stations (Large Areas Served)

The initial costs are obtained for the year 2011 (I C2011) using the following two simple equations:

$$I\ C\ 2011 = I\ C * (1 + e)^{n} * (1 + e')^{n'} \qquad \text{(for stations 1, 2, and 3)}$$

………………..………
(2)

Where: e = 9 %, n = 9 years, e' = 12 %, and n' = 31 years.

$$I\ C\ 2011 = I\ C * (1 + e')^{n'} \qquad \text{(for stations 4 and 5)}$$

………….……………..………
(3)

Where: e' = 12 %, and n' = 27 years.

Then, employing the regression model at the Microsoft excel software, the following equation is got to estimate the initial cost per feddan:

Estimated I C / feddan = - 0.0011 (Area Served, feddan) + 1624.43   ……………… Equation (B)
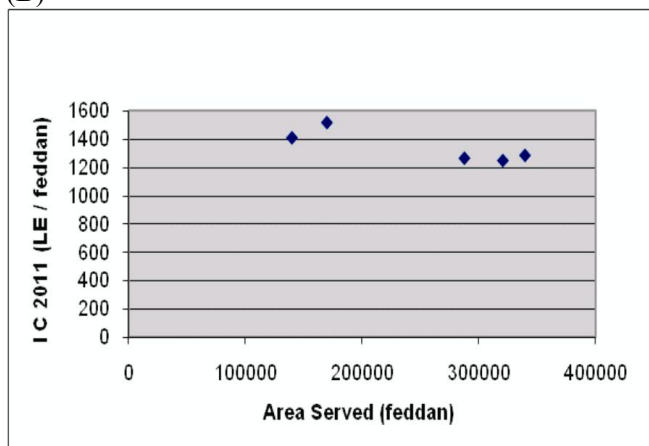

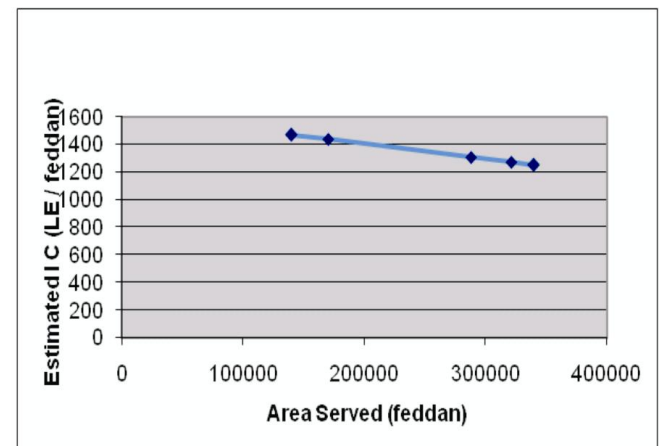**Figure 3. I C 2011/ feddan vs areas served.**   **Figure 4. Estimated I C/ feddan vs areas served.**

2.2 The Operating and Maintenance Cost (O&M C)
2.2.1 The First Group of Pumping Stations (Small Areas Served)

The operating and maintenance cost for the year 2011 (O&M C 2011) is obtained using the equation:

$$\text{O\&M C 2011} = \text{O\&M C} * (1 + e')^{n'} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (4)$$

Where: e' = 12 %, and n' = 23 years.

Then, employing the regression model at the Microsoft excel software, the following equation is got to estimate the operating and maintenance cost per feddan:

Estimated O&M C / feddan = - 0.074 (Area Served, feddan) + 314.387 ………….… Equation (C)

It has to be noticed that the modified operating and maintenance cost is employed because there are two values for the cost associated with the same area served. That is for the areas of 650 and 600 feddan. The difference in the cost is relatively high. While in the case of initial cost for the same areas served (650 and 600 feddan), the difference in the cost is relatively small.
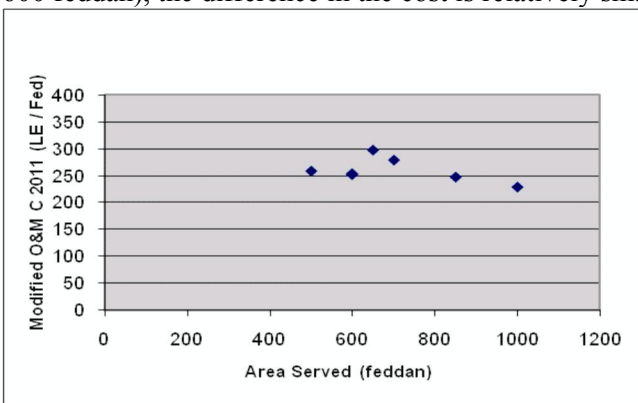

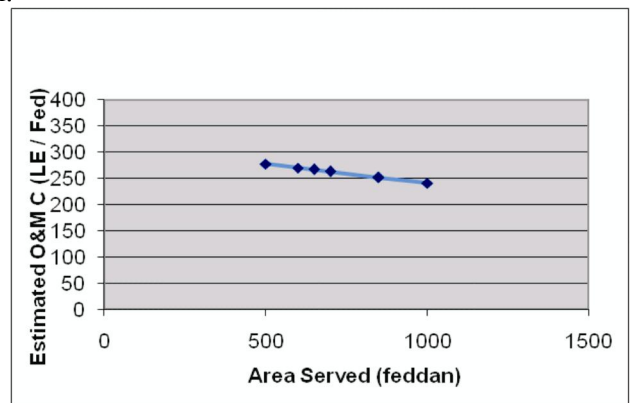| Figure 5. Modified O&M C 2011 / feddan vs areas served. | Figure 6. Estimated O&M C / feddan vs areas served. |

2.2.2 The Second Group of Pumping Stations (Large Areas Served)

The operating and maintenance cost for the year 2011 (O&M C 2011) is obtained using the equation:

$$\text{O\&M C 2011} = \text{O\&M C} * (1 + e')^{n'} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (5)$$

Where: e' = 12 %, and n' = 23 years.

Then, employing the regression model at the Microsoft excel software, the following equation is got to estimate the operating and maintenance cost per feddan:

Estimated O&M C / feddan = 0.000054 (Area Served, feddan) + 15.82 ………….… Equation (D)
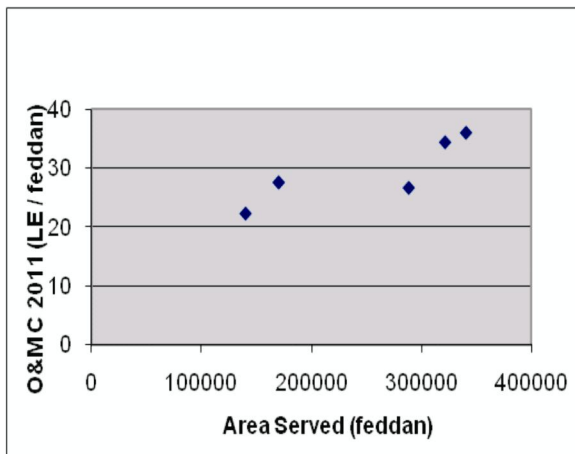

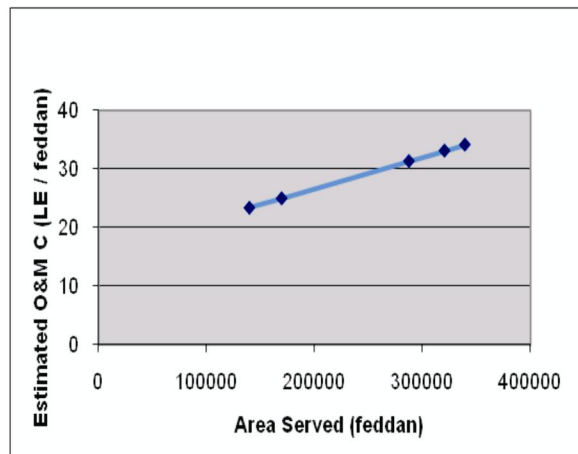| Figure 7. Modified O&M C 2011 / feddan vs areas served. | Figure 8. Estimated O&M C / feddan vs areas served |

310

3 DISCUSSION OF RESULTS

The equation (A) represents the estimated initial cost per feddan for pumping stations with small areas served not larger than 1000 feddan (first group). It is obtained using regression analysis tool of Microsoft excel software. It is associated by R^2 of 0.88. It is plotted versus the areas served in figure (2). Also, figure (1) represents the initial cost per feddan for pumping stations with small areas served not larger than 1000 feddan (first group).

Similarly, the equation (B) represents the estimated initial cost per feddan for pumping stations with large areas served up to 340000 feddan (second group). It is obtained using regression analysis tool of Microsoft excel software. It is associated by R^2 of 0.74. It is plotted versus the areas served in figure (4). Also, figure (3) represents the initial cost per feddan for pumping stations with large areas served up to 340000 feddan (second group).

The equation (C) represents the estimated operating and maintenance cost per feddan for pumping stations with small areas served not larger than 1000 feddan (first group). It is obtained using regression analysis tool of Microsoft excel software. It is associated by R^2 of 0.30. It is plotted versus the areas served in figure (6). Also, figure (5) represents the operating and maintenance cost per feddan for pumping stations with small areas served not larger than 1000 feddan (first group).

Similarly, the equation (D) represents the estimated operating and maintenance cost per feddan for pumping stations with large areas served up to 340000 feddan (second group). It is obtained using regression analysis tool of Microsoft excel software. It is associated by R^2 of 0.73. It is plotted versus the areas served in figure (8). Also, figure (7) represents the operating and maintenance cost per feddan for pumping stations with large areas served up to 340000 feddan (second group).

It can be seen that the obtained equations are very good, except for the equation (C) with R^2 of 0.30. That may be due to the varying needs for maintenance from a year to another.

Also, we can notice that the estimated initial cost per feddan for all pumping stations decrease with the increase of areas served, as shown in figures (2) and (4). This is logical as the total cost has to decrease with the increase of areas served.

For the estimated operating and maintenance cost per feddan, this cost doesn't behave similarly for all pumping stations. It is found that this cost decreases logically for pumping stations with small areas served not larger than 1000 feddan (first group), as shown in figure (6). While, it is obvious that this cost increases for pumping stations with large areas served up to 340000 feddan (second group), as shown in figure (8). That may be due to the increasing needs for operating with increasing of the areas served.

4 CONCLUSIONS AND RECOMMENDATIONS

It can be concluded that the obtained equations (A), (B), (C), and (D) are very good tools for estimating the cost per feddan for pumping stations. These equations predict the initial cost, and the operating and maintenance cost for two sets of pumping stations. The first set is for pumping stations with small areas served not larger than 1000 feddan (first group). While the second set concerns for pumping stations with large areas served up to 340000 feddan (second group).

These obtained equations are accurate, simple, and suitable for decision makers. Also, they can be used for the feasibility studies for land reclamation projects.

It is recommended that more studies have to be done for the costs of pumping stations with large areas served. Also, it is recommended to investigate and apply the obtained equations to other pumping stations within and outside the studied areas served.

REFERENCES

African Development Bank. (2007). "Economic Report on Africa." Abidjan, Côte d'Ivoire.
Association of Agricultural Production Executives. (2010). USA. "Economic Indicators". http://www.associationofagriculturalproductionexecutives.org/AAPEX.html
Ministry of Public Works and Water Resources (MPWWR), Mechanical and Electrical Department. (1988). "The Annual Reports for 13 Pump Stations." Cairo, Egypt.

Ministry of Public Works and Water Resources (MPWWR), Mechanical and Electrical Department. (1992). "The Documents and Tenders for 13 Pump Stations." Cairo, Egypt.

Raziyeh Farmani, Ricardo Abadia and Dragan Savic. (2007) "Optimum Design and Management of Pressurized Branched Irrigation Networks". Journal of Irrigation and Drainage Engineering, ASCE, 133 (6), 528-537.

Wichelns, D. (2001). "An economic perspective on the potential gains from improvements in irrigation water management." Agric. Water Manage. 52, 233–248.