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A Proposed Cropping Pattern in the Light of Policies of Water Management in the Northwest Coast, Egypt

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Abstract: Previous related studies confirmed that Egypt falls under the "water poverty" line or the "water scarcity limit" estimated at around 1000 m^3 annually per capita of the renewal water resources and need the local needs in agriculture, industry, energy and the other necessary needs for the process of socio-economic development. Accordingly, "an increasing "water gap" arose, so the water allotment per capita shrank from 2500 m^3 in 1950's down to 600 m^3 and continue to shrink to reach around 250 m^3 by 2050 under the constant water allocation for Egypt and the overpopulation and the increasing water needs, reusing the water and put the virtual water to use, [5]". The aim of research is to study the economic use for agricultural water resources in the Northwest Cost via reconsidering the cropping pattern combination of agricultural crops. Therefore, Methodology and data sources could be explained as that The research used the descriptive and quantitative economic analysis and some other statistical methods to identify the relationships that govern the main variables besides the quantitative measuring; the multi-purpose programing method was used to set alternatives to the typical cropping pattern with regard to maximizing the utilization of the available water resources for agriculture under the constraints and limitations of the available economic resources in the Northwest Coast. Finally, the research results estimating the net return of water unit for the first and second alternatives indicated a rise in the return of water unit in the proposed crop structure versus the current return of water unit in the crop structure, the second scenario was the best according to the return value of water unit in the proposed crop structure as the rise came to 20.9% than the current crop structure. It was indicated that the return rise achieved in this scenario came to 103 million LE with an increase of 15% than the net return in the current crop structure. Estimation results showed also that the highest average of water unit return was confined to Prickly Pear in the 3 alternatives followed by tomato and apricot, as for the third alternative, assessments indicated a rise in water requirements for the proposed pattern with 2268 million M^3 with 299.2% than that its current counterpart resulting in a reduction in such requirements for other crops i.e. wheat, onion, garlic, winter tomato, winter eggplant, groundnut, summer watermelon, summer cantaloupe, date palm and prickly pear.

Keywords: Economic and Efficiency of Using of Water Resources, Agricultural Needs, Economic Analysis, Multi-purpose Programing Method, Cropping Pattern, Utilization of Water Resources, Net return of Water Unit

1. Introduction

Water is the challenging issue nowadays, water issue has been the focus of attention on the local and international levels and has become a prerequisite for providing and developing our water resources not only as an issue that belongs to Egypt's political administration but also to the average citizen convincing that Egypt's survival basically depends on the continuity of the water flow in the River Nile as the main source for water, so "water is regarded a "national security" issue in the first place, [1]". Due to Egypt's constant water allocation which is estimated at around 55.5 billion m^3 representing around 87% of the total renewal water resources, since Egypt is mainly depending on the River Nile water to meet its annual needs as a source of fresh water. "Egypt has set the issue of providing such annual allotment on top of priorities and concerns not to mention rationalizing water use as best as possible, [2]". Water is one the most crucial and vital inputs in the process of socio-economic development especially in the agricultural development. So, "water shortage and scarcity in the Northwest Coast poses a great challenge to hold the responsibility of managing water resources which entails setting a thorough strategy to manage water resources and reconsidering the current pattern of using such resources and achieving the most efficient management of water resources, [3]". The available amount of irrigation water is the major determinant for developing the agro-economic structure, water resources are also determinant to the horizontal agricultural expansion, so the optimal utilization of water resources, conservation, and developing such resources is a strategic goal to achieve the maximum economic return. The available amount of irrigation water is the major determinant for developing the agro-economic structure, water resources are also determinant to the horizontal agricultural expansion, so the optimal utilization of water resources, conservation, and developing such resources is a strategic goal to achieve the maximum economic return. The FAO has defined certain hubs to managing the use of water in agriculture i.e. modernizing irrigation to give it a relative advantage which necessitates the irrigation authorities to develop and enhance the economic and environmental performance via the application of the new techniques and the sound management in participation of the decision makers in planning and investment and procuring the economic and environmental information that help transfer water with a precise and flexible and organizational pattern. "Investment requires a relative advantage to motivate the investors to control water via giving small loans for small holder farmers on a large scale, [4]". So, the main aim of this study is to investigate clearly, the economic use for agricultural water resources in the Northwest Cost via reconsidering the cropping pattern combination of agricultural crops. Furthermore, this research was conducted to determine suitability of the current utilization pattern of water resources in the Northwest Coast to the economic pattern to maximize the use of such scarce vital resource according to the economic consideration that are taken into account in this respect. Thus, the research dealt with the efficiency of utilizing the agricultural water resources in the Northwest Coast using programing of the objectives based on setting the multiple objectives in a way that reflects the priorities of the decision maker.

2. Using the Multi-objectives Programing in Proposing the Possible Cropping Patterns in Northwest Coast

Crop patterns were set using the multi-purpose programing to create cropping pattern under achieving the objective function that aim at maximizing the net return of agricultural activities, the return of irrigation water unit and rationalizing water consumption according to the priority of implementation i.e. the first objective functions, the second and the third one successively under a number of constraints and limitations of production that are related to the cropping pattern which meet the objective functions most efficiently under the available resources in the Governorate.

2.1. First: Agricultural Activities

Production activities – in the agricultural production- are the successive crops for a single agricultural year, each crop in the crop structure is a separate production activity, the analysis model of the crop pattern in Northwest Coast in Table 1, included 39 crop activities with a total are of around 248317.2 feddans from (2011 – 2015), crops were classified into three groups as follows: winter crops (wheat, barley, broad beans, clover, onion, garlic, tomato, pepper, peas, squash, eggplant, cucumber and leafy vegetables) with a total area of around 134736.2 feddans Summer crops (maize, groundnut, sunflower, sesame, tomato, watermelon, squash, eggplant, cantaloupe, cucumber and leafy vegetables) with a total area of around 24240.4 feddans and fruit tree crops (peach, fig, olive, date palm, almond, grape, citrus, guava, pomegranate, pearl, prickly pear, apricot and alfalfa) with a total area around 114888.4 feddans.

The table also shows that the total water requirements for the current cropping pattern came to roughly 123.18 million m^3, water requirement for winter crops were around 33134 million m^3, for summer crops were around 34261 million m^3 and for perennial crops were around 55623 million m^3, it was indicated that the average water unit return for the current crop pattern reached around 1.3, 1.1 and 3.9 LE for winter, summer and perennial crops respectively.

Table 1. *Averages of cropping pattern, net return/feddan, water requirements/feddan, water unit return and requirement /feddan (2011-2015).*

Crop	Current cropping pattern/feddan(1)	Net return / feddan(2)	Water requirements m^3/feddan(3)	Water unit return LE/m^3
Wheat	24583.2	1210	1099	1.1
Barley	100373	550	1180	0.47
Broad bean	1536.6	630	1175	0.54
Clover	1828	3670	7170	0.51
Onion	206.8	6900	1920	3.6
Garlic	20	7930	2305	3.4
Winter tomato	4079.4	5530	2745	2
W/pepper	57.8	1805	2435	0.74
W/peas	145	2200	2570	0.86
W/squash	1445.6	2020	3265	0.62
W/eggplant	114.4	2100	3260	0.64
W/cucumber	23.2	3200	2110	1.5

Crop	Current cropping pattern/feddan(1)	Net return / feddan(2)	Water requirements m^3/feddan(3)	Water unit return LE/m^3
Leafy vegetables	323.2	2400	1900	1.3
Total W/crops	134736.2	-	33134	1.3
Maize	1940.4	1022	3500	0.29
Groundnut	126	6404	3870	1.6
Sunflower	115	1240	2627	0.47
Sesame	280	3457	2950	1.2
Summer tomato	565.4	3890	3465	1.2
S/watermelon	17726.8	4200	2700	1.5
S/melon	1669.4	3900	2500	1.6
S/squash	420.4	1500	2155	0.70
S/eggplant	215.8	3217	2744	1.2
S/cantaloupe	775.2	5570	2780	2
S/cucumber	97	2500	2870	0.87
Leafy vegetables	309	2500	2100	1.2
Total S/crops	24240.4	-------	34261	1.1
Peach	560	5530	4510	1.2
Fig	64776.8	4330	4640	0.93
Olive	25518.8	2800	4270	0.65
Date palm	11263.2	5640	3570	1.6
Almond	764	5320	4560	1.2
Grape	4200.6	4200	4630	0.91
Citrus	709.2	4260	4910	8.7
Guava	1552.6	2600	3260	0.80
Pomegranate	98	4400	3268	1.3
Pear	1211	4150	3540	1.8
Apple	1382.2	3220	3288	0.98
Prickly pear	22.4	21800	850	22.9
Apricot	109.6	3500	3150	11
Clover Hegazy	2720	3670	7177	0.51
Total perennials	11488.4	-------	55623	3.9
Gross total	273865	-------	123018	2.1

Source: (1)- unpublished data, 2015, Directorate of Agriculture, Marsa Matrouh Governorate.
(2 and 3)- Ministry of Agriculture and Land Reclamation, Central Department for Agricultural Economy, unpublished data (2015).

2.2. Second: Description of the Objective Function to the Model of Multi-objectives Programing

To achieve the research goal, the multi-objectives programing to achieve several objectives simultaneously under in the presence of a number constraints to create cropping pattern that maximizes the net return from agricultural activities, rationalizes and minimizes water consumption and maximizes the use of work element under some production-related constraints and limitations to create the most efficient crop pattern that achieve the objective function, the multi-objectives programing was used to create the most possible and efficient solutions to achieve the desired objective function.

2.3. The Statistical Pattern

Defining the objective function using farm prices with relative weighs according to the importance of the objective function, the model includes three (3) objectives in the following mathematical forms:

2.3.1. First Objective Function: Maximizing the Net Return per Feddan

$$\text{Max } \{g1\ (x), g2\ (x), \ldots\ldots\ldots, gn\ (x)\} \qquad (1)$$

$$\text{Max } g1(x) = NiXi \qquad (2)$$

2.3.2. Second Objective Function: Maximizing the Net Return from Irrigation Water Unit

The Statistical Pattern:

$$\text{Max } g2(x) = RiXi \qquad (3)$$

$$R = N / W \qquad (4)$$

2.3.3. Third Objective Function: Minimizing Water Requirements Consumed

$$\text{Min } g3(x) = WiXi \qquad (5)$$

2.4. Model Constraints

The limited crop area means that the crop area doesn't exceed the average crop are for the period from (2011 – 2015) and estimated at around 273865 feddans

* The total limit for the winter crops area not less than 9780 feddans

* The total limit for summer crops area not less than 24240.4 feddans.

* The total limit for perennials area not less than 114888.4 feddans.

* The total limit for wheat and barley area not less than 124956.2 feddans.

$$\sum Xi \leq XW_{aver} \qquad (6)$$

As, X: is the total crops area under study

X_{aver}.: the average crop area

The limited area grown with winter crops which means that the total winter crops area doesn't exceed the average area grown with winter crops from (2010 to 2015).

$$\sum Xwi \le Xwaver \quad (7)$$

As, Xwi: the total winter crops area

Xw_{aver}.: the average winter crops

The limited summer crops area means the total area grown with summer crops doesn't exceed the average area grown with winter crops area from 2011 – 2015).

As, Xsiis: the total summer crops area

Xsaver.: the average crops area

$$\sum Xpi \le Xpaver \quad (8)$$

The limited perennials area means that the total area grown with perennials doesn't exceed the average area grown with perennials from (2011 to 2015).

As, Xpi: is the total area grown with perennials

Xp_{aver}.: is the average perennials area

$$\sum Xi > Xz \quad (9)$$

The minimum limit of crops area means that the crops area under study doesn't get below the minimum area grown with crops from the period (2011-2015).

$$\sum Xi \le Xy \quad (10)$$

Where, X2: is the minimum limit for each crop.

The maximum limit of crops area means that the area grown with crops doesn't exceed the maximum limit for area grown with crops from the period (2011-2015).

Where, Xy: is the maximum limit for each crop.

3. Water Resources Constraints

The available water resources in the Northwest Coast – through the available water amount for irrigation- was estimated at roughly 756.2 million m^3/year besides 23.8 million m^3/year in Al Hamam and Baheig canals to reach a total of 780 million m^3/year as shown in figures 1, 2, 3, 4 in the appendixes as water resources limitation was formed as follows:

ei = water requirement for the crop

Xi = the area grown with the crop i

W = the available amount of irrigation water

3.1. Organizational Constraints

The lower and higher limitations on production activities that are related to agro-industry, marketing and providing the basic agricultural resources for local consumption.

3.2. Local Consumption Constraints

The minimum agricultural production required for the area which was estimated at 20% of the current agricultural production together with the agro-industry.

3.3. Marketing Constraints

The maximum limit for marketing crops outside the governorate not more than 75% of the current crop area.

4. Results of the Different Alternatives of Programing the Objectives

4.1. Crop Pattern

4.1.1. The First Alternative

Table 2, shows- comparing the proposed cropping pattern with the current one- a reduction in the total winter crops areas by around 49025.2 feddans representing about 36.4% which were all the winter crops and another reduction in the summer crops areas by around 11595.9 feddans i.e. maize, cantaloupe, cucumber and leafy vegetables versus a rise in area grown with summer tomato by around 117.5 feddan, as for the fruit tree crops – the perennial crops- results of the programing pattern indicated a drop in areas of some crops such as peach, fig, olive, date palm, almond, grape, citrus, guava, pomegranate, prickly pear, apricot and alfalfa by about 19849.2 feddans versus a rise in the area grown with apple crop by roughly 875.2 feddans.

4.1.2. The Second Alternative

Table 2, also shows- comparing the proposed cropping pattern with the current one using the pattern of multi-objectives programing - a reduction in the winter crops areas close to 21158.6 feddans for barley, broad bean, clover, pepper, peas, squash, eggplant, cucumber and leafy vegetables versus a rise in areas grown with wheat, onion, garlic and tomato by around 21481.6 feddans, as for the summer crops there was a reduction by nearly 5612 feddans in maize, sunflower, sesame tomato, melon, squash, eggplant, cucumber and leafy vegetables versus an increase in in areas grown with groundnut, watermelon and cantaloupe by roughly 443 feddans. There was also a drop in the areas grown with late summer tomato by about 5412,4 feddans; whereas there was a reduction in the areas grown with some fruit crops i.e. grape, olive and guava by around 27071.4 feddans versus a rise in areas grown with peach, fig, date palm, almond, grape, citrus, pear, apple, prickly pear, apricot and alfalfa by nearly 26771 feddans.

4.1.3. The Third Alternative

Table 2, also shows- comparing the proposed cropping pattern with the current one using the model of multi-objectives programing - a reduction in the winter crops areas close to 19883.8 feddans i.e. barley, broad bean, clover, pepper, pea, squash, cucumber and leafy vegetables versus a rise in areas of some crops i.e. wheat, onion, garlic and eggplant by around 19883.8 feddans, as for summer crops, there was a drop in areas of some crops by almost 1766 feddans for maize, sunflower, sesame, tomato, melon, squash, cucumber and leafy vegetables versus a rise in the areas grown with some crop like groundnut, cantaloupe and melon by around 2044.6 feddans; whereas there was a reduction in the perennial crops by nearly 15349.4 feddan versus an increase in areas grown with other crops by roughly 15349.4 feddans, but that result was not reasonable since it is difficult to replace fruit crops with another ones in such short term, but possibly in the long term it could be reasonably feasible. Results of the programing model in the second scenario which the constraints for crop areas were used according to the maximum limit seem more reasonable comparing the results of programing patter in the first and third scenarios as the total areas grown in the proposed crop pattern was around 168.6 feddans which exceeds the area of the current cropping pattern by roughly 35.4 feddans.

4.2. The Net Return

4.2.1. The First Alternative

Since the multi-objectives programing model aims at maximizing the net return of cropping pattern, Table 3 compares the proposed net return with the current one, there was a drop in the net return of the proposed cropping pattern versus the current one by nearly 212 million LE representing around 31% of the net return of the crop structure versus the current one; accordingly, there was a shortage in the net return of winter, summer and perennial crops of the proposed crop pattern versus the current one by around 58, 72 and 80 million LE representing almost 48.7%, 77% and 17.3% respectively, and a rise in the net return of the summer tomato crop by nearly 2.6 million LE compared with the other crops.

4.2.2. The Second Alternative

Table 3 shows also a rise in the net return of the proposed croppingpattern versus the current one by around 103 million LE representing 15% from the net return of the current crop structure, there was a rise in the net return of the winter, summer and perennial crops for the proposed cropping pattern compared with the current one by around 29, 10 and 63 million LE representing around 24%, 11.1% and 13.6% respectively. There was also an increase in the net return for the winter crops i.e. wheat, onion, garlic and tomato by nearly 19.4, 1.9, 0.4 and 28.7 million LE respectively at the expense of the other crops, there was a rise in net return of the summer crops i.e. groundnut, watermelon and cantaloupe by nearly 0.5, 21, 3.1 million LE respectively. Results show also an increase in the net return of some fruit crops i.e. peach, fig, date palm, almond, grape, citrus, pomegranate, pear, apple, prickly pear, apricot and alfalfa by around 138.7 million LE versus a reduction in the net return of olive and guava crops by nearly 75.5 million LE.

4.2.3. The Third Alternative

Table 3 also indicated a shortage in the net return of the proposed cropping pattern versus the current one by nearly 205 million LE representing almost 30% of the net return of the current cropping pattern; accordingly, the rise in the net return for the winter, summer crops in the proposed crop pattern versus the current one was around 23.8 and 5.3 million LE representing about 19.6% and 5.7% respectively and a reduction in the net return of the perennials in the proposed crop pattern versus the current one by around 234.9 million LE representing roughly 50.2%. Results of the programing model in the second scenario in which constraints of crops areas were used according to the maximum limit were more reasonable versus that of the first and third scenarios as there was a rise in the net return of the suggested cropping pattern versus the current one by around 103 million LE representing roughly 15% of the net return of the current cropping pattern indicating farmers abandonment to grow the more profitable crops.

4.3. Water Unit Return

4.3.1. The First Alternative

Table 4- on the second objective of the multi-objectives programing on maximizing the net return of water unit of cropping pattern- indicated a shortage in water unit return suggested by the pattern by around 42.2% versus the current one. Accordingly, the shortage in winter, summer and perennial crops under the shortage of net return of the suggested crop stricter versus the current one was estimated at around 212 million LE representing roughly 31% from the net return of the current cropping pattern. As a result, it turned out that the average return of water unit reached 46.5 LE/m^3 in the suggested one versus 2.1 LE in the current one, the highest average return of water unit for winter crops was nearly 1.1 LE/m^3 for leafy vegetables, around 2.6 LE/m^3 for summer tomato and 16.3 LE/m^3 for prickly pear and about 9.6 LE/m^3 for apricot crop.

4.3.2. The Second Alternative

Table 4 also indicate a rise in the water unit return suggested by model by around 20.9% compared with the current one, so the increase of winter, summer and perennial crops in the presence of a rise in the net return of the proposed cropping pattern by nearly 103 million LE representing about 15% of the net return of the current crop pattern. It turned out that the average return of water unit reached roughly 111 LE/m^3 for the suggested one versus 2.1 LE/m^3 for the current one, the highest average return of water unit for onion was around 8.4%, 1.6 for groundnut, melon and 15.8 LE/m^3 for grape and 32.7 LE/m^3 for prickly pear.

4.3.3. The Third Alternative

Table 5 shows a rise in the water unit return suggested by the model by around 18.4% versus the current one. As a result, the shortage in net return of the proposed cropping pattern versus the current one by nearly 205 million LE representing roughly 30 of the net return of the current cropping pattern. It turned out that the average return reached roughly 89.3 LE/m^3 for the suggested one versus 2.1 LE/m^3 for the current one.

The highest average return of water unit for winter crops was nearly 3.8 LE/m^3 for winter tomato, 2.7 LE/m^3, 2.6 LE/m^3, 32.2 LE/m^3 the and 9.6LE/m^3 for groundnut, summer tomato, prickly pear and apricot, respectively. Results of water unit return for the second and third scenarios showed an increase in the water unit return in the suggested cropping patterns compared with that in the current ones. It turned out that the second scenario was the best according to the value of water unit return in the suggested cropping pattern with a rise of around 103 million LE which is 15% higher than the net return in the current cropping pattern, Table (5). The highest average return of water unit was for prickly pear crop in the three (3) scenarios followed by summer tomato and apricot, Table (5).

Table 2. *Comparison between the current and proposed cropping pattern using the multi-objectives programming.*

crop	First alternative			
	current	proposed	Change	%
	feddan	feddan	feddan	
Wheat	24583.2	12950	11633.2-	47.3-
Barley	100373	70400	29973-	-30
Broad bean	1536.6	580	956.6-	-62.2
Clover	1828	600	1228-	67.2-
Onion	206.8	71	135.8-	65.7-
Garlic	20	0	20-	100-
Winter tomato	4079.4	692	-3387.4-	83-
W/pepper	57.8	0	57.8-	-100
W/peas	145	5	140-	-96.5
W/squash	1445.6	130	1315.6-	-91
W/eggplant	114.4	2	112.4-	-98.2
W/cucumber	23.2	0	-23.2-	100-
Leafy vegetables	323.2	281	-42.2-	13-
Total W/crops	134736.2	85711	49025.2-	-36.4
Maize	1940.4	970	970.4-	50-
Groundnut	126	0	126-	-100
Sunflower	115	0	115-	-100
Sesame	280	0	280-	100-
Summer tomato	565.4	1230	664.6	117.5
S/watermelon	17726.8	3155	14571.8-	82.2-
S/melon	1669.4	410	1259.4-	-75.4
S/squash	420.4	295	125.4-	30-
S/eggplant	215.8	106	109.8-	51-
S/cantaloupe	775.2	213	562.2-	72.5-
S/cucumber	97	8	89-	91.2-
Leafy vegetables	309	140	169-	54.7-
Total S/crops	24240.4	6527	17713.4-	-73.1
Peach	560	297	263-	-47
Fig	64776.8	62703	2073.8-	-3.2
Olive	25518.8	17409	8109.8-	31.8-
Date palm	11263.2	5895	5368.2-	-47.7
Almond	764	762	2-	0.3-
Grape	4200.6	4003	197.6-	4.7-
Citrus	709.2	345	364.2-	51.3-
Guava	1552.6	829	723.6-	46.6-
Pomegranate	98	16	82-	--83.7
Pear	1211	986	225-	18.6-
Apple	1382.2	507	875.2	63.3-
Prickly pear	22.4	16	6.4-	28.6-
Apricot	109.6	96	13.6-	12.4-
Alfalfa	2720	300	2420-	89-
Total perennials	114888.4	94164	20724.4-	-18
Gross total	273865	186402	87463-	32-

Table 2. *Continued.*

crop	Second alternative				Third alternative			
	current feddan	proposed feddan	Change feddan	%	current feddan	proposed feddan	Change feddan	%
Wheat	24583.2	40591	16007.8	65.1	24583.2	40591	16007.8	65.1
Barley	100373	84365	-16008	-16	100373	84365	16008-	16-
Broad bean	1536.6	0	-1536.6	-100	1536.6	580	956.6-	62.2-
Clover	1828	0	-1828	-100	1828	600	1228-	67.2-
Onion	206.8	485	278.2	134.5	206.8	485	278.2	134.5
Garlic	20	25	5	25	20	25	5	25
Winter tomato	4079.4	9270	5190.6	127.2	4079.4	7672	3592.6	88.1
W/pepper	57.8	0	-57.8	-100	57.8	0	57.8-	100-
W/peas	145	0	-145	-100	145	5	-140-	96.5-
W/squash	1445.6	0	-1445.6	-100	1445.6	130	1315.6-	91-
W/eggplant	114.4	0	-114.4	-100	114.4	2	112.4-	98.2
W/cucumber	23.2	0	-23.2	-100	23.2	0	23.2-	100-
Leafy vegetables	323.2	0	-323.2	-100	323.2	281	42.2-	13-
Total W/crops	134736.2	134736	-0.2	-0.0001	134736.2	134736	0.2-	0.0001-
Maize	1940.4	0	1940.4-	100-	1940.4	970	970.4-	50-
Groundnut	126	210	84	66.7	126	210	84	66.4
Sunflower	115	0	115-	100-	115	0	115-	100-
Sesame	280	0	280-	100-	280	0	280-	100-
Summer tomato	565.4	0	565.4-	100-	565.4	1230	664.6	117.5-
S/watermelon	17726.8	22690	4963.2	28	17726.8	18458	731.2	4.1
S/melon	1669.4	0	1669.4-	100-	1669.4	1482	187.4-	11.2-
S/squash	420.4	0	420.4-	100-	420.4	295	125.4-	30-
S/eggplant	215.8	0	15.8-	100-	215.8	106	109.8-	50.1-
S/cantaloupe	775.2	1340	564.8	72.8	775.2	1340	564.8	72.8
S/cucumber	97	0	97-	100-	97	8	89-	91.7-
Leafy vegetables	309	0	309-	100-	309	140	-169-	54.7-
Total S/crops	24240.4	24240	-0.4	-0.002	24240.4	24239	1.4-	0.006-
Peach	560	952	392	70	560	297	263-	47-
Fig	64776.8	69370	4593.2	7.1	64776.8	62703	2073.8-	3.2-
Olive	25518.8	0	25518.8-	100-	25518.8	17409	8109.8-	31.8-
Date palm	11263.2	29355	18091.8	160.7	11263.2	26603	15339.8	136.2
Almond	764	766	2	0.3	764	762	2-	0.3-
Grape	4200.6	4523	322.4	7.7	4200.6	4003	197.6-	4.7-
Citrus	709.2	1289	579.8	81.7	709.2	345	364.2-	51.3-
Guava	1552.6	0	1552.6-	100-	1552.6	829	723.6-	46.6-
Pomegranate	98	283	185	188.8	98	16	82-	83.7-
Pear	1211	1378	167	13.8	1211	986	225-	18.6-
Apple	1382.2	2019	636.8	46.1	1382.2	507	875.2-	63.3-
Prickly pear	22.4	32	9.6	42.8	22.4	32	9.6	42.8
Apricot	109.6	121	11.4	10.4	109.6	96	13.6-	12.4-
Alfalfa	2720	4500	1780	65.4	2720	300	2420-	89-
Total perennials	114888.4	114588	-300.4	-0.3	114888.4	114888	0.4-	0.0003-
Gross total	273865	273564.2	-300.8	-0.1	273865	273863	2-	0.001-

Source: Result of model analysis of the multi-objectives programming.

Table 3. *Comparison between the current and proposed net return using the multi-objectives programming.*

crop	First alternative			
	current feddan	current Feddan	current	%
Wheat	29745672	15669500	14076172-	47.3-
Barley	55205150	38720000	16485150-	-30
Broad bean	968058	365400	602658-	-62.2
Clover	6708760	2202000	4506760-	67.2-
Onion	1426920	489900	937020-	65.7-
Garlic	158600	0	-158600-	100-
Winter tomato	22559082	3826760	18732322-	83-
W/pepper	104329	0	104329-	-100
W/peas	319000	11000	308000-	-96.5
W/squash	2920112	262600	2657512-	-91
W/eggplant	240240	4200	236040-	-98.2
W/cucumber	74240	0	74240-	100-
Leafy vegetables	775680	674400	101280-	13-
Total W/crops	121205843	62225760	58980083-	-48.7
Maize	1983088.8	991340	991748.8-	50-
Groundnut	806904	0	806904-	-100
Sunflower	142600	0	142600-	-100
Sesame	967960	0	967960-	100-
Summer tomato	2199406	4784700	2585294	117.5
S/watermelon	74452560	13251000	61201560-	82.2-
S/melon	6510660	159000	6351660-	-75.4
S/squash	630600	442500	188100-	30-
S/eggplant	694228.6	341002	353226.6-	51-
S/cantaloupe	4317864	1186410	3131454-	72.5-
S/cucumber	242500	20000	222500-	91.2-
Leafy vegetables	772500	350000	-422500	54.7-
Total S/crops	93720871	21525952	-72194919	-77
Peach	3096800	1642410	1454390-	-47
Fig	280483544	271504000	8979544-	3.2-
Olive	71452640	48745200	22707440-	31.8-
Date palm	63524448	33247800	30276648-	-47.7
Almond	4064480	4053840	10640-	0.3-
Grape	17642520	16812600	829920-	4.7-
Citrus	3021192	1469700	1551492-	51.3-
Guava	4036760	2155400	1881360-	46.6-
Pomegranate	431200	70400	360800-	-83.7
Pear	5025650	4091900	933750-	18.6-
Apple	4450684	1632540	2818144-	63.3-
Prickly pear	488320	349440	138880-	28.6
Apricot	383600	336000	47600-	12.4-
Alfalfa	9982400	1101000	8881400-	89-
Total perennials	468084238	387212230	80872008-	-17.3
Gross total	683010952	470963942	212047010-	31-

Table 3. *Continued.*

crop	Second alternative				Third alternative			
	current feddan	current feddan	current	%	current feddan	current feddan	current	%
Wheat	29745672	49115112	19369440	65.1	29745672	49115112	19369440	65.1
Barley	55205150	46400752	8804398-	-16	55205150	46400752	8804398-	16-
Broad bean	968058	0	968058-	-100	968058	365400	602658-	62.2-
Clover	6708760	0	6708760-	-100	6708760	2202000	4506760-	67.2-
Onion	1426920	3346500	1919580	134.5	1426920	3364500	1937580	134.5
Garlic	158600	198250	39650	25	158600	198250	39650	25
Winter tomato	22559082	51263100	28704018	127.2	22559082	42426160	19867078	88.1
W/pepper	104329	0	104329-	-100	104329	0	104329-	100-
W/peas	319000	0	319000-	-100	319000	11000	308000-	96.5-
W/squash	2920112	0	2920112-	-100	2920112	262600	2657512-	91-
W/eggplant	240240	0	240240-	-100	240240	4200	236040-	98.2
W/cucumber	74240	0	74240-	-100	74240	0	74240-	100-
Leafy vegetables	775680	0	775680-	-100	775680	674400	101280-	13-
Total W/crops	121205843	150323714	29117871	24	121205843	145024374	23818531	19.6
Maize	1983088.8	0	1983088.8-	100-	1983088.8	991340	991748.8-	50-
Groundnut	806904	1344840	537936	66.7	806904	1344840	537936	66.4
Sunflower	142600	0	142600-	100-	142600	0	142600-	100-
Sesame	967960	0	967960	100-	967960	0	967960-	100-
Summer tomato	2199406	0	2199406-	100-	2199406	4784700	2585294	117.5-
S/watermelon	74452560	95298000	20845440	28	74452560	77524864	3072304	4.1
S/melon	6510660	0	6510660-	100-	6510660	5782530	728130-	11.2-
S/squash	630600	0	630600-	100-	630600	442500	188100-	30-
S/eggplant	694228.6	0	694228.6-	100-	694228.6	341002	353226.6-	50.1-
S/cantaloupe	4317864	7463800	3145936	72.8	4317864	7463800	3145936	72.8
S/cucumber	242500	0	242500-	100-	242500	20000	222500-	91.7-
Leafy vegetables	772500	0	772500-	100-	772500	350000	422500-	54.7-
Total S/crops	93720871	104106640	10385769	11.1	93720871	99045576	5324704.6	5.7
Peach	3096800	5264560	2167760	70	3096800	1642410	1454390-	47-
Fig	280483544	300372096	19888552	7.1	280483544	271504	280212040-	3.2-
Olive	71452640	0	-71452640	100-	71452640	48745200	22707440-	31.8-
Date palm	63524448	165562208	102037760	160.7	63524448	150040928	86516480	136.2
Almond	4064480	4075120	10640	0.3	4064480	4053480	11000-	0.3-
Grape	17642520	18996600	1354080	7.7	17642520	16812600	829920-	4.7-
Citrus	3021192	5491140	2469948	81.7	3021192	1469700	1551492-	51.3-
Guava	4036760	0	-4036760	100-	4036760	2155400	1881360-	46.6-
Pomegranate	431200	1245200	814000	188.8	431200	70400	360800-	83.7-
Pear	5025650	5718700	693050	13.8	5025650	4091900	933750-	18.6-
Apple	4450684	6501180	2050496	46.1	4450684	1632540	2818144-	63.3-
Prickly pear	488320	697600	209280	42.8	488320	697600	209280	42.8
Apricot	383600	423500	39900	10.4	383600	336000	47600-	12.4-
Alfalfa	9982400	17616000	7633600	65.4	9982400	1101000	8881400-	89-
Total perennials	468084238	531963904	63879666	13.6	468084238	233120662	234963576-	50.2-
Gross total	683010952	786394258	103383306	15	683010952	477190612	205820340-	30-

Source: Result of model analysis of the multi-objectives programming

Table 4. *Comparison between the current and proposed water unit return using the multi-objectives programming.*

p	First alternative				
	current	current	current	%	Proposed water unit return
	feddan	feddan			
Wheat	27041.52	14245	12796.52-	47.3-	0.6
Barley	47175.31	33088	14087.31-	-30	0.3
Broad bean	829.764	313.2	516.564-	-62.2	0.2
Clover	932.28	306	626.28-	67.2-	0.2
Onion	744.48	255.6	488.88-	65.7-	1.2
Garlic	68	0	68-	100-	0
Winter tomato	8158.8	1384	6774.8-	83-	0.3
W/pepper	42.772	0	42.772-	-100	0
W/peas	124.7	4.3	120.4-	-96.5	0.02
W/squash	896.272	80.6	815.672-	-91	0.1
W/eggplant	73.216	1.28	-71.936	-98.2	0.01
W/cucumber	34.8	0	-34.8	100-	0
Leafy vegetables	420.16	365.3	54.86-	13-	1.1
Total W/crops	86542.074	50043.28	-36498.794	-42.2	4
Maize	562.716	281.3	-281.416	50-	0.1
Groundnut	201.6	0	-201.6	-100	0
Sunflower	54.05	0	-54.05	-100	0
Sesame	336	0	-336	100-	0
Summer tomato	678.48	1476	797.52	117.5	2.6
S/watermelon	26590.2	4732.5	-21857.7	82.2-	0.3
S/melon	2671.04	656	-2015.04	-75.4	0.4
S/squash	294.28	206.5	-87.78	30-	0.5
S/eggplant	258.96	127.2	-131.76	51-	0.6
S/cantaloupe	1550.4	426	-1124.4	72.5-	0.5
S/cucumber	84.39	6.96	-77.43	91.2-	0.1
Leafy vegetables	370.8	168	-202.8	54.7-	0.5
Total S/crops	33652.916	8080.46	-25572.456	76-	5.5
Peach	672	356.4	315.6-	-47	0.6
Fig	60242.424	58313.79	1928.634-	3.2-	0.9
Olive	16587.22	11315.85	5271.37-	31.8-	0.4
Date palm	18021.12	9432	8589.12-	-47.7	0.8
Almond	916.8	914.4	2.4-	0.3-	1.2
Grape	3822.546	3642.73	179.816-	4.7-	0.9
Citrus	6170.04	3001.5	3168.54-	51.3-	4.2
Guava	1242.08	663.2	578.88-	46.6-	0.4
Pomegranate	127.4	20.8	106.6-	-83.7	0.2
Pear	2179.8	1774.8	405-	18.6-	1.5
Apple	1354.556	496.86	857.696-	63.3-	0.3
Prickly pear	512.96	366.4	146.56-	28.6	16.3
Apricot	1205.6	1056	149.6-	12.4-	9.6
Alfalfa	1387.2	153	1234.2-	89-	0.1
Total perennials	114441.75	91507.73	22934.02-	20-	37.4
Gross total	86542.074	50043.28	-36498.794	-42.2	46.5

Table 4. *Continued.*

p	Second alternative				
	current	current	current	%	Proposed water unit return
	feddan	Feddan			
Wheat	27041.52	44650.1	17608.58	65.1	1.8
Barley	47175.31	39651.55	-7523.76	-16	0.4
Broad bean	829.764	0	-829.764	-100	0
Clover	932.28	0	-932.28	-100	0
Onion	744.48	1746	1001.52	134.5	8.4
Garlic	68	85	17	25	4.2
Winter tomato	8158.8	18540	10381.2	127.2	4.5
W/pepper	42.772	0	-42.772	-100	0
W/peas	124.7	0	-124.7	-100	0
W/squash	896.272	0	-896.272	-100	0
W/eggplant	73.216	0	-73.216	-100	0
W/cucumber	34.8	0	-34.8	-100	0
Leafy vegetables	420.16	0	420.16-	-100	0
Total W/crops	86542.074	104672.65	18130.576	20.9	19.3
Maize	562.716	562.716	0	100-	0.3
Groundnut	201.6	201.6	336	66.7	1.6
Sunflower	54.05	54.05	0	100-	0.5
Sesame	336	336	0	100-	1.2
Summer tomato	678.48	678.48	0	100-	1.2
S/watermelon	26590.2	26590.2	34035	28	1.5
S/melon	2671.04	2671.04	0	100-	1.6
S/squash	294.28	294.28	0	100-	0.7
S/eggplant	258.96	258.96	0	100-	1.2
S/cantaloupe	1550.4	1550.4	2680	72.8	2
S/cucumber	84.39	84.39	0	100-	0.9
Leafy vegetables	370.8	370.8	0	100-	1.2
Total S/crops	33652.916	33652.916	37051	10.1	13.9
Peach	672	1142.4	470.4	70	2
Fig	60242.424	64514.1	4271.676	7.1	1
Olive	16587.22	0	16587.22-	100-	0
Date palm	18021.12	46968	28946.88	160.7	4.2
Almond	916.8	919.2	2.4	0.3	1.2
Grape	3822.546	4115.93	293.384	7.7	1
Citrus	6170.04	11214.3	5044.26	81.7	15.8
Guava	1242.08	0	1242.08-	100-	0
Pomegranate	127.4	367.9	240.5	188.8	3.7
Pear	2179.8	2480.4	300.6	13.8	2
Apple	1354.556	1978.62	624.064	46.1	1.4
Prickly pear	512.96	732.8	219.84	42.8	32.7
Apricot	1205.6	1331	125.4	10.4	12
Alfalfa	1387.2	2295	907.8	65.4	0.8
Total perennials	114441.75	138059.65	23617.9	20.6	77.8
Gross total	86542.074	104672.65	18130.576	20.9	111

Table 4. *Continued.*

p	Thirdt alternative				
	current feddan	current feddan	current	%	Proposed water unit return
Wheat	27041.52	44650.1	17608.58	65.1	1.8
Barley	47175.31	39651.55	7523.76-	16-	0.4
Broad bean	829.764	313.2	516.564-	62.2-	0.2
Clover	932.28	306	626.28-	67.2-	0.2
Onion	744.48	1746	1001.52	134.5	8.4
Garlic	68	85	17	25	4.2
Winter tomato	8158.8	15344	7185.2	88.1	3.8
W/pepper	42.772	0	42.772-	100-	0
W/peas	124.7	4.3	120.4-	96.5-	0.02
W/squash	896.272	80.6	815.672-	91-	0.1
W/eggplant	73.216	1.28	71.936-	98.2	0.01
W/cucumber	34.8	0	-34.8-	100-	0
Leafy vegetables	420.16	365.3	54.86-	13-	1.1
Total W/crops	86542.074	102547.33	16005.256	18.4	20.23
Maize	562.716	281.3	281.416-	50-	0.1
Groundnut	201.6	336	134.4	66.4	2.7
Sunflower	54.05	0	54.05-	100-	0
Sesame	336	0	-336-	100-	0
Summer tomato	678.48	1476	797.52-	117.5-	2.6
S/watermelon	26590.2	27687	1096.8-	4.1	1.5
S/melon	2671.04	2371.2	299.84-	11.2-	1.4
S/squash	294.28	206.5	87.78-	30-	0.5
S/eggplant	258.96	127.2	131.76-	50.1-	0.6
S/cantaloupe	1550.4	2680	1129.6	72.8	3.4
S/cucumber	84.39	6.96	77.43-	91.7-	0.1
Leafy vegetables	370.8	168	202.8-	54.7-	0.5
Total S/crops	33652.916	35340.16	1687.244	5	13.4
Peach	672	356.4	-315.6-	47-	0.6
Fig	60242.424	58313.79	1928.634-	3.2-	0.9
Olive	16587.22	11315.85	5271.37-	31.8-	0.4
Date palm	18021.12	42564.8	24543.68	136.2	3.8
Almond	916.8	914.4	2.4-	0.3-	1.2
Grape	3822.546	3642.73	179.816-	4.7-	0.9
Citrus	6170.04	3001.5	3168.54-	51.3-	4.2
Guava	1242.08	663.2	578.88-	46.6-	0.4
Pomegranate	127.4	20.8	106.6-	83.7-	0.2
Pear	2179.8	1774.8	405-	18.6-	1.5
Apple	1354.556	496.86	857.696-	63.3-	0.3
Prickly pear	512.96	732.8	219.84	42.8	32.7
Apricot	1205.6	1056	149.6-	12.4-	9.6
Alfalfa	1387.2	153	1234.2-	89-	0.1
Total perennials	114441.75	125006.93	10565.18	9.2	56.8
Gross total	86542.074	102547.33	16005.256	18.4	89.35

Source: Result of model analysis of the multi-objectives programming

Table 5. *Comparison between the current and proposed water requirements using the multi-objectives programming.*

crop	First alternative			
	current	current	current	%
	feddan	feddan		
Wheat	27016937	14232050	12784887-	47.3-
Barley	118000000	83072000	34928000-	-30
Broad bean	1805505	681500	1124005-	-62.2
Clover	13106760	4302000	8804760-	67.2-
Onion	397056	136320	260736-	65.7-
Garlic	46100	0	46100-	100-
Winter tomato	11197953	1899540	9298413-	83-
W/pepper	140743	0	140743-	-100
W/peas	372650	12850	359800-	-96.5
W/squash	4719884	424450	4295434-	-91
W/eggplant	372944	6520	366424-	-98.2
W/cucumber	48952	0	48952-	100-
Leafy vegetables	614080	533900	80180-	13-
Total W/crops	177839564	105301130	72538434-	-40.8
Maize	6791400	3395000	3396400-	50-
Groundnut	487620	0	487620-	-100
Sunflower	302105	0	302105-	-100
Sesame	826000	0	826000-	100-
Summer tomato	1959111	4261950	2302839	117.5
S/watermelon	47862360	8518500	39343860-	82.2-
S/melon	4173500	1025000	3148500-	-75.4
S/squash	905962	635725	270237-	30-
S/eggplant	592155.2	290864	301291.2-	51-
S/cantaloupe	2155056	592140	1562916-	72.5-
S/cucumber	278390	22960	-255430	91.2-
Leafy vegetables	648900	294000	354900-	54.7-
Total S/crops	66982559	19036139	-47946420-	-71.6
Peach	2525600	1339470	1186130-	-47
Fig	301000000	290941920	10058080-	-3.2
Olive	109000000	74336430	34663570-	31.8-
Date palm	40209624	21045150	19164474-	-47.7
Almond	3483840	3474720	9120-	0.3-
Grape	19448778	18533890	914888-	4.7-
Citrus	3482172	1693950	1788222-	51.3-
Guava	5061476	2702540	2358936-	46.6-
Pomegranate	320264	52288	267976-	83.7
Pear	4286940	3490440	796500-	18.6-
Apple	4544674	1667016	-2877658	63.3-
Prickly pear	19040	13600	-5440	28.6-
Apricot	345240	302400	42840-	12.4-
Alfalfa	19521440	2153100	-17368340-	89-
Total perennials	513249088	421746914	-91502174	-17.8
Gross total	758071211	546084183	211987028-	28-

Table 5. *Continued.*

crop	Second alternative				Third alternative			
	current feddan	current Feddan	current feddan	%	current feddan	current feddan	current feddan	%
Wheat	27016937	44609509	17592572	65.1	27016937	44609509	17592572	65.1
Barley	118000000	99550700	-18449300	-16	118000000	99550700	-18449300	16-
Broad bean	1805505	0	-1805505	-100	1805505	681500	-1124005	62.2-
Clover	13106760	0	-13106760	-100	13106760	4302000	-8804760	67.2-
Onion	397056	931200	534144	134.5	397056	931200	534144	134.5
Garlic	46100	57625	11525	25	46100	57625	11525	25
Winter tomato	11197953	25446150	14248197	127.2	11197953	21059640	9861687	88.1
W/pepper	140743	0	-140743	-100	140743	0	-140743	100-
W/peas	372650	0	-372650	-100	372650	12850	-359800	96.5-
W/squash	4719884	0	-4719884	-100	4719884	424450	-4295434	91-
W/eggplant	372944	0	-372944	-100	372944	6520	-366424	98.2
W/cucumber	48952	0	-48952	-100	48952	0	-48952	100-
Leafy vegetables	614080	0	-614080	-100	614080	533900	-80180	13-
Total W/crops	177839564	170595184	-7244380	-4.1	177839564	172169894	-5669670	3.2-
Maize	6791400	0	6791400-	100-	6791400	3395000	3396400-	50-
Groundnut	487620	812700	325080	66.7	487620	812700	325080	66.4
Sunflower	302105	0	-302105-	100-	302105	0	302105-	100-
Sesame	826000	0	826000-	100-	826000	0	826000-	100-
Summer tomato	1959111	0	1959111-	100-	1959111	4261950	2302839	117.5-
S/watermelon	47862360	61263000	13400640	30	47862360	49836600	1974240	4.1
S/melon	4173500	0	4173500-	100-	4173500	3705000	468500-	11.2-
S/squash	905962	0	-905962-	100-	905962	635725	270237-	30-
S/eggplant	592155.2	0	592155.2-	100-	592155.2	290864	301291.2-	50.1-
S/cantaloupe	2155056	3725200	1570144	72.8	2155056	3725200	1570144	72.8
S/cucumber	278390	0	278390-	100-	278390	22960	255430-	91.7-
Leafy vegetables	648900	0	648900-	100-	648900	294000	354900-	54.7-
Total S/crops	66982559	65800900	1181659.2-	-1.8	66982559	66979999	2560.2-	0.004-
Peach	2525600	4293520	1767920	70	2525600	1339470	-1186130	47-
Fig	301000000	321876800	20876800	7.1	301000000	290941920	-10058080	3.2-
Olive	109000000	0	-109000000	100-	109000000	74336430	-34663570	31.8-
Date palm	40209624	104797350	64587726	160.7	40209624	94972710	54763086	236.2
Almond	3483840	3492960	9120	0.3	3483840	3474720	-9120	0.3-
Grape	19448778	20941490	1492712	7.7	19448778	18533890	-914888	4.7-
Citrus	3482172	6328990	2846818	81.7	3482172	1693950	-1788222	51.3-
Guava	5061476	0	-5061476	100-	5061476	2702540	-2358936	46.6-
Pomegranate	320264	924844	604580	188.8	320264	52288	-267976	83.7-
Pear	4286940	4878120	591180	13.8	4286940	3490440	-796500	18.6-
Apple	4544674	6638472	2093798	46.1	4544674	1667016	-2877658	63.3-
Prickly pear	19040	27200	8160	42.8	19040	27200	8160	42.9
Apricot	345240	381150	35910	10.4	345240	302400	-42840	12.4-
Alfalfa	19521440	32296500	12775060	65.4	19521440	2153100	-17368340	89-
Total perennials	513249088	506877396	-6371692	-1.2	513249088	495688074	-17561014	-3.4-
Gross total	758071211	743273480	14797731.2-	-1.9	758071211	1510470192	2268541403	299.2

Source: Result of model analysis of the multi-objectives programming

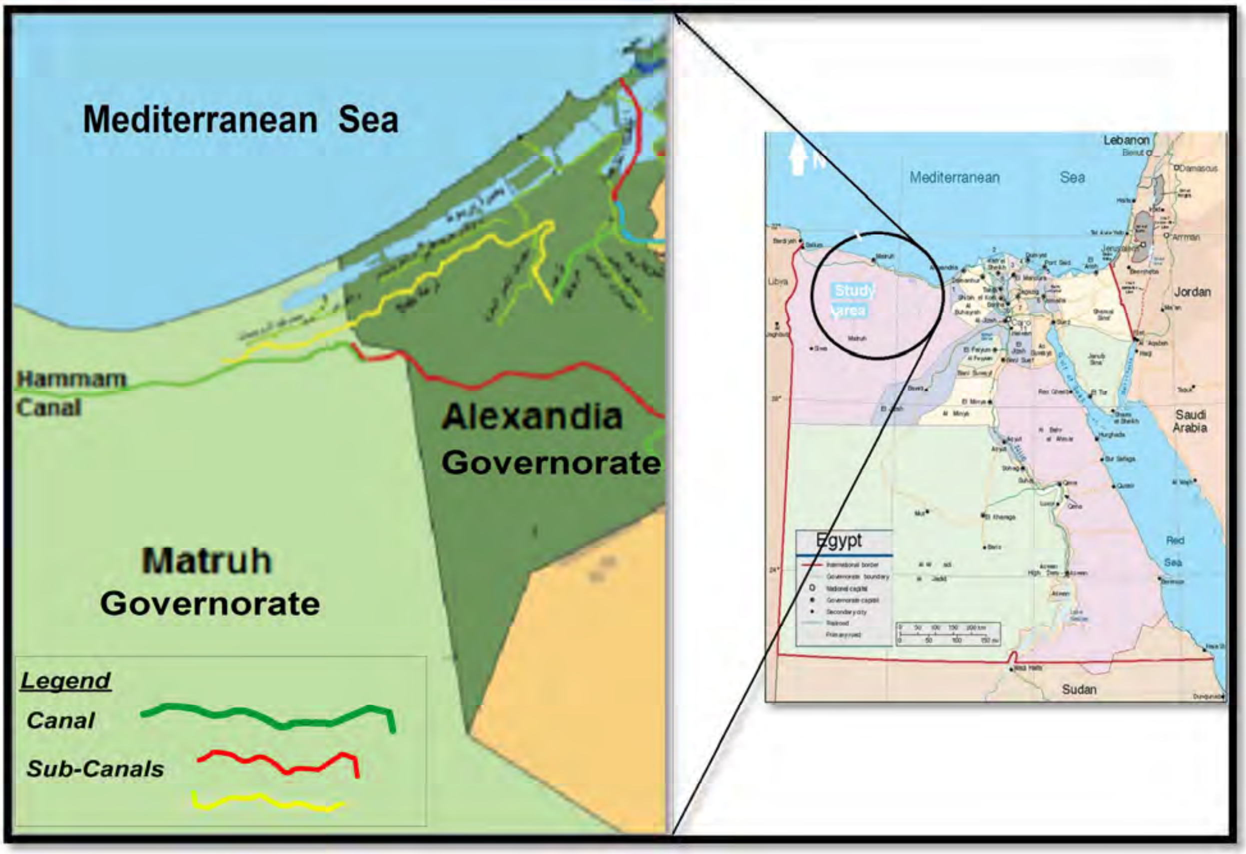

Figure 1. *Location Map of study area & its Canals Net, ((Modified After NWRC, RIGW, 2015).*

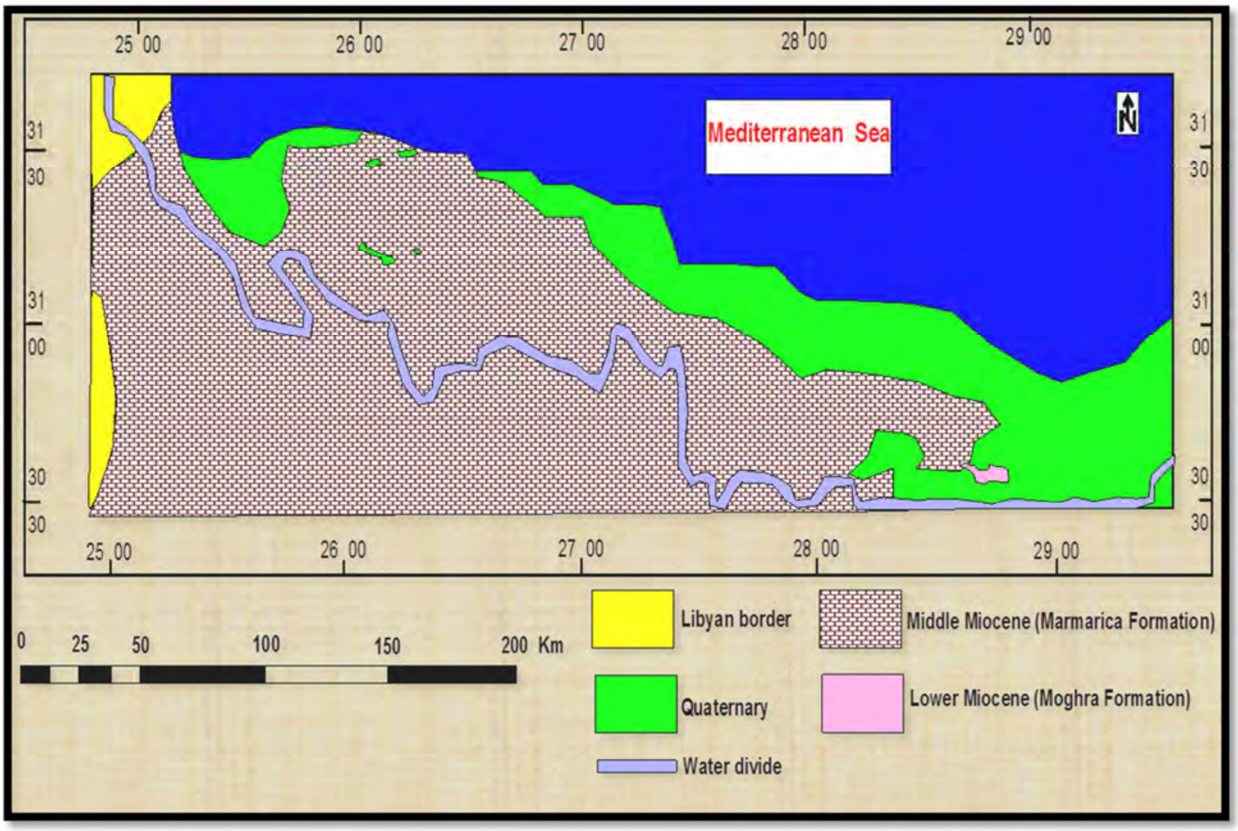

Figure 2. *Geological map of the study area. ((Modified after Conoco, 1987).*

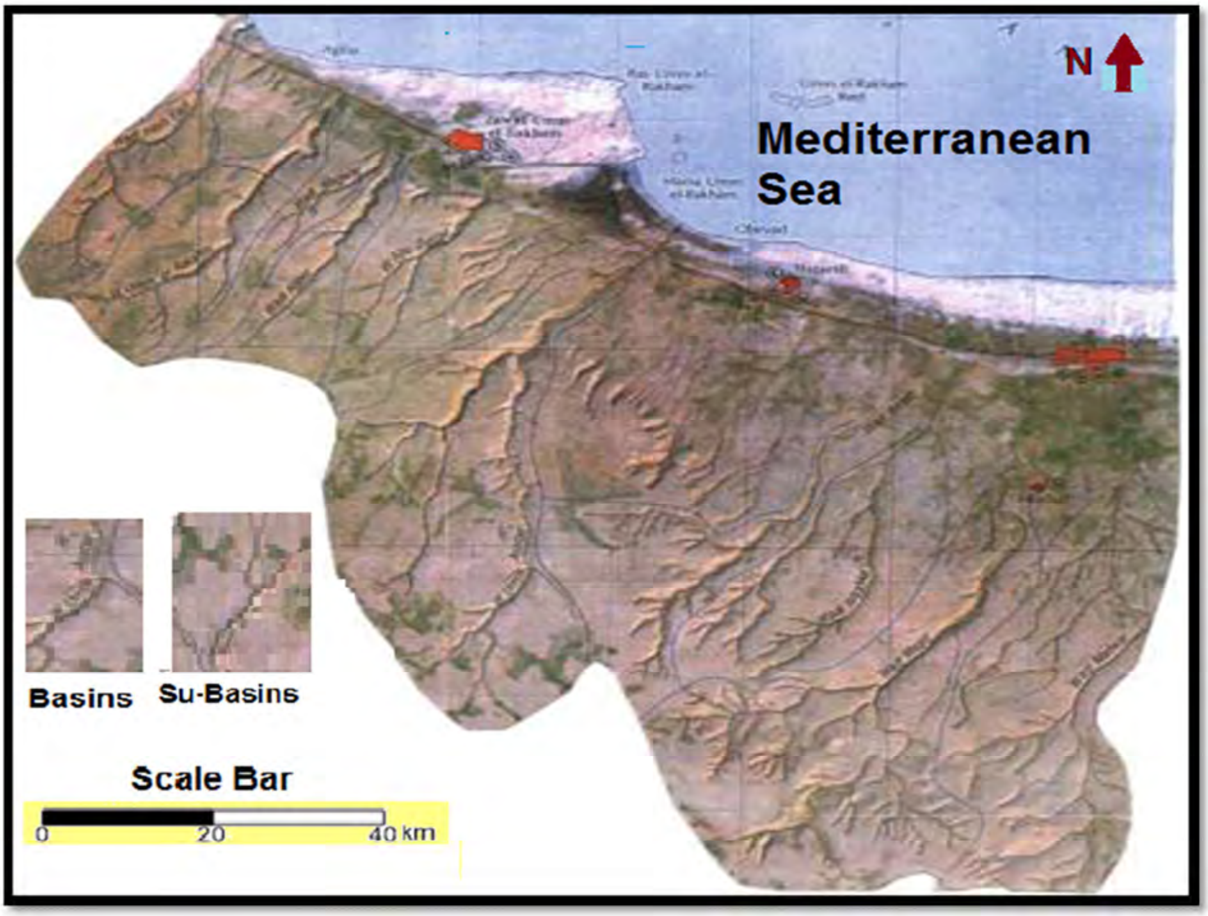

Figure 3. Digital Elevation Model (2-D DIM) Marsa Matruh Governorate.

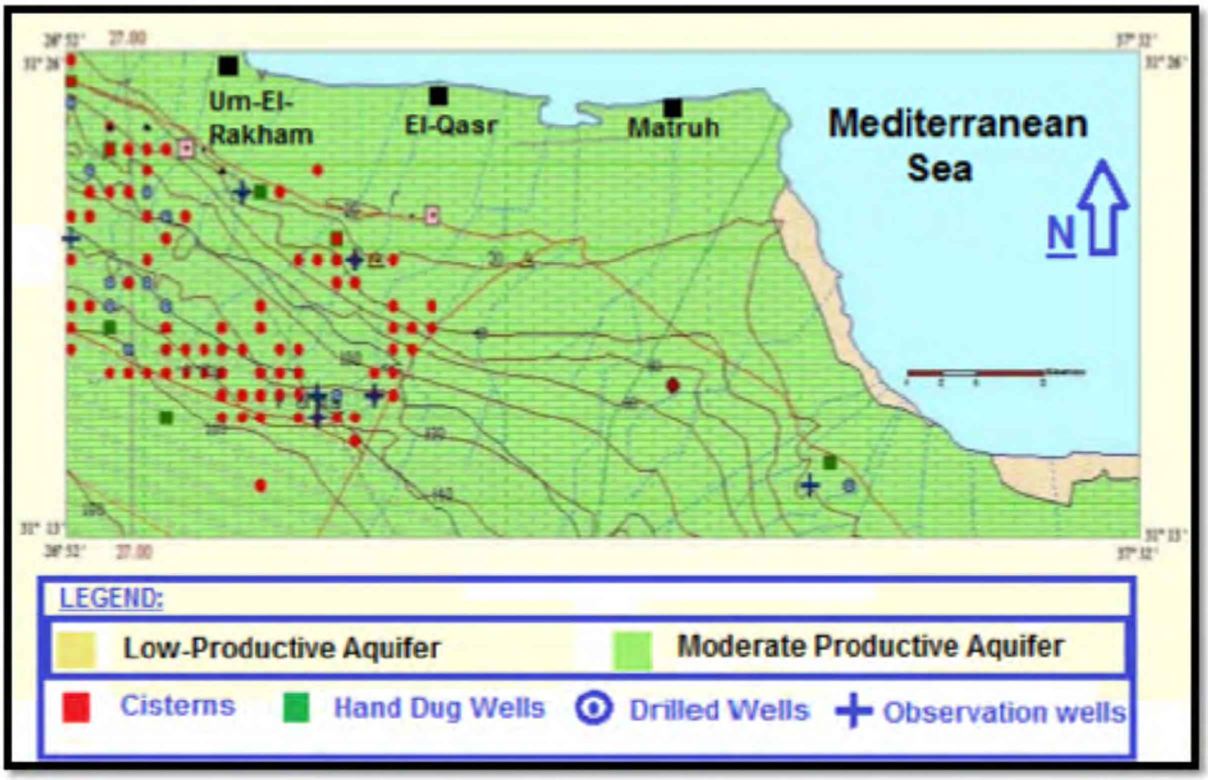

Figure 4. Hydrological Map For Matruh Basin, (Modified After Ministry of NWRC, RIGW, 2015).

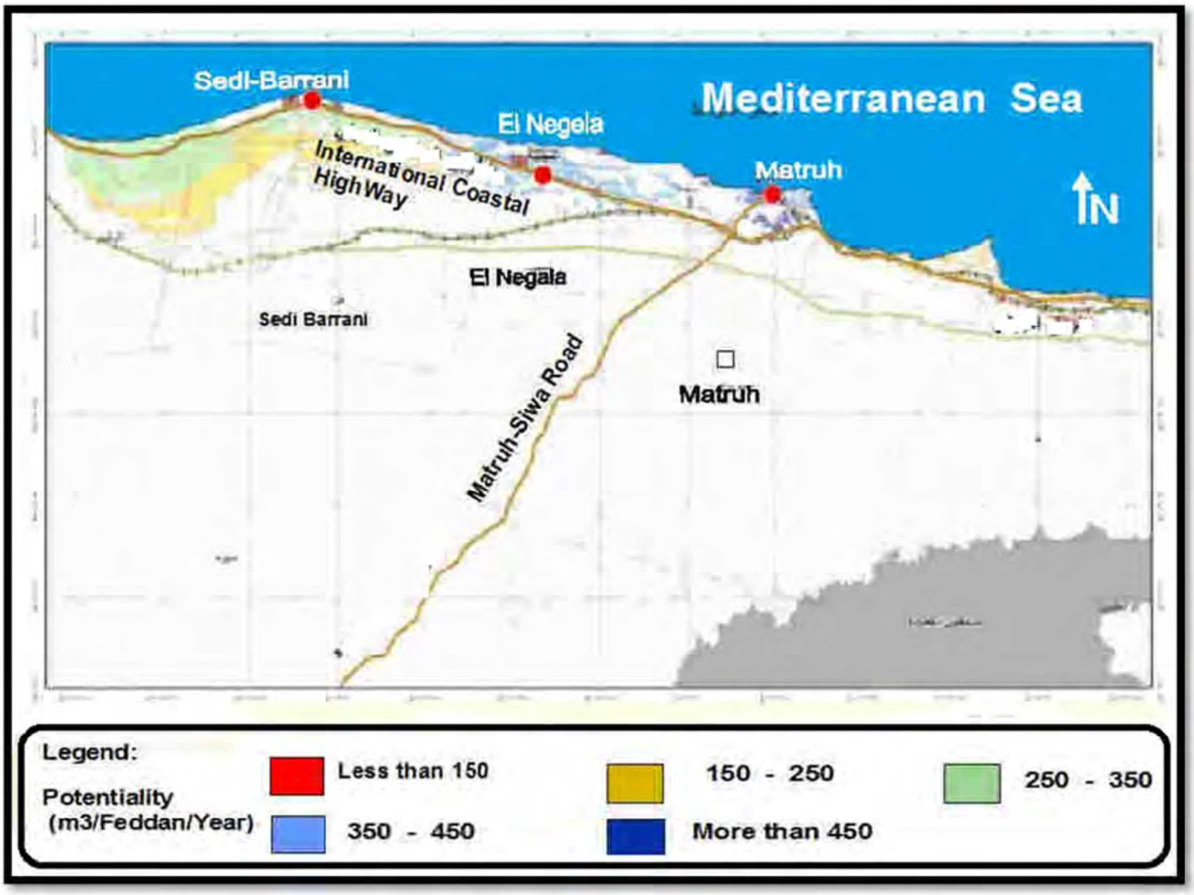

Figure 5. Renewable Groundwater Potentiality of Western-North Coast (Matroh and its Viciniets), ((Modified After NWRC, RIGW, 2015).

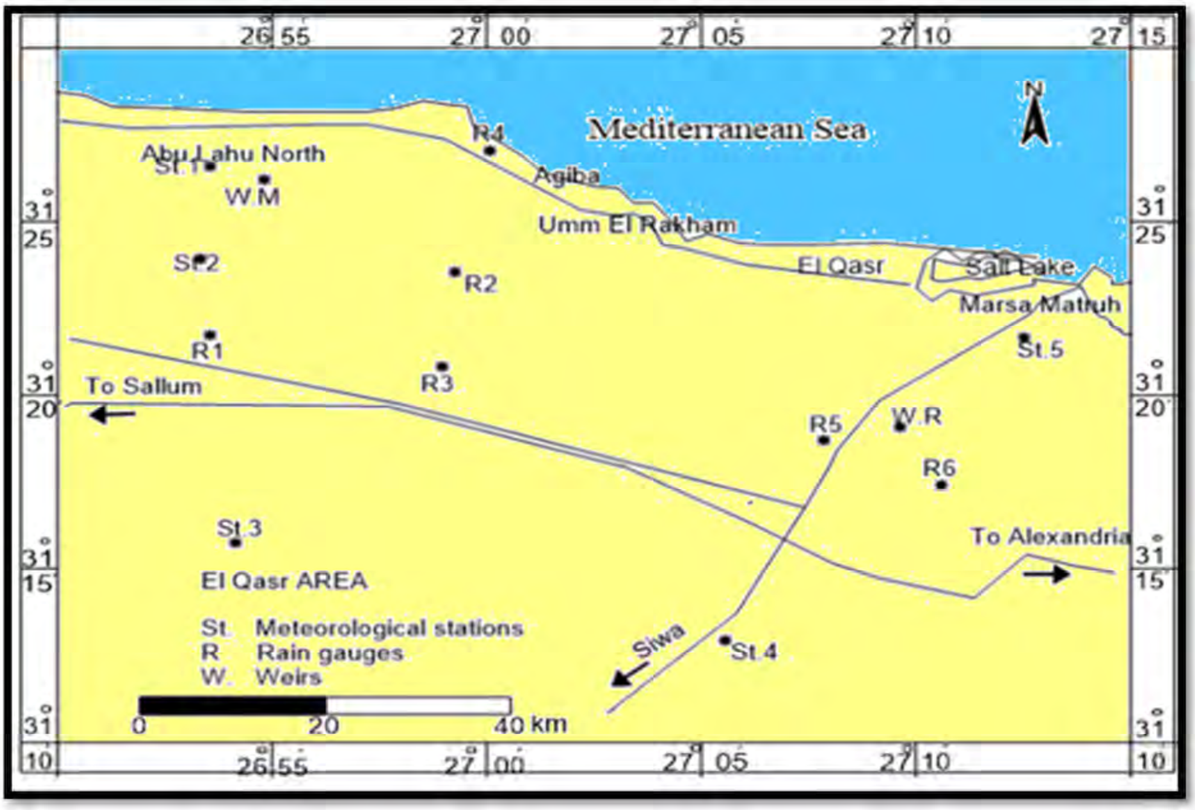

Figure 6. Meteorological stations, Rain gauges and Weirs within the study are.

5. Conclusion

Water is one of the most important inputs of the process of socio-economic development, considering the availability of the necessary required amount of water for the agriculture development in the presence of the limited water resources, since water scarcity entails a huge challenge to hold responsibility of managing water resources in the Northwest Coast and set an overall management strategy and reconsider the current patterns of utilizing such resources to maximize the optimal management of water resources. The research was conducted to determine suitability of the current utilization pattern of water resources in the Northwest Coast to the economic pattern to maximize the use of such scarce vital resource according to the economic consideration that are taken into account in this respect. The research dealt with the efficiency of utilizing the agricultural water resources in the Northwest Coast using programing of the objectives based on setting the multiple objectives in a way that reflects the priorities of the decision maker.

Three (3) objectives were set as follows:

First: to maximize the agricultural net return estimated at around 683 million LE in the actual structure from 2011-2015.

Second: to maximize the net return of irrigation water unit.

Third: to minimize the consumption of irrigation water estimated at roughly 780 billion m^3 to cultivate an area of 273,865 feddans during the same period. It included a pattern of crop structure analysis, 39 crops (2011-1015), crops were classified into (3) groups i.e. 13 winter crops with a total area of 134736.2 feddans, 12 summer crops with a total area of 24240.4 feddans and 14 fruit crops with a total area of 114888.4 feddans.

After using the objectives, the research came up with the results of the programing pattern in the second scenario in which the limitations of crop areas according to the maximum limit which was more reasonable versus the results of the programing pattern in the first and third scenarios as the total cultivated area in the proposed crop structure was about 168.6 feddans which exceeded the current total crop structure area with 35,400 feddans. Results of the programing pattern in the second scenario in which limitations of crop areas were used according to the maximum limit were more reasonable than that of the first and third scenarios as there was a rise in the net return of the current proposed crop structure with 1.3 million LE representing 15% of the net return of the current crop structure indicating farmers' inclination not to grow the most profitable crops. Results estimating the net return of water unit for the first and second alternatives indicated a rise in the return of water unit in the proposed crop structure versus the current return of water unit in the crop structure, the second scenario was the best according to the return value of water unit in the proposed crop structure as the rise came to 20.9% than the current crop structure. It was indicated that the return rise achieved in this scenario came to 103 million LE with an increase of 15% than the net return in the current crop structure. Estimation results showed also that the highest average of water unit return was confined to Prickly Pear in the 3 alternatives followed by tomato and apricot, as for the third alternative, assessments indicated a rise in water requirements for the proposed pattern with 2268 million m^3 with 299.2% than that its current counterpart resulting in a reduction in such requirements for other crops i.e. wheat, onion, garlic, winter tomato, winter eggplant, groundnut, summer watermelon, summer cantaloupe, date palm and prickly pear.

Recommendations

The study concluded several results for the alternatives of the proposed crop structure compere to the current one as follows:

1. To achieve a total net return of 103 million LE and to save a return of 111 LE/m^3 of water unit, the study suggested that the agricultural crop areas are determined by the authorities concerned e.g. wheat, onion, garlic and winter tomato with areas of 40,591 feddans, 485 feddans, 25 feddans, 9270 feddans respectively, date palm, citrus, pomegranate, prickly pear and apricot with areas of 29355 feddans, 283 feddans and 121 feddans respectively.
2. To rationalize in irrigation water in the Northwest Coast with 2268 m^3, growing in several crops were to be expanded e.g. wheat, onion, garlic, groundnut, summer tomato, summer water melon, summer cantaloupe, date palm and prickly pear.
3. To expand the areas grown with date palm and olive since they are resistant to environmental conditions in the Northwest Coast for their importance in the environmental industries.

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