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EXPLANATORY STUDY OF THE POSSIBILITY OF REPLACEMENT SUGAR BEET INSTEAD OF SUGAR CANE UNDER LIMITED WATER RESOURCES

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ABSTRACT

Two field experiments were carried out at Mallaway Research Station, El-Minia Province, Middle Egypt during the growing seasons of 2006 and 2007. The research plan of this study aimed to evaluate and compare the validity of applying the partially or completely using of sugar beet instead of sugar cane crops. The study includes a comparison between the two crops and their water consumption and agricultural practices on the economical side and also providing suggestive sequence about the replacement to study the validity of the replacement from the present cropping pattern and especially the crops which consume much water such as sugar cane under the condition of the current limited water supply. The results indicate in terms of water that the average quantities of water applied and actual consumptive use were 10682.12 and 6491.12 m^3/fed for sugar can crop, respectively. While it were 3374.76 and 1990.12 m^3/ fed for sugar beet, respectively. The sugar beet has high values of field and crop water use efficiency (10.37 and 17.58 kg root / m^3), while sugar cane has lowest values of them (4.35 and 7.16 kg stalk cane /m^3), respectively. The results indicate also that, from view point water and economic, the sugar beet recorded the highest values of net return of each water applied and consumptive use units (0.31 and 0.52 L.E /m^3), respectively, while sugarcane has the lowest values of them (0.20 and 0.33 L.E /m^3), respectively. This due to increasing the quantity of water applied and water consumptive use for sugar cane which led to decrease this efficiency.

Results indicate that, from view point of social, the water awareness of farmer is less which leads to waste much water where over irrigation practices by the farmers usually leads to low irrigation efficiency water logging and high losses of water and fertilizer. The Results indicate that 6.6% of sugar cane farmers agree on the completely replacement of sugar beet instead of sugar cane and 71.1 % of farmers accepted the partial replacement by decreasing the sugar cane areas and cultivating using the sugar beet, this due to the insistence of cane farmers on planting the cane because they used to cultivate it for along time. Also the results indicated that there are a few farmers (7.9%) know the idea of planting the cane by transplanting method and the majority of farmers prefer planting the cane in furrow and small portion (13.2%) know the idea of Stiva plant and 11.8 % agree on planting the sugar in new lands. So we concluded that the sugar cane farmers prefer planting the sugar cane crop in furrow, this due to decrease water awareness about the water importance by limiting the water, and decreased agriculture and water culture about applying the modern methods as the method of transplanting to limit the water, this due to, there isn't agricultural direction to increase the culture of farmers.

At the end of study it could be concluded that it is necessary to expand, the sugar beet in the old lands by partially replacement and in the new lands. On other hand, irrigation water saving can be used for increasing cereal crop areas to meet the shortages of food production.

INTRODUCTION

Agricultural sector plays an important role in the economic development in Egypt and it is considered the basis of the national economy and the main source of income for more than half the population in Egypt. In addition, agriculture is responsible for satisfying the consumers need for cloth and food. It also provides the industry sector with raw materials needed for various industries. Continuation of these roles demand achieving the economic development which are derived from two main sources, the agricultural horizontal and vertical expansion resources. In the present and the future, water resources are considered the scarcest element among other economic production resources. Consequently, it is not only one of the main determinations but also the strategic one which determines the horizontal expansion through adding new lands. The optimal use of water is the corner stone of the agricultural development sector because the present water resources available in Egypt are not enough for the future horizontal agricultural expansion in the light of the present types of water use. Eid *et al.* (1966), EWUP, (1984), Abu –Zeid (1992_b) and Abu-Zeid (1990_a).

The study problem :

Making amendment in cropping pattern is one of proposed solutions for solving the water problem and its lack in future.This amendment includes decreasing the areas of the crops that need a lot of water like sugar cane and rice which consume mush water a bout 25-30% of irrigation water (Abu-Zied 1992 a). On the other hand, making amendment in cropping pattern considers complicated and big issue links to political, economical, institutions and environmental sides. So solving this case should be treated gradually and public opinion and different institutions should play an active role in this issue. So, it is necessary to do essential changes in present cropping pattern to save land and water resources and increase farmer income.

From the theoretical view, there is not any difficulty in knowing the cropping patter which is the most suitable for our conditions (the land, the water, the climate and the society needs) but the difficulty appears when we practically try to applicator in field.

So, through this summarized study we can put the main points of the cropping pattern especially about the crops that consume much water (as sugar cane crop) to make a decision about the changes in current cropping pattern.

Research goals :

1- Evaluating and comparing between sugar cane and sugar beet from view points water, and economic.
2- Suggesting different seniors of replants replacing sugar beet.
3- Reaching scientific recommendations for the possibility of amending corps combination for corps that consume a lot of water (as sugar cane crop)

MATERIALS AND METHODS

The research plan of this studying aims to evaluate the validity of applying the partial or completely using of sugar beet crop instead of sugar cane crop. The study includes a comparison between the two crops through all the water, agricultural, economical, and social sides. It also provides suggestive sequence about the replacement. To study the a validity of the replacement from the present cropping pattern and especially the crops, which consume much water(sugar cane crop) in the condition of the current limited water"

Research province :

Malawy province in Minia governorate was chosen as one of the basic centers for sugar cane and sugar beet crops production.

Study of crop choice :

Sugar cane and sugar beet were chosen because of their importance for farmers and the effect of the sugar cane on the water requirement.

Questionnaire form :

Questioner were made by interviewing some of the sample members, and forms were designed according to the research objectives. Random sample consists of 140 farmers from sugar cane and beet farmers, was extracted that cane farmers were 76, (54.3%) from the total sample and the beet farmers were 64 (45.7%) from the total sample and interviews were done for each farmer to study the subjective goals of the questioners to know the most important results.

Statistical analysis :

Data were calculated and tabulated and prepared computerizing by using the statistical bundle program for the social science (SPSS) to analyze using (square χ) to know the nature and sort of the relation between all the dependent and independent variables of the study.

Recorded data from soil water relationships :

Water Measurements

In the two growing seasons (2006&2007) water was measured by using a rectangular sharp crested weir. The discharge was calculated using the following formula : $Q=CLH^3$ (Masoud, 1967)

Where :

Q: The discharge in cubic meters per second.

L: The length of the crest in meters

H : The head in meters

C : An empirical coefficient that must be determined from discharge measurements

Water applied was added at each irrigation and at the end of each growing season. The total quantity of water applied was estimated (m^3/fed).

Water consumptive use (CU)

The quantities of water consumptive use were calculated till 90 cm soil depth for sugar cane and 60 cm for sugar beet crops which were assumed to be the depth of the roots zone as reported by many investigators.

Monthly and seasonal water consumptive use were calculated by the summation of water consumed for the different successive irrigation rotation through growing season (Serry *et al..* 1980).

Water consumptive use per feddan (4200 m^2) can be obtained by the following equation which described by Israelsen and Hansen, 1962

$$CU = \frac{\theta_2 - \theta_1}{100} \chi b.d \chi \frac{Depth}{100} \chi Area(4200 m^2)$$

Where :

CU = Amount of water consumptive use (m^3 /fed.)

θ_2 = Soil moisture content % after irrigation (by weigh).

θ_1= Soil moisture content % before the next irrigation (by weigh).

b.d = Bulk density (g/ cm^3).

Calculation of CU was repeated for each irrigation until the harvesting date.

Crop Coefficient (Kc)

Crop coefficient defined as the ratio between actual crop evapotranspiration(ET_a) and potential evapotranspirtaion (ET_p) when both are in a large fields, under optimum growing conditions (FAO, 1977). In the experiment the following equation was applied to compute the Kc values.

$$\mathbf{Kc = ET_a / ET_p}$$

Where :

Kc= Crop coefficient

ET_a= Actual evapotranspirtation (mm/ day).

ET_p= potential evapotranspiration calculated by modified Penman (mm/ day).

Modified Pemman equation

$$\mathbf{ET_p = c\ [\ (W.Rn + 1\text{-}w).f\ (u).(ea\text{-}ed)]\ mm/day.}$$

Where :

$ET_{p=}$ Reference crop evapotranspiration (mm/ day).

W=Temperature –related weighting factor.

Rn=Net radiation in equivalent evaporation in mm/day.

f (u) =Wind-related function.

ea=Saturation vapour pressure of the air in (mm bar).

ea= Mean actual vapour pressure of the air in (m bar)

=ea x RH mean /100, in which, RH = relative humidity.

(ea-ed) =Difference between the saturation vapour pessue at mean air remperature and the mean actual vapour pressure of the air, both in mbar.

c=Adjustment factor to compensate for the effect of day and night weather conditions.

Crop water use efficiency (C.W.U.E)

The crop water use efficiency is the weight of marketable crop produced per the unit volume of water consumed by plants or the evapotranspiration quantity.

The crop water use efficiency was computed for each crop by dividing the yield (kg) over units of evapotranspiration expressed as cubic meters of water (Abd El-Rasool *et al..*1971) It is calculated by the following formula :

$$C.W.U.E. = \frac{Yield(kglfed.)}{water \quad consumptive \quad use(m^3lfed.)} = kglm^3$$

Field water use efficiency (F.W.U.E.)

The field water use efficiency is the weight of marketable crop produced per the unit volume of irrigation applied expressed as cubic meters of water (Michcal, 1978).

It as calculated by the following equation :

$$F.W.U.E. = \frac{Yield(kglfed.)}{water \quad applied\,(m^3lfed.)} = kglm^3$$

Economic efficiency :

The economic efficiency refers to the combinations of inputs that maximize individual or social objective. It is defined in terms of two conditions : necessary and sufficient. The necessary condition is met in production process when producing the same amount of product with fewer inputs or producing more products with the same amount of inputs but the sufficient condition for efficiency encompasses individual or social goals and values (John and Frank 1987).

It is calculated by the formula :

$$Economic \quad efficiency = \frac{Netprofit(L.Elfed.)}{Total\,costs(L.Elfed.)}$$

RESULTS AND DISCUSSION

The first : from view point of water :

Comparison between sugar cane crop and sugar beet crop ;

Data in Table (1) reveal that the comparison between sugar cane and sugar beet from view point of water. The average quantity of water requirements and actual water consumptive use (m/fed) from planting until harvest were 10682.12 and 6497.12 m^3/fed for sugar cane in 2006 and 2007 seasons respectively, while it were 3374.76 and 1990.42 m^3 /fed for sugar beet respectively. These results indicate the sugar beet crop have highest values of crop and field water use efficiencies (17.37 and 10.37 kg of root /$m^{3)}$ in 2006 and 2007 seasons, respectively) compared to sugar cane which has lowest values of them that were (7.6 and 4.35 kg stalk cane /m^3) in 2006 and 2007 seasons, respectively. Results indicate also that the sugar beet have high values of water use efficiencies (L.E /m^3 applied and consumed) that were 0.31 and 0.52 L.E/ m^3 respectively while, sugar cane crop have lowest values for them that were 0.20 and 0.33 L.E/m^3 respectively, this due to increase the quantity of water requirements and water consumptive use for sugar cane which led to decrease this efficiencies. These results are in agreement with those reported by Cucci and Caro (1986), Abd El-wahab *et al.* (1996), Khan (1992), Emara *et al.* (2000 a) and ESST, (2006).

Table (1): Comparison between sugar cane and sugar beet crops through all the water, agricultural and economical Points in the two studied seasons.

Comparison phase	Sugar cane crop	Sugar beet crop
Scientific name	Saccharunm Afficinarum L.	(Beta Vlgaris L.)
Crop remain duration, day	330	186
*Cultivate area in Egypt, fed.	315000	167327
*The Contribution rate in the international sugar production	65%	35%
*The Contribution rate in the locally sugar production	90%	10%
Sugars percentage (%)	14%	11%
**Water applied (m^3/fed.)	10682.5	3374.76
**Water consumptive use (m^3/fed.)	6491.12	1990.42
Maximum period of water (Critical period)	May,June,July and August	January and February
Irrigation efficiency(surface irrigation)	48.9	49.2%
Crop coefficient	0.95	0.58
Total costs (LE/fed.)	6680	4553
Total income L.E/fed.)	8835	5600
Net return (L.E/fed.)	2155	1047
Average costs of ton (L.E/ton)	143.66	130.09
Production (ton/ fed.)	46.5	35
Field water use efficiency (kg/ m^3)	4.35	10.37 mg/m^3
Crop water use efficiency (kg/m^3)	7.16	17.58kg/m^3
Efficiency of applied water utilization (L.E/m^3)	0.20	0.31
Efficiency of consumption water utilization (L.E /m^3)	0.33	0.52
Field water use efficiency express as (kg sugar /m^3)	0.51 Kg sugar raw/m^3	1.21 kg sugar raw /m^3
Crop water use efficiency express as (kg sugar /m^3)	0.84 Kg sugar raw /m^3	2.06 kg sugar /m^3
produce one ton sugar needs	1193.22 m^3water consumed	485.47 m^3water consumed
produce one ton sugar needs	1963.69 m^3water applied	823.11 m^3water applied
Economic efficiency	0.32 L.E	0.23 L.E
Average of yield (ton/fed.)	46.5	35
Average of sugar (ton/fed.)	5.44	4.1
Price of unit (L.E/ton of yield)	190	160

Water saving (m^3/ area)

Water saving per cubic meter / area represents the different between the quantity of water applied for sugar cane crop and suggested rotations of replacement. Data in Tables (2 & 3) show that the third suggested rotation (sugar beet + potato crop) of transformation gave high values of saving irrigation water about (41.16 %) compare with water requirements to sugar cane crop. This quantity of saving water as result of partially and completely replacement were (1.385 and 0.946 milliard m^3/ area) enough to cultivate area (generally) in old lands about 216390.23 and 147694.92 fed. respectively or cultivate different areas of horticulture and field crops

This results reflex how much irrigation water can be saved when using the best suggested rotation of replacement.

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The second : from view point of economic :

Total costs, production, total income, (L.E/ fed.) and water use efficiency

Data in Table (4) illustrate values of total costs, total income and net profit of irrigation water (L.E/ m^3) for sugar cane crop and different suggestive rotations of replacement.

Results indicate that the highest values of total income, net profit (16400 and 5340 L.E/ fed.) and net return of each unit of water applied (0.89 L.E/$m^{3)}$ were obtain from the third suggested rotation (sugar beet + potato crop) of replacement. While the lowest values of net profit (1682 L.E/fed.) and net return of each unit of water applied (0.24 L.E/m^3) were obtained from the first rotation of replacement (sugar beet + corn crop).

Results indicate also that by estimating the economic efficiency under lifting irrigation system, present study found that the highest values of economic efficiency was obtain from the forth suggested rotation (sugar beet + tomato crop) of replacement (0.53 L.E), each one Egyptian pound (L.E) was spend for production. It is clear from the data in Table (4) that both the third suggested rotation (sugar beet + potato crop) and the fourth suggested rotation (sugar beet + tomato crop) were more efficient in use of irrigation water, while the sugar cane crop gave the lowest values of water use efficiency. This due to increasing quantity of water applied for sugar cane crop which led to decrease of this efficiency.

These results are in agreement with those reported by DDC (1978), John and Frank *et al.* (1987) and Skold *et al..* (1994)

In the light of the results the third suggested circle of replacement (sugar beet crop+ potato) is the best circle economically for the farmer followed by the fourth circle for replacement (sugar beet + tomato) which gave net profit 5340 and 4615 L.E, respectively. According to the economical side only, the previous circles are the best which give a great income to the farmer, but there are some obstacles especially for the southern farmers who used to cultivate the sugar cane greatly and the vegetables in a secondly level because the costs of production especially potatoes are great according to the economical conditions of farmers which lead farmers to avoid applying these suggested circles and decreasing farmers experience about vegetables about vegetables planting which give them a great income. So increasing the experience of farmers and support the farm economy to be able to apply the circles which give him a high profit. On the other hand, we must compete the foreign market to export and bring the hard currency for bringing a national income directed to buy the sharp shortage of cereals needs or opening national markets and agriculture industry areas, which can take the remaining of summer vegetables, That not only increases the income, but also offers job chances which limit the unemployment problem, that annoying for the government and the society in a huge degree.

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The third : from view point of social :

(1) The water awareness at sugar cane and beet farmers in dealing with the water use :

Data in Tables (5 and 6) show the measure of water awareness at sugar cane and sugar beet farmers. Results of Table (5) indicate that 88.4% of sugar cane farmers believes that the selling sugar cane according to the weight without considering the sugar level, which led the farmer to add water in a great amount, and 71.1% think that the sugar cane crop needs water more than any other crops and 73.7 % of framers prefer planting the sugar can in furrow.

Data of Table (6) indicate the measure of water awareness of sugar beet farmers when dealing with irrigation water, that results indicated that farmers agree 82.8% agree on the irrigation of sugar beet crop by drain water because the farmer thinks, the sugar beet crop is different from sugar cane crop in its ability to bear the salt level of drain water. So through the previous results it is appeared that the water awareness of farmer is less which leads to waste much water where over irrigation practices by the farmers usually leads to low irrigation efficiency water logging and high losses of water and fertilizer

Table (5) : Measure of water awareness at sugar cane farmers in dealing with the water use

No	The questions	Yes		No		χ^2
		Frequency	%	Frequency	%	
1	When there is a shortage in irrigation water, will you use the drain water in irrigation ?	48	63.2	28	36.8	5.26*
2	2-Do you think that sugar cane production upon the weight only without the sugar level, is one of the basic reasons which lead the farmer to add much water to the cane ?	67	88.2	9	11.8	44.26**
3	Do you agree planting the sugar cane in beds instead of furrow to save irrigation water	20	26.3	56	73.7	0.33**
4	5-Do you think that the sugar cane crop needs water more than any other crop ??	54	71.1	22	28.9	13.41**

LSD. ** 1 % Significant * 5 % Significant

Source : calculated and estimating from sample data

Table (6): Measure of water awareness at sugar beet crop farmers in dealing with the water use

No	The questions	Yes		No		χ^2
		Frequency	%	Frequency	%	
1	When there us a shortage in irrigation water will you use agricultural drainage water ?	43	67.2	21	32.8	7.56**
2	Do you agree on sugar beet crop with drainage water ?	53	82.8	11	17.2	27.56**

LSD. ** 1 % Significant

Source : calculated and estimating from data sample

By using question significant of questioners and (χ^2 square) the significant of all the sentences appeared, that indicated to the difference between farmers of water awareness definitions in real differences don't happen by chance.

(2) The level of farmers acceptance of sugar beet crop instead of sugar cane both partially of totally.

Data in Tables (7 and 8) illustrate sugar cane and sugar beet farmers acceptance of planting sugar beet crop instead of sugar cane (both partially or totally), the results of Table (7) indicate that 6.6% of sugar cane farmers agree on the total transformation of sugar beet instead of sugar cane, 71.1 of farmers accepted the partial transformation by decreasing the sugar cane areas and using the sugar beet, so the results indicated to the insistence of sugar cane farmers on planting the sugar cane crop because they used to cultivate it for along time and refusing the idea of totally transforming the sugar beet instead of the sugar cane, and there are a great acceptance between the sugar canefarmers on the partial transforming by decreasing the cane areas.

Table (7) : The level of farmers acceptance of sugar beet crop instead of sugar cane both partially or completely.

No	The questions	Yes		No		Few		χ^2
		Frequency	%	Frequency	%	Frequency	%	
1	Will you agree if you are asked to cancel the cane area (completely replacement) and plant sugar beet crop instead ?	5	6.6	71	93.4	-	-	57.32**
2	Do you have an idea about sugar beet crop planting ?	28	36.8	31	40.8	17	22.4	6.28*
3	If the government orders to area decrease (partial replacement) to sugar cane crop, will you agree ?	54	71.1	22	28.9	-	-	13.47**

LSD. ** 1 % Significant * 5 % Significant
Source : calculated and estimating from sample data

Table (8): Measure of sugar beet farmers acceptance to continue in sugar beet crop cultivation.

No	The questions	Yes		No		Anthor Institutes		χ^2
		Frequency	%	Frequency	%	Frequency	%	
1	Did you plant sugar beet yourself ?	44	68.8	11	17.2	9	14.1	36.21**
2	Do you prefer to continue in sugar beet crop planting ?	45	70.3	19	29.68	-	-	0.56*
3	Do you have a good idea about sugar beet planting	49	76.7	2	3.1	13	20.3	56.66**
4	Do you agree on planting the sugar beet in new lands ?	48	75	16	25	-	-	16.1**
5	Dose the price of selling the sugar beet to the company is suitable for the farmer ?	53	82.8	11	17.2	-	-	18.2**

LSD. ** 1 % Significant * 5 % Significant
Source : calculated and estimating from sample data

Data in Table (8) also show that the level of farmers acceptance of sugar beet on the continuous sugar beet planting the results indicate that 70.3 % of sugar beet farmers prefer the continuity of sugar beet planting instead of the cane, there are 75% of framers agree on planting the sugar beet in the new lands and, there are 82.8% of farmers see that the price of selling sugar beet to the company is suitable that led farmers to continue planting the sugar beet and by using he value level by (χ^2 square test). It appears that all the questions have a value which indicated to the level of farmers acceptance of planting sugar beet instead of sugar cane both partially or totally in real differences without chance.

3) The level of agriculture awareness of farmers about planting the sugar cane crop by the modern methods and the level of their knowledge about substitute crops for sugar.

Data in Table (9) indicate the level of agriculture culture about planting sugar cane with the modern way to save water such as planting the cane by transplanting method and planting in terraces instead of furrow and their knowledge about substitute crops as Sativa plant. The result indicated that there are a few farmers 7.9% know the idea of planting the cane by transplanting and the majority prefer planting the cane in furrow and a small portion 13.2% know the idea of Sativa plant and 11.8 agree on planting the sugar in new lands, so we concluded that sugar cane farmers prefer planting the sugar cane crop in furrow instead of beds because the decreased water awareness about the water importance by limiting the water, and the decreased agriculture and water culture about applying the modern ways as the way of transplanting cane to limit the water, because there isn't agricultural direction to increase the culture of farmers so, the study recommended to select some crops with decreased water usage and increased production and focusing on using modern ways of agriculture and increasing the water awareness and changing the traditional way of planting by the transplanting way and using terraces instead of furrow.

Table (9): The level of agriculture awareness of farmers about planting the sugar cane crop by the modern methods and the level of their knowledge about the crops substitutes for sugar.

No	The question	Yes		No		χ^2
		Frequency	%	Frequency	%	
1	Do you have an idea about sugar cane crop planting by transplanting ?	6	7.9	70	92.1	53.89**
2	When you plan cane, do you prefer planting it in furrow ?	56	78.7	20	26.3	0..33**
3	If you have an idea about sugar cane planting by transplanting do you agree on applying it ?	6	7.9	70	92.1	53.89**
4	Do you have information about planting Stiva crop instead of the cane for sugar ?	10	3.2	66	86.8	41.26**
5	Do you agree on planting sugar cane crop in the new lands ?	9	11.8	67	88.2	44.26**

LSD. ** 1 % Significant * 5 % Significant

Source : calculated and estimating from data sample

Conclusion

Upon this presented study we can conclude that, it is necessary to expand the planting of sugar beet in the old lands by the partially replacement or completely and planting it in the new lands with a better method, especially, it needs marginal land, not rich land, as with the sugar cane, and directing the resulted water from the replacement to produce others crops, especially, which don't have a self satisfaction such as cereals crops. On the other hand, we can trend to decrease the water requirements for sugar cane by changing the conventional planting method to produce the sugar cane with less water by using transplanting method. That may be the mediate solution between the farmers wish to plant the sugar cane crop and desire of researches and decision makers to save our water resources.

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دراسة استكشافيه عن مدى امكانية احلال محصول بنجر السكر بدلا من قصب السكر فى ظل محدودية الموارد المائية

حسن أحمد عبدالرحيم* و حسين فرويز**

*** معهد بحوث ادارة المياه – المركز القومى لبحوث المياه**

**** معهد بحوث المحاصيل السكرية – مركز البحوث الزراعية**

اقيمت تجربيتان حقلتان بمحطة مقننات رى ملوى البحثية بمنطق المنيا التابعة لمعهد بحوث ادارة المياه – والمركز القومى لبحوث المياه خلال موسمى 2006 ، 2007 وذلك بهدف تقييم ومقارنة مدى امكانية تطبيق الاحلال الكلى أو الجزئى لمحصول بنجر السكر بدلا من محصول قصب السكر واشتملت الدراسة على المقارنة بين المحصولين من كافة النواحى المائية والزراعية والاقتصادية والاجتماعية. وكذلك وضع سيناريوهات مقترحة للاحلال لدراسة مدى إمكانية التعديل فى التركيب المحصولى الحالى وخاصة للمحاصيل المستهلكة للماء بدرجة أكبر " قصب السكر" فى ظل محدودية المياه حالياً.

وقد اظهرت النتائج الاتى :

أولاً : من الناحية المائية :

1- أوضحت النتائج أن متوسط كميات الماء المضافه وكذلك الاستهلاك المائى الفعلى لمحصول قصب السكر كانت 10682.12 ، 6491.12 م3/ف بينما كانت لمحصول بنجر السكر 3374.76 ، 1990.42 م3/ ف على التوالى.

2- أوضحت النتائج بأن الفترة الحرجة للماء لمحصول قصب السكر كانت خلال اشهر نمو المحصول (مايو – يونيو – يوليو – اغسطس) بينما كانت هذه الفترة خلال شهرى يناير وفبراير لمحصول بنجر السكر

3- تم حساب متوسط معامل المحصول (kc average) الموسمى وكانت بمقدار 95, ، 58, لمحصول قصب السكر وبنجر السكر على التوالى.

4- أوضحت النتائج بان كفاءة الرى الحقلى الكلية (الرى السطحى) كانت بمقدار 49.2% ، 48095 % لمحصول قصب السكر وبنجر السكر وبمتوسط عام قدرة 49.05 %

5- اعطى محول قصب السكر انتاجية قدرها 46.5 طن عيدان قصب / فدان بينما اعطى محصول بنجر السكر انتاجية قدرها 35 طن جذور / فدان.

6- اعطى محصول قصب السكر انتاجية قدرها 5.44 طن سكر خام / فدن بينما اعطى محصول بنجر السكر أنتاجية قدرها 4.1 طن سكر خام / فدان

7- اوضحت النتائج بأن كفاءات الانتفاع بالوحدة المائية المضافه والمستهلكة معبرا عنها (كجم عيدان قصب / م3م) كانت بمقدار 4.35 ، 7.16 كجم عيدان قصب / م3 لمحصول قصب السكر على التوالى بينما كانت بمقدار 10.37 ، 17.58 كجم جذور /م3 لمحصول بنجر السكر على التوالى.

8- أوضحت النتائج ايضا بأن كفاءة الانتفاع بالوحدة المائية المضافه والمستهلكة معبرا عنها (كجم جرام سكر خام / م3) كان بمقدار 51 , ، 84 , كجم سكر خام /م3 لمحصول قصب السكر على التوالى بينما كانت بمقدار 1.21 ، 2.06 كيلو جرام سكر خام /م3 لمحصول بنجر السكر على التوالى.

9- تشير النتائج ايضا بصفة عامة بأن انتاج طن واحد من السكر الخام يحتاج الى 1193.22 م3 مياه عند انتاجه من محصول قصب السكر بينما يحتاج الى 823.11 م 3 مياه مضافه عن انتاجه من محصول بنجر السكر.

10- تشير النتائج السابقه المتحصل عليها بأن محصول بنجر السكر يبدو من الناحية المائية افضل من محصول قصب السكر حيث يحتاج الى كميات مياه اقل بالاضافه الى كفاءات انتفاع بالوحدة المائية اكبر من محصول قصب السكر الا انه لكى تكون المقارنة من الناحية المائية عميقه وحقيقيه ومبنيه على اسس علميه سليمة يجب ان تكون المقارنة بين المحصولين على مدار عام زراعى مائى كامل حيث يمكث محصول قصب السكر فيما يقرب من موسم زراعى مائى كامل بينما يمكث محصول بنجر السكر فيما يقرب من مده سته شهور لذا يتطلب الامر عند عمل مقارنة حقيقيه ان يستكمل الموسم الزراعى المائى لمحصول بنجر السكر بادخاله فى دورات زراعية مقترحه استكمالا للموسم الزراعى المائى مماثلا فى ذلك محصول قصب السكر.

ثانياً : من الناحية الاقتصادية :

1- أوضحت النتائج من وجه النظر الاقتصادية بأن كفاءات الانتفاع بالوحده المائية معبرا عنها جـ/م3 سواء كميات المياه المضافه أو المستهلكه كانت بمقدار 20, ، 33, جـ/ م3 لمحصول قصب السكر على التوالى بينما كانت بمقدار 31, ، 52, جـ/ م3 لمحصول البنجر على التوالى.

2- أوضحت النتائج بأن اجمالى التكاليف لكلية واجمالى الايراد وصافى الربح (جـ/ ف) كانت بمقدار 6680 ، 8835 ، 2155 (جـ/ ف) لمحصول قصب السكر على التوالى بينما كان بمقدار 4553 ، 5600 ، 1047 (جـ/ ف) لمحصول بنجر السكر على التوالى.

3- أوضحت النتائج بأن الكفاءة الاقتصادية تحت نظام الرى بالرفع كانت بمقدار 32, ، 23, جنيه لكل جنيه ثم اتفاقه فى عمليات الانتاج لمحصول قصب السكر وبنجر السكر على التوالى.

4- أوضحت النتائج المتحصل عليها بأن اعلى صافى ربح (جـ/ف) وصافى العائد لوحده استخدام المياه معبرا عنها (جـ/م3) كان ناتجا من الدوره الثالثه المقترحة للاحلال (بنجر سكر + بطاطس) حيث كانت بمقدار 5340 جـ/ ف ، 89, جـ/ م3 على التوالى بينما اعطت الدوره الاولى المقترحة للاحلال (بنجر سكر + ذرة شامية) أقل القيم الصافى الربح (1682 جـ/ ف) ولصافى العائد لوحده المياه المضافه بمقدار 24, جـ/ م3 على التوالى.

5- اعطت الدورة الثالثة المقترحة للاحلال (بنجر السكر + بطاطس) اعلى القيم للوفر المائى المتحصل عليه باجمالى كميات مياه قدرها 1.385 مليار م3/ مساحة نتيجة الاحلال الكلى لمحصول البنجر وبمقدار 0.945 مليار متر مكعب نتيجة الاحلال الجزئى وبنسبه قدرها 41.16 % وذلك عند مقارنة الاحتياجات المائية لهذه الدورة بالاحتياجات المائية لمحصول قصب السكر وان هذه الكميات من المياه المتحصل عليها يمكن توجيها بصفه عامة (على أساس الاحتياج المائى للفدان فى الاراضى القديمة بنحو 6400 م3/ ف) الى زراعة مساحات من الاراضى القديمة قدرت بنحو 216390.23 فدان نتيجة الاحلال الكلى و مساحة قدرها 147694.92 فدان نتيجة الاحلال الجزئى او توجيها الى زراعة مساحات مختلفة من المحاصيل الحقلية والبستانية طبقا للمقنن المائى لكل محصول.

ثالثاً : من الناحية الاجتماعية :

1- اوضحت النتائج من الناحية الاجتماعية بأن هناك انخفاض فى الوعى المائى لدى المزارعين فى التعامل مع وحدة المياه الامر الذى يؤدى الى اهدار المياه بدرجة اكبر وبالتالى انخفاض كفاءة الرى وزيادة نسب الفواقد المائية والسمادية.

2- أوضحت النتائج ايضا بأن هناك نسبه قليله من المزراعين 6.6% يوافقون على احلال بنجر السكر محل القصب احلالا كليا الا ان هناك نسبه كبيرة 71.1% من المزراعين يوافقون على الاحلال الجزئى عن طريق تخفيض مساحات قصب السكر واحلال بدلاً منها بنجر السكر ويرجع ذلك الى تمسك مزراعى قصب السكر فى زراعة محصول قصب السكر نظرا لتعودهم على زراعة المحصول لمدة طويله وعدم تقبلهم لفكرة احلال محصول بنجر السكر محل محصول قصب السكر احلالا كليا.

3- أوضحت النتائج ايضاً بأن هناك نسبه قليله من المزارعين 7.9 % من الزراع لديهم فكرة عن زراعة محصول قصب السكر بالشتل وان الاغلبية العظمى من المزارعين يفضلون زراعة القصب فى خطوط وأن هناك نسبة قليلة 13.2% من الزراع لديهم فكرة عن نبات الاستيفا البديل وكذلك 11.8% من المزارعين يوافقون على زراعة قصب السكر فى الاراضى الجديدة ومن ذلك نستطيع ان نستخلص ان مزراعى قصب السكر يفضلوا بنسبه عالية زراعة محصول قصب السكر فى خطوط بدلا من مصاطب ويرجع ذلك لانخفاض الوعى الثقافى والزراعى لدى مزارعى قصب السكر فى زراعة محصول قصب السكر بالطرق الحديثة لتوفير المياه ومنها طريقه الشتل وكذلك الزراعه فى مصاطب بدلا من خطوط وكذلك مدى المعلومات لديهم عن النباتات البديله لانتاج السكر مثل نبات Stiva ويرجع ذلك لعدم الارشاد الزراعى والمائى لزياده الثقافه المائية والزراعية لدى المزارعين.

التوصيات والحلول المقترحة

والخلاصة أن هناك حاجة ملحة لاجراء تعديلات جوهرية فى التركيب المحصولى الحالى للمحافظة على الموارد الأرضية والمائية وتعظيم العائد منها فمن الناحية النظرية لا توجد صعوبة تذكر فى معرفة التركيب المحصولى الأمثل لظروفنا (الأرض والماء والمناخ واحتياجات المجتمع)

ولكن الصعوبة نأتى فى كيفية تنفيذ ذلك على أرض الواقع ومن خلال هذه الدراسة المختصرة والتى عرضنا نتائجها يمكن أن نضع الخطوط العريضة للتركيب المحصولى خاصة من ناحية المحاصيل المستهلكة للماء بدرجة أكبر وذات احتياجات مائية عالية ومنها محصول قصب السكر لكى نصل الى قرار حاسم يتضمن تعديلات جذرية فى التركيب المحصولى الحالى ومن خلال ما سبق لنا عدة اقتراحات فى ضوء نتائج هذه الدراسة ومنها على سبيل المثال :

1- يمكن للسياسة الزراعية أن تحدد المساحات التى يجب أن تزرع بمحاصيل معينة ومنها محصول قصب السكر ولكن قد يبدو هذا الاقتراح مستبعد حاليا وغير وارد فى الوقت التى تتجه فيه السياسة الزراعية الى الحرية الكاملة للمزارعين بما يسمى " بتحرير الزراعة " وترك الحرية كاملة للمزارعين فى أن يزرعوا ما يرغبون الا أنه عندما يتعلق الأمر بحسن استخدام الموارد المحدودة فإن تدخل السياسة الزراعية بطريقة أو بأخرى يصبح مسألة حتمية لأن سوء استخدام المياه وإدارتها لا تقل أهمية عن تجريف الأرض الزراعية.

2- فى ظل محدودة المياه والحفاظ عليها من سوء إدارتها وإهدارها وفى ظل عدم تطبيق أساليب الرى الحديثة حاليا على وجه العموم يمكن للساسة المائية بوضع تسعيرة لمياه الرى بنظام الشرائح التصاعدية وبذلك يمكن أن تدفع المزارعين الى الابتعاد أو التردد فى زراعة المحاصيل المستهلكة للمياه أو قليلة الكفاءة فى استعمال المياه مثل القصب والأرز وحيث أن هذه المحاصيل موجه لإشباع الطبقات العليا

(الأكثر غنى فى المجتمع) لذا يمكن أن ترفع أسعار منتجاتها لتغطية ارتفاع التكاليف لها الناتجة عن توضع تسعيرة للمياه المستهلكة لها.

3- يمكن للسياسة المائية أن توجه التركيب المحصولى بطريقة أفضل عن طريق تشجيع زراعة المحاصيل الأكثر كفاءة فى استعمال الموارد وخاصة الماء والموجهة الى اشباع الغالبية العظمة من السكان عن طريق إعفائها من سعر مياه الرى أو دعمها لبعض مستلزمات الانتاج الأخرى.

4- يمكن للسياسة الزراعية الاتجاه الى الابقاء على زراعة هذه المحاصيل المستهلكة للمياه بدرجة أكبر ومنها محصول قصب السكر نظراً لخبرة وتمسك المزارعين بزراعته فى مناطق انتاجه ولكن عن طريق تغيير نمط طريقة زراعته التقليدية واسلوب الرى ذلك عن طريق استخدام طريقة الشتل باستخدام اسلوب الرى فى مصاطب بدلا من خطوط لانتاج محصول قصب السكر الأمر الذى يؤدى الى تقليل زمن مرور المياه بين الخطوط مما يؤدى ذلك الى تعظيم الاستفادة من الوحدة المائية المضافة.

5- العمل على تحميل محصول بنجر السكر على محصول قصب السكر بهدف التوسع فى انتاج بنجر السكر بجانب القصب فى الاراضى القديمة بجانب التوسع للبنجر السكر فى الاراضى الجديدة.

6- أو العمل على إحلال بنجر السكر محل محصول قصب السكر احلالا جزئياً وفهذه الحالة يتم الحصول على وفر مائى كما اوضحت النتائج السابقة المتحصل عليها وتوجيه هذا الوفر الى انتاج محاصيل اخرى خصوصا محاصيل الحبوب..

7- توصى الدراسة بالعمل على زيادة الثقافة المائية والثقافة الزراعية للمزارعين لترشيد استخدام المياه ورفع الكفاءة الكلية للرى الحقلى.

8- توصى الدراسة أيضاً بالعمل على زيادة الثقافة المائية لكافة جميع المواطنين فى ظل محدودية المياه للحد من استهلاك السكر الخام لخفض معدل الاستهلاك السنوى للفرد حتى يتناسب ما نخطط له مع امكانيتنا الموجودة حالياً من مواردنا المائية

9- توجية المزارع إلى جدوى اختيار التركيب المحصول المناسب والاكثر كفاءة مائية واقتصادية فى استخدام المياه باعتبار ان عنصر المياه اكثر ندره من عناصر الانتاج الاخرى.

التوصية

فى ضوء هذه الدراسة والنتائج المتحصل عليها نستطيع ان نستخلص بأنه يجب التوسع فى زراعة محصول بنجر السكر سواء فى الاراضى القديمة عن طريق الاحلال الجزئى بتخفيض المساحة المنزرعة من محصول قصب السكر أو الاحلال الكلى فى ظل محدودية المياه الحاليه وندرتها فى المستقبل وكذلك زراعتة فى الاراضى الجديدة بصورة أفضل وتوجيه الوفر المائى المتحصل عليه نتيجة الاحلال الكلى أو الجزئى الى انتاج محاصيل أخرى وخصوصا المحاصيل التى بها عدم اكتفاء ذاتى مثل محاصيل الحبوب أو العمل على ابقاء انتاج هذه المحاصيل المستهلكة للمياه مثل محصول قصب السكر مع تغيير نمط الزراعة المعتادة فى انتاجة وذلك عن طريق زراعته فى مصاطب بدلا من خطوط وكذلك زراعته بطريقة الشتل بدلا من الزاعة التقليدية العادية بهدف الحصول على انتاجية عالية من المحصول بأقل كميات مياه مضافه ممكنة وقد يكون هذا هو الحل المعتدل بين رغبة المزارعين فى زراعة محصول قصب السكر ورغبتنا نحن االباحثين وصناع القرار فى المحافظة على مواردنا المائية

قام بتحكيم البحث

أ.د / السيد محمود فوزى الحديدى — كلية الزراعة – جامعة المنصورة

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Table (2) : Quantity of total water saving (milliard m^3 / area) and the areas (fed.) which can be cultivated in old lands as a result of water saving (completely replacement).

Suggested rotations for replacement	* Water applied m^3/fed.	Water saving		** Average area cultivated sugar can crop in Egypt	Total of water saving milliard m^3/area)	The area (fed.) which can be cultivated in old lands (generally) as a result of saving water	The areas (fed.) which can be cultivated in old lands of some crops (specially) as result of saving water											
							Tomato		Pea		wheat		Corn		Potato		Soybean	
		m^3	%				Water requirement (m^3/fed.)	The area which can be cultivated	Water requirement m^3/fed.	The area which can be cultivated	Water requirement m^3/fed.	The area which can be cultivated	Water requirement m3/fed.	The area which can be cultivated	Water requirement (m3/fed.)	The area which can be cultivated	Water requirement (m^3/fed.)	The area which can be cultivated
Sugar can crop The first suggest rotation (sugar beet+corn)	10680.25 7031.93	3648.32	34.15	315000	1.149220800	179565.75	3264.57	35202.823	3213.10	357667.29	2657.30	432476.87	3657.23	314235.27	2909.05	95050.20	3315.78	345913.90
Sugar can crop The second suggested rotation (sugar beet + Soybean)	10680.25 6690.48	3989.77	37.36	315000	1.256777500	196371.4	3264.57	38497.489	3213.10	391141.73	2657.30	472954.42	3657.23	343641.90	2909.05	113202.334	3315.78	379029.21
Sugar can crop The third suggested rotation (suger beet + potato)	10680.25 6283.75	4396.5	41.16	315000	1.384897500	216390.23	3264.57	42422.049	3213.10	431015.99	2657.30	521167.16	3657.23	378673.88	2909.05	476065.20	3315.78	417668.69
Sugar can crop The fourth suggested rotation (sugar beet + tomta)	10680.25 6639.27	4040.98	37.8	315000	1.272908700	198891.98	3264.57	38991.619	3213.10	396162.17	2657.30	479025.28	3657.23	348052.67	2909.05	437568.51	3315.78	383894.19

*** Source : Actual field measurements.**

**** Source : CCSC (2007) : central council for Sugar Crops. Annual Report, Ministry of Agriculture, Egypt.**

Table (3) : Quantity of total water saving (milliard m^3 / area)and the areas (fed.) which can be cultivated in old lands as a result of water saving (partially replacement)

Suggested rotations for replacement	* Water applied (m^3/fed.)	Water saving		decrease of area cultivated sugar can by partially replac-ement	Total of-water – saving m^3/area milliard m^3/ area)	The area (fed.) which can be cultivated in old lands (generally) as a result of saving water	The areas (fed.) which can be cultivated in old lands of some crops (specially) as result of saving water											
							Tomato		Pea		wheat		Corn		Potato		Soybean	
		m3	%				Water require-ement (m3/fed.)	The area which can be cultivated	Water require-ement m^3/fed.	The area which can be cultivated	Water require-ement m^3/fed.	The area which can be cultivated	Water require-ement (m^3/fed.).	The area which can be cultivated	Water require-ement (m^3/fed.)	The area which can be cultivated	Water require-ement (m^3/fed.)	The area which can be cultivated
Sugar can crop The first suggest rotation (sugar beet+corn)	10680.25 7031.93	3648.32	34.15	215000	0.78438800	12256.75	3264.57	240273.23	3213.10	244198.12	2657.30	295182.62	3657.23	214476.20	2909.05	269637.44	3315.78	236562.37
Sugar can crop The second suggested rotation (sugar beet + Soybean)	10680.25 6690.48	3989.77	37.36	215000	0.856080550	133762.28	3264.57	262233.78	3213.10	266434.44	2657.30	322161.92	3657.23	234078.94	2909.05	294281.81	3315.78	258183.76
Sugar can crop The third suggested rotation (suger beet + potato)	10680.25 6283.75	4396.5	41.16	215000	0.945247500	147694.92	3264.57	289547.32	3213.10	294185.52	2657.30	355716.28	3657.23	258459.95	2909.05	324933.90	3315.78	285075.45
Sugar can crop The fourth suggested rotation (sugar beet + tomta)	10680.25 6639.27	4040.98	37.8	215000	0.868791350	135748.64	3264.57	276127.33	3213.10	270390.37	2657.30	326445.15	3657.23	237554.46	2909.05	298651.22	3315.78	262017.18

***Source : Actual field measurements.**

Table (4) : Values of total cost, production, total income and net return per cubic meter of water (L.E/m^3) for sugar cane crop and different suggested rotations during the two studies seasons.

The suggested rotations	Crops	Average total yield (kg/fed.)	Total costs (L.E/ fed.)	Total income (L.E/ fed)	Net profit (L.E/ fed.)	* Water applied m3/fed)	Field water use efficiency (kg/m^3)	* Water consumptive use (m^3/fed)	Crop water use efficiency (kg/m^3)	Water issues (L.E/m^3/ fed.)		
										Net return from unit water applied (L.E/m^3)	Net return from unit water consumptive use (L.E/m^3)	Economic efficiency
	Sugar cane	46.5	6680	8835	2155	1068.25	4.35	6461.22	7.16	0.20	0.33	0.32
The first suggested rotation	Sugar beet	35000	4553	5600	1047	3374.7	10.37	1990.42	17.58	0.31	0.52	0.23
	Corn	2660	3147	3800	635	3657.23	0.73	2443.32	1.09	0.18	0.27	0.21
Total			7700	9400	1682	7031.93	-	4433.74		-	-	-
Average		-	-	-			5.55	-	9.33	0.24	0.39	0.22
The second suggested rotation	Sugar beet	3500	4553	5600	1047	3374.70	10.37	1990.42	17.58	0.31	0.52	0.23
	Soybean	1500	2947	3750	803	3315.78	0.45	2380.14	0.63	0.24	0.34	0.27
Total			7500	9350	1850	6690.84	-	4375.56	-	-	-	-
Average			-	-	-	-	5.4	-	9.1	0.27	0.43	0.25
The third suggested rotation	Sugar beet	35000	4553	5600	1047	3374.70	10.37	1990.42	17.58	0.31	0.52	0.23
	Potato	9000	6507	10800	4293	2909.05	3.09	1600.73	5.62	1.47	2.68	0.66
Total			11060	16400	5340	6283.75	-	3596.15	-	-	-	-
Average			-	-	-	-	6.73	-	11.60	0.89	1.6	0.44
The forth suggested rotations	Sugar beet	35000	4553	5600	1047	3374.70	10.37	1990.42	17.58	0.31	0.52	0.23
	Tomato	13000	4232	7800	3568	3264.57	3.98	2437.26	5.33	1.09	1.46	0.84
Total			8785	13400	4615	6639.27	-	4432.86	-		-	-
Average		-	-	-	-	-	7.17		11.45	0.7	0.99	0.53

***Source : Actual field measurements.**