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RESEARCH ARTICLE

EVALUATION OF RAINFED AGRICULTURE MANAGEMENT PRACTICES AS AN APPROACH FOR SUSTAINABILITY IN NORTHWESTERN COAST (NWC), EGYPT

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Abstract

Sustainable development can be possible in rainfed agriculture by integrated approach of soil management measures. Soil quality in the form of a quantitative index is used as an indicator of environmental quality and sustainability. Twelve farms selected to achieve the targets of the present investigation (six farms under traditional rainfed agriculture system and six farms under rainfed with supplemental irrigation) at Northwestern Coastal Zone (NWCZ). These farms varied in land use and management practices concerning fertilization practices, tillage system, crop type and cultivated period. This study selected some soil indicators vis-à-vis soil physicochemical properties of the selected farms of studied areas at NWCZ. The rating of soil quality index (SQI) and relative of soil quality (RSQI) values in this study were higher towards to rainfed agriculture with supplement irrigation farms than in traditional rainfed farms. In addition, most of the values of soil quality change (Δ RSQI) were moderately increase (class II) and most of these farms were under traditional rainfed management. The results of cumulative rating index CRI showed a negative correlation and significant relationship with RSQI ($R^2=0.82$, $p<0.05$). concerning the impacts of soil quality on productivity, the relationship between relative yield (R_y %) and RSQI was positive significant correlation ($R^2=0.78$, $p<0.05$). Also, CRI showed negative significant correlation with R_y (%) ($R^2=0.81$, $p<0.05$). Moreover, the highly soil quality class I, highly sustainability, low changes in soil quality and highly crop yield observed was in the farms under rainfed with supplemental irrigation system and good fertilization practices (NPK+organic manure). So, this study recommended to expansion rainfed with supplemental irrigation management system and add suitable dose of NPK application with manure along scientific lines to encourage crop yields that can be achieved on a sustainable basis, but it need a long time to reach class I quality and highly sustainable status.

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Introduction:-

In recent decades, Desert development became greater in Egypt due to high population pressure on the Delta land. The Northwestern Coastal Zone (NWCZ) constitutes the most important agriculture development in Egypt. It is having more attention recently for future sustainable development. NWCZ are mostly cultivated by rainfed

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agriculture management practices, which occupy 70.1% of rainfed agriculture in Egypt [1]. The soils in NWCZ of Egypt are mostly cultivated with orchards crops as (Olive and Fig) and annual crops as cereal crops [1] and [2]. NWCZ soils are predominated by calcareous types of soil [3]. The major of shortcomings and problems facing rainfed agriculture such as misuse and mismanagement, soil erosion, decline in the soil organic carbon (SOC), low input enterprise for resource, nutrient depletion, and low fertilizers [1], [2], [3] and [4]. The most important reason of low productivity is from soil degradation or depletion of soil quality. In this context, Soil degradation is an element of the land degradation process and refers to a decrease in soil's productivity and quality [5]. So, it is considered constrain of sustainable development [5]. In this light, the concept of agriculture sustainability is "the ability of crop production systems to continuously produce food without degradation to the environment" [6]. In addition, the concept of soil quality has emerged during the last decades; several research proposed several definitions for soil quality which mainly focused on relating the soil with crop yield [7] and [8]. On other hand, it is relating with soil functions [9], [10] and [11]. Soil quality evaluation by soil quality index; Soil quality index (SQI) can be used for assessing the impacts of agriculture management practices on soil quality and the crop yield. on the other hand, the assessment of soil sustainability by cumulative rating index (CRI). It is helpful for assessment the sustainability status of long-term cropping systems and soil management [12].

Generally, the concept of soil quality is as a measure of agriculture sustainability. Soil quality in the form of a quantitative index is used as an indicator of environmental quality and sustainability [13]. There are two types of soil quality inherent soil quality and dynamic soil quality; that, the dynamic soil quality effects by changes of dynamic soil properties by human use and occurring rapidly of responds to agriculture management practices [14]. In this light, Soil properties are effect by changes in external factors such as management practices. So, it became necessary to identify a few soil properties as soil quality indicators which can reflect the changes in soil quality. In this context, it measured by several soil indicators including chemical, physical, and biological features [8]. The soil management assessment as one of the conceptual frameworks to evaluate soil quality has been designed to make a quantitative evaluation of soil quality [11]. Soil quality indices are considered the most common methods for soil quality evaluation. These represent the cumulative effects of different soil properties as an index from the role soil quality indicators [15]. Furthermore, the selection of soil quality indicators depends on they can be easily measured; easy to use, flexibility and quantification sensitive to change of soil conditions and therefore, they must be able to identify appropriated sustainable soil conditions [9]. For the select indicators for evaluation of soil quality, it should be using principal component analysis (PCA) for selected minimum data set (MDS) from different soil properties (chemical, physical and biological soil properties); which better represent the total data set (TDS) [16] and [17]. Soil quality index (SQIs) had been successfully applied to assess the impacts of agriculture management practices, soil management, salinization and alkalization on soil quality and crop production [15], [18], [19] and [20]. There are different approaches to assessment soil sustainability in different agriculture management such as cumulative Rating index (CR) and it's proved suitability for soil sustainability assessment [5], [9] and [21]. The CR is a critical limit of soil properties that would be helpful for assessment the sustainability status of agriculture practices at farm scale [22], [23] and [24].

In this study, applies a soil quality assessment framework to frame a strategy to quantify soil quality. The latter will help to perform soil quality evaluated for soil sustainability evaluation for rainfed management practices. In so doing it will define major chemical and physical processes in soil and they reflect conditions as they exist in the field under rainfed management system. In addition, establish a MDS for assessing soil quality as representative of TDS and using CR assessment the sustainability status of agriculture practices. Hence, this study will be useful to mitigate the accelerated environmental degradation by assess quantitatively sustainability of rainfed agriculture management and sustained production.

Material and Methods:-

Description of the study Area

Studied area scope between El Negila west of and Herega east of Marsa Matrouh city located at the northwestern coastal region of Egypt. They located from west to east of Marsa Matrouh city as follow: El Negila (1), Halazin (7), Abu Lahu (6), Habes (4, 5 and 12), Hawala (11), Hashem (2, 3), Ras El-Hekma (8, 9) and Heriga (10) areas as seen in Fig (1). This area bounded by Latitudes 31° 07' – 31° 27' N and longitudes 26° 47' – 27° 51' E as seen in Table (1). This area represented the catchment area of twelve farms. In such area, seven farms have been in traditional rainfed agriculture system type No., (1, 2, 3, 4, 5, 6 and 7) varied in their cultivation period >10, >30, 10,>20, 10 and 10 years, respectively. Moreover, such six other farms No., (8, 9, 10, 11 and 12) have rainfed with supplemental irrigation system type for varied in their cultivation period, 15, >15, 24, >20 years, respectively.

Fig. (1):- Geographical location of the studied areas at NWCZ.



Soil sampling and laboratory analysis

Soil samples were collected at triplicate at 0-20 cm depth from selected fields for each selected farms by soil auger. Each field was represented by one undisturbed sample of each depth and eroded materials from 0-5cm depth. These disturbed soil samples were air dried, crushed and passed through 2 mm sieve and prepared for soil analysis. The undisturbed soil samples were collected to determine chemical and physical properties were determined using the relevant standard methods described by [25], [26], [27] and [28]. These properties included particle size distribution; ER the erosion ratio (ER) was computed by using relationships suggested by [29]. It was determined as the ratio of dispersion to the percentage of clay in the moisture equivalent. Dispersion ratio was determined as the ratio of the percentage of silt plus clay in undispersed soil to the percentage of silt plus clay in dispersed soil. Soil moisture constants (field capacity "FC", and wilting percentage "WP" and calculated available water AW), Soil bulk density (BD), porosity (P), Total calcium carbonate (CaCO_3), Coarse Fragment Fraction (CFF) ($>2\text{mm}$), Soil pH of the saturated soil paste extract, soil salinity (ECe), soluble cations and anions and calculated sodium adsorption ratio SAR, Cation Exchange Capacity (CEC), soil organic matter (SOC), total nitrogen (TN), available phosphorus (P) and available potassium (Av.K).

Method of statistically modeled SQI

Selected MDS

In this study quantify SQ by four steps to form of soil quality index (SQI) as follow: 1- identification of production or sustainability goal. 2- Selection of SQ indicators. 3- Transformation of soil properties. 4- Computation of soil quality index according to [8]. A statistics method to estimate SQI based on using Principal Component Analysis (PCA) was performed for the determination by [30]. proposed by [7], [8], [9] and [21]. In this study selected 10 indicators (MDS) from about twenty-three potential SQ indicator as form of total data set (TDS) based on the PCA model (Table 2). The PCA is a commonly used and widely accepted method to select MDS because of using statistical tools which could avoid any biasness and data redundancy while, retaining as much as possible of the variations present in the data set by choosing an MDS. MDS is reducing the indicator load in the model and avoid data redundancy [31]. PCA with eigenvalues ≥ 1 was considered to contribute for explain greatly total variability. In each PC soil indicators with a loading within 10% of the highest factor loading were chosen as the most appropriate indicators for the MDS [31].

Table (1):- The location and description of the selected farms of studied area at NWCZ

Far m. No.	location		Agriculture system		Irrigation		crop rotat ion	Crop type at soil sampling time		Cu lt. are a (fe d.)	Tillage system	Fertiliz ation practic e	Crop yield (Mg/ fed)	Ry %*
	latit ude	longit ude	Type	Peri od (yea rs)	sour ce	meth od								
1	31° 27' 09" N	26° 47' 23"E	Traditi onal rainfed	10	Rainfall			orch ard	fig	10	Moldb oard plow	organic manure	17.32	78. 78
2	31° 08' 35" N	27° 40' 45"E		20					oliv e	2	Moldb oard plow	organic manure	3.91	71. 91
3	31° 09' 07" N	27° 37' 50"E		10					oliv e	3	Chisel Plow	without	3.47	63. 64
4	31° 23' 10" N	27° 02' 30"E		20					fig	11	Chisel plow+ scribbl e	without	16.28	74. 01
5	31°	27°							oliv				3.85	70.

	23' 15" N	02' 36"E						e					00	
6	31° 19' 45" N	26° 53' 06"E		10			fallow - wheat-fallow	annual	wheat (grains)	5	Moldboard	without	1.79	71.72
7	31° 20' 52" N	26° 50' 55"E		10					wheat (grains)	5	Moldboard	organic manure	2.98	85.40
8	31° 07' 43" N	27° 49' 59"E	Rainfed with supp. Irrig.	15	Well	Drip irrigation		orchard	fig	5	Moldboard	without	17.76	80.73
9	31° 07' 40" N	27° 49' 59"E							Olive	5	Chisel Plow		4.17	75.91
10	31° 12' 04" N	27° 51' 37"E		15					fig	10	Chisel Plow	organic manure	18.49	84.09
11	31° 11' 08" N	27° 32' 42"E		24		Drip irrigation			fig	4	Chisel Plow	NPK + organic manure	21.75	98.86
12	31° 23' 30" N	27° 02' 31"E		30	Trench	Surface irrigation			olive	40	Chisel Plow	NPK + organic manure	5.47	99.55
Ry% : Relative yield % = (Actual yield (Mg/fed))/(Max. yield prevailing in the study area (Mg/fed)) *100 [21] (Wassif 2017)														

Methodology of evaluation SQI

Soil quality can be evaluated using appropriate indicators which represent soil functions linked to the defined management goal. However, a quantitative value is necessary to make comparisons to management systems. The SQI is calculated by aggregating the indicators after converting the indicators into dimensionless units. The absolute values are used to derive SQI by various methods, viz., weighted [31]. The weight for each indicator was assigned to each soil function (Table 3) according to [5], [7], [10] and [32]

Table (2):- The retained principal components (PCs) obtained from twenty-two soil physical and chemical properties of all farms NWCZ. (Only PCs with eigenvalues ≥ 1).

Soil depth (cm)	Total					
Component	principal component					
	PC ₁	PC ₂	PC ₃	PC ₄	PC ₅	CE*
Eigenvalue	6.04	4.38	3.64	2.79	2.00	
proportion of variance	28.76	20.84	17.35	13.30	9.53	
cumulative proportion	28.76	49.60	66.95	80.25	89.79	
Rotated principal components (PCs)						
Av.K	0.92					0.85
TP	0.89		0.19	0.17		0.87
BD	-0.86		-0.31	-0.18		0.88
SOC	0.82		-0.12	-0.45		0.90

TN	0.77	0.36	-0.37	0.30		0.95
Av.P	0.68		0.46		-0.11	0.68
CLAY		0.98				0.98
CEC		0.93	0.17		-0.11	0.93
ER	-0.27	-0.93				0.95
Pe	0.64	-0.70		0.25		0.97
WP			0.98			0.97
AW			0.97	-0.12		0.97
FC		0.18	0.96	-0.12		0.97
CS		-0.22	-0.10	0.94	-0.19	0.98
CaCO ₃	0.26		-0.23	0.71		0.78
FS	-0.35	-0.46		-0.74	-0.31	0.97
CFF	0.56		0.10	-0.68	-0.26	0.85
pH	-0.82			0.56	0.45	0.79
EC		-0.12	-0.18	0.13	0.93	0.94
SILT	0.41	0.27		-0.23	0.77	0.90
SAR	-0.17	-0.46	-0.15	0.27	0.68	0.79

¹FS: fine sand(%); CS: coarse sand(%); BD: bulk density(Mg/cm³); TP: total porosity(%); FC: Field capacity(%); WP: wilting point(%) ; AW: available water (%); Pe: effective porosity (%); EC: electrical conductivity(dS/m); CEC: cation exchange capacity(cmolc.kg⁻¹); SOC: soil organic carbon(%); TN: total nitrogen(%); Av.P: available phosphorus(mg/kg); Av.K: available potassium(meq/100gm); SAR: sodium adsorption ratio;ER: Erosion Rate (soil erodibility) (Mg/ha); CFF: coarse fragment fraction(%). *CE: comunity estimates.

In this study, ten SQ indicator were used based on their sensitively to management practices, ability to describe major soil processes, ease and cost of sampling and laboratory analysis, and significance of increasing productivity and protecting environmental soil functions. The selected indicators include texture to reflect the suitability of soil physical conditions for plant growth; available water (AW), bulk density (BD) and Porosity for water transportation and retention function; soil organic carbon (SOC) and Erosion rate (ER) for resistance to physical degradation and erodibility index; finally, pH, ECe, Av.K and CEC for plant growth according to [5], [10] and [32]. Each of the indicators was divided into four classes. Class I is the most suitable for plant growth; Class II is suitable to plant growth but with slight limitations; Class III is with more serious limitation than Class II; and Class IV is with severe limitations for plant growth. Marks of 4, 3, 2, and 1 were given to class I, II, III, and IV, respectively. The range for each class is shown in Table 3. The sum of all weights is normalized to 1.

$$SQI = \sum W_i L_i$$

Where W_i is weights of the indicators and L_i is the marks of the indicators classes. SQI of every indicator was calculated separately by multiplying weight of indicators and marks allotted and summing up of all ten indicators obtained the SQI value for this study soils (Table 3).

Methodology of calculate Relative Soil Quality Index (RSQI)

The concept of RSQI is to quantify evaluating of changes in soil quality. The ten indicators were combined according to [5]. The equation for calculating RSQI value is given below:

$$RSQI = \frac{SQI}{SQI_m} \times 100$$

Where SQI is soil quality index and SQI_m is the maximum value of SQI. The maximum value of SQI for soil is 4 and the minimum value 1 [33]. Optimum RSQI in any normalized soil in any region equal 1 but in real soils will have lower values which directly indicate their distance from the optimal soil [5]. According to the RSQI values, soils were classified into five classes from best to follow in Table 4 worst as.

Table (3):- Soil quality and their weights and classes for the evaluation of soil quality according to [5],

[7], [10] and [32].

Indicator	weight	Class I	Class II	Class III	Class IV
Texture	0.13	Loam	*Si L, S, SCL	*CL, SL, Si C	Loamy, LS, clay, sand
*ER	0.30	<10	10-30	30-50	>50
*BD (Mg m ⁻³)	0.04	<1.3	1.3-1.4	1.4-1.5	>1.5
Porosity	0.16	>0.20	0.18-0.20	0.15-0.18	<0.15
*SOC (%)	0.15	>0.45	0.3-0.45	0.15-0.3	<0.15
pH	0.03	6-7	7-7.4	7.4-8.2	>8.2
CEC (cmolc.kg-1)	0.06	>20	15-20	10-15	<10
Av. k (ppm)	0.10	<75	75-100	150-250	>250
E.Ce (dS/m)	0.03	<2	2-4	4-8	>8
AW %	0.10	>0.30	0.20-0.30	0.08-0.20	<0.08
Marks allotted	1	4	3	2	1

* ER: Erosion ratio (soil erodibility indices), BD: Bulk density, SOC: Soil organic carbon, CEC: Cation Exchange capacity, Av.K: Available K, AW: Available water, Sity Loam, Silty Clay, silty clay loam, Clay Loam, sandy loam, silty clay, loamy sand

Table (4):- Soil Quality classification based on Relative Soil Quality Index (RSQI) according to [5].

Soil Quality status	RSQI Value
Class I	90-100
class II	80-90
class III	70-80
class IV	60-70
class V	<60

For quantifying the change of soil quality (Δ RSQI) by computing RSQI values by compared with highly value of studies soils even if these soils with different evaluation systems, weightings, and classes. Change of soil quality index (Δ RSQI) classified into six classes from great increase to Great decrease in change of soil quality as follow in Table 5 according to [5].

Table (5):- Changes in soil quality (Δ RSQI) were grouped into six classes according to [5].

Changes classes	Δ RSQI
Great increase	> 15
Moderate increase	10-15
Slight increase	10 - 0
Slight decrease	0 to -10
Moderate decrease	-10 to -15
Great decrease	< -15

Cumulative Rate Index (CRI)

to quantify evaluation of soil sustainability was calculated CRI by assigning a relative weighting factor (RWF) was obtained from critical limits approach of [34] for each soil indicator to test its efficiency Table (6). The CRI of sustainability was obtained by summing the values of critical limitation of each soil indicator ranging from 1 to 5 as follow in Table (6). Showing “no limitation” to “extreme limitation” classes according to [5], [10] and [27]. CR in Table (7) for various soils can range from highly sustainable (CR<20) to unsustainable (CR>40) for ten indicators according to [27].

Table (6):- Relative weighting factors (RWF) based on the threshold values of soil quality indicators using the cumulative rating (CR) according to [5], [10], [27] and [29].

Soil indicator	Limitation				
	None	Slight	Moderate	Severe	Extreme
Texture	Loam	SiL, S, SCL	*CL, SL	*SiC, LS	Clay, sand
*ER (%)	<10	10-30	30-50	50-70	>70
BD (Mg m ⁻³)	<1.3	1.3-1.4	1.4-1.5	1.5-1.6	>1.6
Porosity	>0.20	0.18-0.20	0.15-0.18	0.10-0.15	<0.10
SOC (%)	>6	0.45-6	0.3-0.45	0.15-0.3	<0.15
pH	6-7	7-7.4	7.4-7.8	7.8-8.2	>8.2
CEC (cmolc.kg-1)	>20	15-20	10-15	5-10	<5
A.v k (ppm)	<75	75-150	150-250	250-800	>800
EC (dS m ⁻¹)	<3	3-5	5-7	7-10	>10
AW (cm ³ .cm ⁻³)	>0.30	0.20-0.30	0.08-0.20	0.02-0.08	<0.02
RWF	1	2	3	4	5
* ER: Erosion ratio (soil erodibility), BD: Bulk density, SOC: Soil organic carbon, CEC: Cation Exchange capacity, Av.K: Available K, AW: Available water, Sity Loam, Silty Clay, silty clay loam, Clay Loam, sandy loam, silty clay, loamy sand					

Table (7):- Soil sustainability classification based on Cumulative Rate Index (CRI) according to [27].

sustainability status	*CR (Ten factors)
Highly sustainable	<20
Sustainable	20-25
Sustainable with high input	25-30
Sustainable with another land use	30-40
Unsustainable	>40

Results and Discussion:-

Soil quality and soil sustainability at rainfed agriculture managements

Soil quality evaluation in 12 farms where wheat, fig and olive were grows in both of traditional rainfed and rainfed with supplement irrigation management. Table (8) shows the data on selected soil indicators vis-à-vis soil physicochemical properties of the selected farms of studied area at NWCZ.

The rating index of SQI and RSQI values was higher side in rainfed with supplement irrigation farms than in traditional rainfed farms (Table 9).

The change of soil quality (Δ RSQI) evaluation was evaluated quantify for both of two kinds of rainfed management (traditional rainfed and rainfed with supplement irrigation managements). The selected farms under study were classified according to soil quality change classes; Generally, the values of soil quality change were above 10 and classified under moderately increase of change of soil quality (class II) and most of these farms were under traditional rainfed management. On the other hand, the values of farms No. 3, 5 and 9 Δ RSQI= 22.02, 21.34 and 21.45 respectively were classified to great increase in change of soil quality class (Class III). As noted from the above, these farms were without fertilization practices management. Otherwise, the values of farms No. 7, 11 and 12 were below 5 (Δ RSQI= 4.03, 3.86 and 0.00 respectively) and classified under slight increase of soil quality change (Class I). Moreover, the latter farms were under rainfed with supplement irrigation management and good fertilizer practices management.

The values of sustainability status by using cumulative rating index (CRI) approach were above 20 and classified to sustainability and sustainability with high input. In this context, the values of CRI for farms No. 3, 5 and 9 were 27, 25 and 26 respectively. These farms were classified to sustainable with high input. This is due to; these farms haven't fertilization practices management. Otherwise, farms No. 11 and 12 the values of CRI were below 20 and

classified to highly sustainability status. The latter were under rainfed with supplement irrigation and have a good fertilization practices management.

The results of sustainability by using CRI showed a strong correlation and negative significant relationship with RSQI ($R^2=0.82$, $p<0.05$) Fig. (2).

Table (8):- physicochemical properties of the selected farms of studied area at NWCZ.

Soil indicators	Types of Rainfed agriculture practices											
	Traditional Rainfed						Rainfed with supplement irrigation					
	1	2	3	4	5	6	7	8	9	10	11	12
Soil texture	S.L	S.C. L	S.C. L	S.L	S.L	S.L	L	S.L	S.L	S.L	S.C. L	S.L
B.D (Mg/m^3)	1.44	1.47	1.51	1.45	1.50	1.47	1.40	1.34	1.49	1.37	1.31	1.30
A.W($\text{cm}^3.\text{cm}^{-3}$)	0.15	0.17	0.19	0.16	0.15	0.17	0.16	0.14	0.15	0.13	0.17	0.13
Porosity	0.28	0.28	0.17	0.21	0.28	0.77	0.24	0.27	0.22	0.29	0.27	0.38
PH	7.15	7.10	7.90	7.10	7.30	7.80	7.80	7.90	8.00	7.80	7.00	7.00
E.Ce (dS/m)	0.87	0.78	3.93	0.85	0.72	1.60	8.73	1.88	3.55	1.90	0.43	2.49
SOC%	0.66	0.45	0.26	0.45	0.37	0.45	0.62	0.45	0.36	0.45	0.81	0.76
ER (%)	46.08	42.12	40.74	44.22	57.37	45.07	31.73	44.15	53.60	45.28	30.29	25.24
CEC (cmolc.kg^{-1})	19.58	20.57	25.75	19.46	11.34	19.90	20.52	18.74	18.45	18.05	22.47	20.59
Av.K (ppm)	76.44	76.13	45.00	56.67	29.54	36.00	78.97	65.00	35.00	66.24	99.95	96.67

BD: Bulk density, AW: Available water, SOC: Soil organic carbon, ER: Erosion ratio (soil erodibility indices),CEC: Cation Exchange capacity, Av.K: Available K.

Table (9):- Soil quality changes and sustainability of long term two types of rainfed agriculture management in NWCZ.

Rating index	Types of Rainfed agriculture practices											
	Traditional rainfed						Rainfed with supplement irrigation					
	1	2	3	4	5	6	7	8	9	10	11	12
SQI	3.16	3.14	2.71	2.75	3.13	2.77	3.10	3.38	3.14	2.77	3.14	3.39
RSQI	89.61	89.05	77.98	88.88	78.66	88.02	95.97	89.16	78.55	89.16	96.14	100.00
ΔRSQI	10.39	10.95	22.02	11.12	21.34	11.98	4.03	10.84	21.45	10.84	3.86	0.00
CRI	21	20	27	22	25	23	23	23	26	22	17	17
Class	II	II	III	II	III	II	I	II	III	II	I	I
Change Class	Moderate increase	Moderate increase	Great increase	Moderate increase	Great increase	Moderate increase	Slight increase	Moderate increase	Great increase	Moderate increase	Slight increase	Slight increase
Sustainability	Sustainable	Sustainable	Sustainable with high	Sustainable	Sustainable with high	Sustainable	Sustainable	Sustainable	Sustainable with high	Sustainable	Highly sustainable	Highly sustainable

			input		input				input			
SQI (Soil Quality Index), RSQI (Relative Soil Quality Index), CRI (Cumulative Rate Index)												

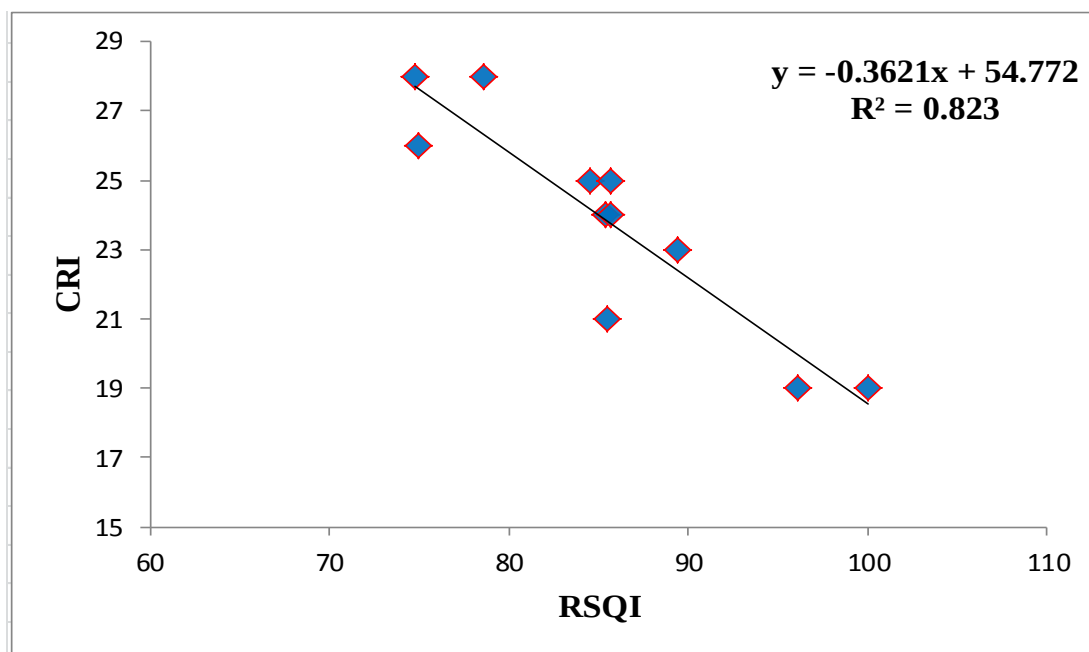


Fig. (2):- Relationship between cumulative rate index (CRI) and Relative soil quality index (RSQI) under the studied farms at NWCZ.

The farms have low value of CRI (CR=17) where the same farms have highly RSQI (96.14 and 100) and have slight increase of soil quality change under rainfed with supplement irrigation management and have good fertilization practice management (NPK + organic manure). These results were agreed with [5].

The relationship between RSQI and CRI proved both indices had good efficiency in evaluated of soil quality. This relationship between both approaches was negatively correlated. Direction and intensity of soil quality changes was found great increase in farms No. 3, 4 and 9. This indicates that have loss of nutrient and low input of fertilizers practices. This indicates that these farms have poor management practices although these farms were under different rainfed management practices.

Relationship between RSQI, CRI and crop yield

In this study, emphasis is placed on the impacts of soil quality on productivity. The relationship between relative yield (Ry%) and RSQI was strong correlated and positive significant relationship ($R^2=0.78$, $p<0.05$). On the other hand, the CRI also showed strong correlated and negative significant relationship with Ry% ($R^2=0.81$, $p<0.05$) (Fig. 3). This result agrees with [21].

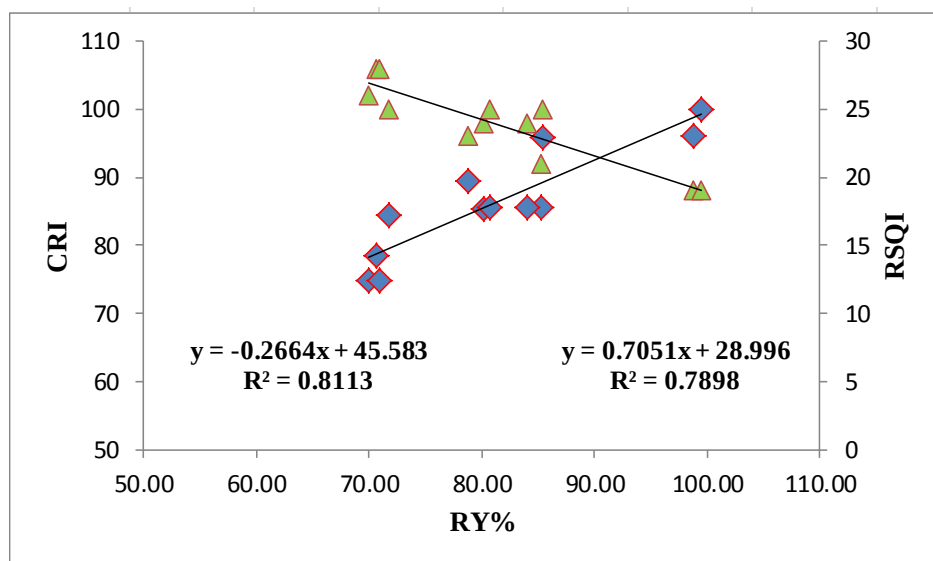


Fig (3):- Relationship between Relative soil quality index (RSQI) and cumulative index (CRI) under the studied farms at NWCZ.

However, when the values of RSQI were increase significantly increase the values of Ry% or productivity. In this light, the CRI values were decrease significantly increase the values of Ry% (Fig. 4).

A study identifying several biological, chemical, and physical indicators of soil quality also concluded that the highest SQI and low CRI indicated improve soil quality and the sustainability status moving towards sustainability and highly sustainable status. Also, it is indicated that improved crop yield. In addition, the results illustrated that the highest SQI values and lowest CRI values of farms under rainfed with supplemental irrigation better than farms under traditional rainfed.

Direction and intensity of in soil sustainability were highly sustainable in farms No.11 and 12 under rainfed with supplemental irrigation than farms under traditional rainfed management. Moreover, soil sustainability status of these farms has good fertilizer practices management (NPK + organic manure) than farms have added organic manure only towards to highly sustainable. This indicates that soil recovered the loss of nutrients these results agree with [5] and [21].

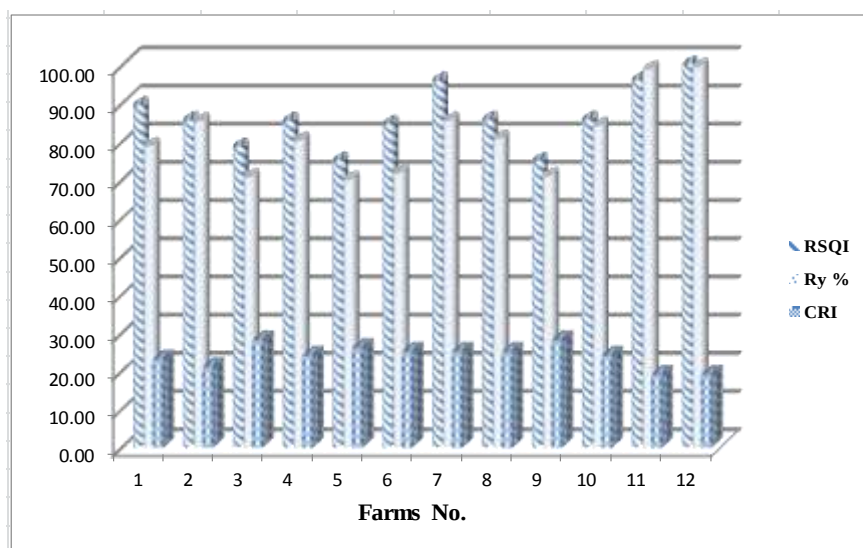


Fig. (4):- Relationship between Relative Soil Quality Index (RSQI), Cumulative Rating Index (CRI) and Relative yield (Ry %) under the studied farms at NWCZ.

This study recommended that to expansion of rainfed with supplemental irrigation management system to solve the biggest obstacle of rainfed agriculture management. This because of, supplemental irrigation plays an important, critical, and essential role in dryland agriculture if practiced on scientific lines this agree with [35]. On the other hand, it is also recommended to dose of NPK application along with manure improved low quality soils, but it took a long time to reach class I quality and highly sustainable status. In another studies, agreement with this study where these explained the low fertilizer use efficiency for rainfed agriculture. Since most of the rainfed area are being exposed to higher temperature, the warmer conditions speed the natural decomposition of organic matter and at the same time also increase the rates of other soil processes that affect fertility. Moreover, application of fertilizers may be required to realize enhanced crop growth and realized higher crop yield. The latter can be real if applied in the correct doses, in the appropriate combination and at the proper time [4], [5], [36], [37], and [38].

Conclusions:-

In this study revealed the potential usefulness physicochemical indicators, crop yield and plant nutrient content are seldom linked with soil quality and sustainability. Also, it is useful for assessment of soil quality and sustainability under long term rainfed agriculture system. This research showed that agriculture land use and improper management practices have led to degradation of soil quality. Also, both of SQI and CRI approaches have a strong relation with each other and with productivity. The expert knowledge with respect to this study might be considered of expert opinion in indicator selection could improve the validity and applicability of SQI, CRI and defined management goal. The combination of a soil change database has proved to be an effective method for evaluating changes in soil quality. In this context, the results showed that both of SQI and CRI approaches indicated convergent results in evaluating soil quality and sustainability. The farms under rainfed with supplemental irrigation and good fertilization practices (NPK + organic manure) have good soil quality, highly sustainability and low of soil quality changes.

This study can be considered in recent developments as visual evaluation techniques to assessment SQ in the field. It could be advantageous as landowners and farmers can participate in visual assessment of soil quality. In this light, it can be helping the policymakers, researchers, and farmers to take decisions on best management under rainfed agriculture system and to monitor the change of soil quality. Finally, if rainfed agriculture management practices is practiced along scientific lines and improvement strategies are adopted, tangible and encouraging crop yields can be achieved on a sustainable basis.

References:-

1. Omnia Wassif, M., Adil A. Meselhy, Saad F. Sharkawy, Alaa A. Ali. (2020). quantify impact of wind erosion on organic matter content under management practices, wadi el raml, nwcz, egypt Egyptian J. Desert Res., 70, No. 1, 83-102.
2. Mohamed Y. I. 1, A. A. Aldabaa (2017).Yield Prediction of some Orchard Trees Based on Soil Characteristics under Rainfed Conditions Alexandria Science Exchange Journal, 38(3).
3. Khalifa M. E. A. and Nawal F. Beshay (2015). Soil Classification and Potentiality Assessment for Some Rainfed Areas at West of Matrouh, Northwestern Coast of Egypt Alexandria science exchange Journal, 36(4).
4. Mirza B. Baig, Shabbir A. Shahid, and Gary S. Straquadine (2013). Making rainfed agriculture sustainable through environmentally friendly technologies in Pakistan: A review International Soil and Water Conservation Research, 1(2), 36 – 52.
5. Singh, A. K., S. P. Mazumdar, A. R. Saha & D. K. Kundu (2017). Soil Quality Changes Resulting from Long-Term Fertilizer Application Under Intensive Cropping System in Alluvial Soils communications in soil science and plant analysis, 48(13), 1503–1510, www.researchgate.net/publication/319877302.
6. Sharma KL, Mandal B (2009) Soil quality and its relevance or sustainable agriculture. J Indian Soc Soil Sci 57:572–586
7. Mukherjee, A., R. Lal (2014). Comparison of Soil Quality Index Using Three Methods. 9 (8), www.plosone.org.
8. Vasu, D., P. Tiwary, P.Chandran, and S. K. Singh (2020). Soil Quality for Sustainable Agriculture chapter of Nutrient Dynamics for Sustainable Crop Production © Springer Nature Singapore Pte Ltd. 2020 41R. S. Meena (ed.), https://doi.org/10.1007/978-981-13-8660-2_2.
9. Ghaemi, M., A.R. Astaraei1, H. Emami1, M. Nassiri Mahalati, S.H. Sanaeinejad (2014). Determining soil indicators for soil sustainability assessment using principal component analysis of Astan Quds- east of Mashhad- Iran Journal of Soil Science and Plant Nutrition, 14 (4), 987-1004.

10. Vashisht, B. B., B. Maharjan, S. Sharma and S. Kaur (2020). Soil Quality and Its Potential Indicators under Different Land Use Systems in the Shivaliks of Indian Punjab. 12, 3490; doi:10.3390/su12083490 www.mdpi.com/journal/sustainability
11. Nabiollahi, K., E. Heshmat, A. Mosavi, R. Kerry, M. Zeraatpisheh and R. T. Mehrjardi (2020). Assessing the Influence of Soil Quality on Rainfed Wheat Yield Agriculture, 10,469; doi: 10.3390/agriculture10100469 www.mdpi.com/journal/agriculture.
12. Bouma J, van Ittersum MK, Stoorvogel JJ, Batjes NH, Droogers P, Pulleman MM (2017) Soil capability: exploring the functional potentials of soil. In: Field D et al (eds) Global soil security. Springer, Cham, pp 27–44
13. Bünemann EK, Bongiorno G, Bai Z, Creamer RE et al (2018) Soil quality – a critical review. Soil Biol Biochem 120:105–125
14. Hoda Elia, A., (2009). Impact of farming systems on soil quality and agriculture sustainability (with special reference to physical properties). PhD thesis. Departement of soil science. Fac. of Agri. Ain Shams Uni.
15. Gura, I. and P. Mkeni, (2019) Crop rotation and residue management effects under no till on the soil quality of a Haplic Cambisol in Alice, Eastern Cape, South Africa. Geoderma, 337, 927–934.
16. Calero, J.; Aranda, V.; Montejo-Ráez, A.; Martín-García, J.M. (2018) A new soil quality index based on morpho-pedological indicators as a site-specific web service applied to olive groves in the Province of Jaen (South Spain). Comput. Electron. Agric., 146, 66–76.
17. Obade, V.D.P. (2019) Integrating management information with soil quality dynamics to monitor agricultural productivity. Sci. Total Environ., 651, 2036–2043.
18. Juhos, K.; Szabo, S.; Ladanyi, M. (2016). Explore the influence of soil quality on crop yield using statistically-derived pedological indicators. Ecol. Ind., 63, 366–373.
19. Nabiollahi, K.; Taghizadeh-Mehrjardi, R.; Kerry, R.; Moradian, S. (2017). Assessment of soil quality indices for salt-affected agricultural land in Kurdistan Province, Iran. Ecol. Indic., 83, 482–494.
20. Yu, P.; Liu, S.; Zhang, L.; Li, Q.; Zhou, D. (2018). Selecting the minimum data set and quantitative soil quality indexing of alkaline soils under different land uses in northeastern China. Sci. Total Environ., 616, 564–571.
21. Omnia Wassif, M., (2017). Impact of long term management practices on soil properties under the conditions of Egypt. Doctor of Philosophy in agriculture science (soil science); Department of soil science Fac. of Agri. Ain Shams Uni.
22. Liu, Z., Zhou, W., Shen, J., Li, S., Ai, C. (2013). Soil quality assessment of yellow clayey paddy soils with different productivity. Biol Fert Soils, 50: (3), 537–548.
23. Gomez A.A., D.E.S. Kelly, J.K. Syers and K.J. Coughlan (1996). Measuring Sustainability of Agricultural Systems at Farm Level. In: Doran J.W. and Jones A.J., Eds. Methods for Assessing Soil Quality. SSSA Special Publication Number 49, Soil Science Society of America, INC., Madison, WI, pp: 401–410.
24. Shukla, M.K., R. Lal and M. Ebinger (2004). Soil quality indicators for the northern Appalachian experimental watersheds in Coshocton Ohio. Soil Science 169 (3)195–205.
25. Klute, A. (1986). Water Retention Laboratory Methods. pp. 635–661. In A. Klute (ed.) Methods of Soil Analysis. Part 1. 2nd ed. Agronomy Monograph, 9. ASA, Madison WI.
26. USDA, SCS (1988). National Agronomy Manual, Wind Erosion. Part 502. Title 190. Washington D.C., USA.
27. Ikemura, Y. and Manoj K. Shukla (2009). Soil quality in organic and conventional farms of New Mexico, USA Journal of Organic Systems –4 (1), 177–4258.
28. Page, A. L., R.H. Miller, and D. R. Keeny (1982). Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. Agron. Monograph No. 9 ASA, Madison, WI, USA.
29. Middleton H. E. (1930). Properties of soils which influence soil erosion. Technical Bulletin No.178; USDA: Washington, DC, USA.
30. SPSS. (2007). SPSS Statistical Package for Windows. SPSS Base 16.0 User's Guide. SPSS Base 16.0 User's Guide Copyright © 2007 by SPSS Inc. Printed in the United States of America. <http://www.spss.com/worldwide>.
31. Andrews, S.S., D.L. Karlen and J.P. Mitchell (2002). A comparison of soil quality indexing methods for vegetable production systems in Northern California. Agr Ecosyst. Environ. 90, 25–45.
32. Gelaw, A. M., B. R. Singh and R. Lal (2015). Soil Quality Indices for Evaluating Smallholder Agricultural Land Uses in Northern Ethiopia 37, 2322–2337; doi:10.3390/su7032322
33. Wang, X., and Z. Gong. (1998). Assessment and analysis of soil quality changes after eleven years of reclamation in subtropical China. Geoderma 81:339–55. doi:10.1016/S0016-7061(97)00109-2.
34. Lal, R. (1994). Methods and Guidelines for Assessing Sustainable Use of Soil and Water Resources in the Tropics. Soil Management Support Services, USDA-NRCS, Washington, D.C, pp. 78.

35. Shah, A. H., Gill, K. H. and Syed, N. I. (2011). Sustainable salinity management for combating desertification in Pakistan. *Int. Journal of Water Resources and Arid Environments*, Vol. 1, No. 5, pp. 312-317.
36. Dawe, D., A. Dobermann, P. Moya, S. Abdulrachman, B. Singh, P. Lal, S. Y. Li, B. Lin, G. Panaullah, and O. Sariam. (2000). How widespread are yield declines in long-term rice experiments in Asia? *Field Crops Research* 66:175–93. doi:10.1016/S0378-4290(00)00075-7.
37. Ladha, J. K., D. Dawe, H. Pathak, A. T. Padre, R. L. Yadav, B. Singh, Y. Singh, P. Singh, A. L. Kundu, R. Sakal, N. Ram, A. P. Regmi, S. K. Gami, A. L. Bhandari, R. Amin, C. R. Yadav, E. M. Bhattarai, S. Das, H. P. Aggarwal, R. K. Gupta, and P. R. Hobbs. (2003). How extensive are yield declines in long-term rice-wheat experiments in Asia? *Field Crop Research* 81:159–80. doi:10.1016/S0378-4290(02)00219-8.
38. Chaudhury, J., U. K. Mandal, K. L. Sharma, H. Ghosh, and B. Mandal. (2005). Assessing soil quality under long-term rice based cropping system. *Communication in Soil Science and Plant Analysis* 36:1141–61. doi:10.1081/CSS-200056885.