UNIVERSITÀ DEGLI STUDI DI FIRENZE

First Level Master degree in

Irrigation Problems in Developing Countries

Using information technology for checking the irrigation water requirements of center pivot sprinkler irrigation system for wheat crop in comparison with surface irrigation system under conditions of salinity irrigation water in IRAQ– BASRAh

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DEDICATION

To the soul of my father and mother

&

To the greatest lady in my life, for being supportive
during my studies in Italy

(MY WIFE)....
Acknowledgements

IRAQ:

- MINISTRY OF AGRICULTURE
- AGRICULTURAL DIRECTORATE OF BASRAH
- MY FAMILY

ITALY

- Professor, Ing. Elena Bresci, the coordinator of this master
- Dr. Ivan Solinas, the supervisor
- Dr. Giovanni Totino, Director General of (IAO)
- Dr. Tiberio Chiari, Technical Director
- Dr. Andrea Merli, administrative and logistic coordinator
- Professor MOHAMAD HUEESIN
- Dr. Eliza Masi, Technical and scientific tutor.
- Finally, for all my friends in the Irrigation and Geomatics master students.
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List of Abbreviations

FAO: food and agriculture organization
Km: unite to measure distance kilo meter
ET: Evapotranspiration
ET\(_o\): Reference Crop Evapotranspiration
ET\(_c\): Crop evapotranspiration under standard conditions
Kc: 5 Crop coefficient, ks: Water stress coefficient
D\(_r\): root zone depletion
PH: measure of the acidity
EC\(_e\): soil salinity (EC\(_e\) = electric conductivity)
EC\(_w\): water salinity.
LF: leaching fraction
EC\(_i\)w: electric conductivity of the irrigation water
p.p.m: parts per million
MS: milliohms
Wua: water user Associations
IRR: irrigation water requirements
Ec: Conveyance efficiency
Eb: is the ratio between water received at the field inlet and that received at the inlet of the block of fields
Ea: Field application efficiency
Ep: is the ratio between water made directly available to the crop and that released from the headwork
CP: center pivot
LEPA: Low Energy Precision Application
LDN: Low Drift Nozzle
CWR: crop water requirements
HWSD: Harmonized world soil database viewer
FC: field capacity
WP: wilting point
AW: available water
TAW: total available water
CU: Coefficient of Uniformity (Christiansen uniformity)
DU: distribution uniformity
CAMS: Computer aided management systems

Ha: Hectare
M: Meters
mm: Millimeter, m\(^3\): cubic meter, m\(^2\): Square meters

Dunum: Iraqi local unite for measure size of land its equal 2500 m\(^2\)

SPAW: Soil Plant Air Water
TDS: total dissolved sodium
Abstract

This paper provides an overview of center pivot irrigation for wheat crop. Search tries to estimate the actual requirement of irrigation water for wheat crop using the center pivot sprinkler system, which is existing in southern Iraq, Basrah. This is based on the software information technology (Cropwat 8.0, NEW-Locclim) under the conditions of irrigation with salinity water; where is a famous for the Basra area, up the tongue salted, although the laboratory results indicate that the source of the water of the Tigris River (2.16 MS/cm) is within the acceptable limit at the moment. It was also estimated total gross irrigation (339.9 mm) with field efficiency reaches (87%). And based on the scientific literature published for the company manufacturing and matched to the style used in the study area. The LDN for nozzle model show us that the percentage coefficient uniformity is 87 % compared with the previous system, a system of surface irrigation who appreciates efficiency 60-70 %. The new system is much better than before and can get higher rates if you follow the scientific recommendations. The theoretical results reached by the study can be the starting point for actual research work in the study area to measure the coefficient of uniformity and coefficient distribution to estimate the efficiency of the performance.
Introduction

Background

Iraq, with a total area of 438,320 square kilometers (km²) including 924 km² of inland waters, Topographically Iraq is shaped like a basin, consisting of the Great Mesopotamian alluvial plain of the Tigris and the Euphrates; Both the Tigris and the Euphrates are international rivers originating in Turkey. The Tigris river basin in Iraq has a total area of 253,000 km², or 54% of the total river basin area.

The average annual flow of the Euphrates as it enters Iraq is estimated at 30 cubic kilometers (km³), with a fluctuating annual value ranging from 10 to 40 km³. Unlike the Tigris, the Euphrates receives no tributaries during its passage in Iraq. About 10 km³ per year are drained into the Hawr al Harnmar (a marsh in the south of the country). For the Tigris, average annual runoff as it enters Iraq is estimated at 21.2 km³.

There is only one river basin in Iraq, the Shatt Al-Arab basin. The Shatt Al-Arab is the river formed by the confluence downstream of the Euphrates and the Tigris and flows into the Arabian Gulf after a course of only 190 kilometers (km). Before their confluence, the Euphrates flows for about 1,000 km and the Tigris for about 1,300 km respectively within the Iraqi territory. Nevertheless, due to the importance of the Euphrates and the Tigris, the country is generally divided into three river basins: the Tigris, the Euphrates, and the Shatt Al-Arab.

The total water managed area was estimated at 3.5 million ha in 1990, all of it being equipped for full or partial control irrigation. The areas irrigated by surface water are estimated at 3,305,000 ha, of which 105,000 ha (3%) are in the Shatt Al-Arab river basin, 2,200,000 ha (67%) are in the Tigris river basin, and 1,000,000 ha (30%) are in the Euphrates river basin. However, it should be noted that all these areas are not actually irrigated, since a large part has been
abandoned due to waterlogging and salinity. Only 1,936,000 ha were estimated to be actually irrigated in 1993. Salinity has always been a major issue in this area and it was already recorded as a cause of crop yield reductions some 3,800 years ago; It is estimated that in 1970 half the irrigated areas in central and southern Iraq were degraded due to waterlogging and salinity. The absence of drainage facilities and, to a lesser extent, the irrigation practices used (flooding) were the major causes of these problems.

In 1991, there were 224,490 ha of irrigated wheat, with an average yield of 2.7 tons/ha, while the rainfed wheat area was estimated at 508,620 ha, with an average yield of 1.7 tons/ha. There were 200,770 ha of irrigated barley, with an average yield of 1.8 tons/ha, while the rainfed barley (FAO, Irrigation in the near east region in figure; FAO, AQUASTAT 2008).

The research aims is; by using information technology to checking irrigation water requirements of center pivot sprinkler irrigation system for wheat crop in comparisons with surface irrigation system under concoctions of salinity water in south Iraq, Basra, the importance for search come from increasing destroyed for a large number of land because appearance of slimily tongue in the last period in south Iraq, Basra and destroyed agricultural lands.

The research hypotheses based on the main concept which is increasing problems for scarcity water; because of reducing revenue for Rivers (Tigris and Euphrates) and farmers used to irrigated by surface irrigation system for reasons don’t need for skills and low costly Relatively if we compare with modern irrigation for example sprinkler irrigation system, for those reasons will try through the search to estimate irrigation water requirement for center pivot sprinkler irrigation and simulation coefficient uniformity to estimate the best efficiency for pivot to put this result for hands of farmers who cultivated
wheat in Iraq generally and Basrah; Qurnah especially to support them to change their ex-method of surface irrigation system, and view through comparative between two methods, in addition the Iraqi government try to Preservation of national wealthy (water) because considering it national wealth and to Save agricultural land from degradation, the government in Iraq supply farmers center pivot sprinkler irrigation system in framework of agriculture imitative and guide them how to manage this system after instilling for them in the farms, through professionals engineering. The study area in Basrah, south Iraq; Qurnah district which is far (110 KM) of center of Basrah
Chapter I

Generality
1.1 Importance water for plants

Plants need water for proper growth and development. The crops demand for water must be met the water in soil, via the root system. Application of water to meet the crop water demand at the proper time in the proper way is termed irrigation. If the crop water demand is met by other ways (such as rainfall, irrigation, capillary rise of ground water table, etc.). There is no need for irrigation. Irrigation requirement for cereal and no cereal are not the same, among cereal, irrigation requirement of rice is the highest. On the other hand, irrigation requirement of wheat is less than when compared with the rice. Proper irrigation scheduling also affects the irrigation requirement of different crops. (M. H. Fundamentals of irrigation and on-farm water management)

Figure N01: water irrigation requirement

1.1.2 Evapotranspiration Concepts (ET)

Evaporation and transpiration occur simultaneously and there is no easy way of distinguishing between tow processes. A part from the water availability in the soil top, the evaporation from a cropped soil is mainly determined by their fraction decreases over the growing period as the crop develops and crop is small, water is predominately lost by soil evaporation, but once the crop is well develops and crop is small, water is predominately lost by soil evaporation, but once the crop is well makes the soil lose their water content, therefore,
irrigation is very important to compensate for this makes the soil Loss their water content, therefore, irrigation is very important to compensate for this loss of water thereby, providing water for plant. The combination of two separate processes whereby water is lost on the one hand from the soil surface by evaporation and on the other hand from the crop by transpiration is referred to as evapotranspiration (ET). Evaporation is the process whereby liquid water is converted to water vapour (vaporization) and removed from the evaporating surface (vapour removal). Water evaporates from a variety of surfaces, such as lakes, rivers pavements, soils and wet vegetation, and Transpiration consists of the vaporization of liquid water contained in plant tissues and the vapour removal to the atmosphere. Crops predominately lose their water through stomata. These are small openings on the plant leaf through which gases and water vapour pass.

. (Crop evapotranspiration - Guidelines for computing crop water requirements ; FAO Irrigation and drainage paper 56) .

Figure N°2 : transpiration and Evaporation

![Diagram of transpiration and evaporation](image-url)
1.1.2.3 Reference Crop Evapotranspiration (ETo)

The evapotranspiration from a reference surface not short of water is called the reference crop evapotranspiration and is denoted by ETo. The reference is a hypothetical grass reference crop with specific characteristics. The only factors affecting ETo are climatic parameters and does not consider crop and soil factors. The evapotranspiration rate from a reference surface, not short of water, is called the reference crop evapotranspiration or reference evapotranspiration and is denoted as ETo. The reference surface is a hypothetical grass reference crop with specific characteristics. The use of other denominations such as potential ET is strongly discouraged due to ambiguities in their definitions. The concept of the reference evapotranspiration was introduced to study the evaporative demand of the atmosphere independently of crop type.

Crop development and management practices. As water is abundantly available at the reference evapotranspiration surface, soil factors do not affect ET. Relating ET to a specific surface provides a reference to which ET from other surfaces can be related. It obviates the need to define a separate ET level for each crop and stage of growth. ETo values measured or calculated at different locations or in different seasons are comparable as they refer to the ET from the same reference surface.

The only factors affecting ETo are climatic parameters. Consequently, ETo is a climatic parameter and can be computed from weather data. ETo expresses the evaporating power of the atmosphere at a specific location and time of the year and does not consider the crop characteristics and soil factors. The FAO Penman- method is recommended as the sole method for determining ETo. The method has been selected because it closely approximates grass ETo at the location evaluated, is physically based, and explicitly incorporates both physiological and aerodynamic parameters. Moreover, procedures have been developed for estimating missing climatic parameter (Crop evapotranspiration - Guidelines for computing crop water requirements; FAO Irrigation and drainage paper 56).
1.1.2.4 Crop evapotranspiration under standard conditions (ETc)

The crop evapotranspiration under standard conditions, denoted as ETc is the evapotranspiration from disease-free, well-fertilized crop grown in large fields under optimum soil water conditions and achieving full production under given climatic conditions. The values of Etc and CWR (Crop Water Requirements) are identical, whereby, ETc refer to the amount of water lost through evapotranspiration and CWR refers to the amount of water that is needed to compensate for the loss. ETc can be calculated from climatic data by directly integrating the effect of crop characteristics into ETo using recognized methods an estimation of ETo is done. (Crop evapotranspiration - Guidelines for computing crop water requirements ; FAO Irrigation and drainage paper 56)

1.1.2.5 Crop coefficient (kc).and Water stress coefficient (ks)

Experimentally determined ratios of ETc/ETo called crop coefficients (Kc) is used to relate ETc to ETo as given in the following equation:

\[ \text{ETc} = \text{ETo} \times \text{Kc} \]

Where:

ETc: Crop evapotranspiration (mm/day)
Kc: Crop coefficient

The Kc for a given crop changes over the growing period as the groundcover, crop height and leaf area changes

For growth stages are recognized for the selection of Kc: initial stage, crop development stage, mid-season stage and the late season stage. The variation of Kc for different crop is influenced by weather factors and crop development. (FAO, Irrigation and Drainage Papers 56).
Figure N°3: Generalized kc curve for single crop coefficient approach (source FAO, 1998a)

Water stress coefficient (Kₚ):

The effects of soil water stress on crop ET are described by reducing the value for the crop coefficient. This is accomplished by multiplying the crop coefficient by the water stress coefficient.

Water content in the root zone can also be expressed by root zone depletion, Dᵣ, i.e., water shortage relative to field capacity. At field capacity, the root zone depletion is zero (Dᵣ = 0). When soil water is extracted by evapotranspiration, the depletion increases and stress will be induced when Dᵣ becomes equal to RAW. After the root zone depletion exceeds RAW (the water content drops below the threshold qₜ), the root zone depletion is high enough to limit evapotranspiration to less than potential values and the crop evapotranspiration begins to decrease in proportion to the amount of water remaining in the root zone. (FAO, Chapter 8 - ETₜ under soil water stress conditions)
1.2 General Description and conditions for the wheat crop

1.2.1 Wheat crop

Wheat is one of the first cereals known to have been domesticated, and wheat's ability to self-pollinate greatly facilitated the selection of many distinct domesticated varieties. The archaeological record suggests that this first occurred in the regions known as the [Fertile Crescent]. Recent findings narrow the first domestication of wheat down to a small region of southeastern Turkey.

Bread and durum wheat (Triticum aestivum and T. turgidum) were domesticated in the near and Middle East. Present world production is about 582.7 million tons from 213.8 million ha.(FAOSTAT, 2001). In Iraq wheat crop is cultivated in south and middle depends on irrigations and for north country it depends on rainfed , in south Iraq especially in AL-Bararh , Qurna , there is a lot of farmers cultivate wheat crop and barely and small land for cultivate maize (for animals uses). (FAO, Crop water information,2013)
1.2.2 The appropriate conditions for wheat crop

1.2.2.1 Climate

The crop is grown as a rain fed crop in the temperate climates, in the sub-tropics with winter rainfall, in the tropics near the equator, in the highlands with altitudes of more than 1500 m and in the tropics away from the equator where the rainy season is long and where the crop is grown as a winter crop.

Wheat is grown under irrigation in the tropics either in the highlands near the equator and in the lowlands away from the equator. In the sub-tropics with summer rainfall the crop is grown under irrigation in the winter months. In the sub-tropics with winter rainfall it is grown under supplemental irrigation. (FAO, Crop water information, 2013).

The optimum growing temperature is about 25°C, with minimum and maximum growth temperatures of 3° to 4°C and 30° to 32°C, respectively (Briggle, 1980). Wheat is adapted to a broad range of moisture conditions from xerophytic to littoral. Although about three-fourths of the land area where wheat is grown receives an average of between 375 and 875 mm of annual precipitation, it can be grown in most locations where precipitation ranges from 250 to 1750 mm (Leonard and Martin, 1963). Optimal production requires an adequate source of moisture availability during the growing season; however, too much precipitation can lead to yield losses from disease and root problems. Cultivars of widely differing pedigree are grown under varied conditions of soil and climate and show wide trait variations. Although wheat is being harvested somewhere in the world in any given month, harvest in the temperate zones occurs between April and September in the Northern Hemisphere and between October and January in the Southern Hemisphere (Percival, 1921; FAO, wheat in the world B.C Curtis ). Especially in Iraq Wheat crop requires high temperatures at the beginning of the growing season and to moderate temperatures for vegetative growth and the relatively low temperatures in the
flowering stage and to elevated temperatures in a relatively advanced stage of the life of the crop to complete the ripening grain.

As it gives the best production of the crop in terms of quantity and quality when the average temperature during the growth period between (25-35 m), As regards to rates of temperature maximum and minimum growth of the wheat crop the maximum temperatures recorded an increase during the month at November as it was in Basra (20.5 m), Either what the rates of minimum temperatures for the planting season, the lowest drop in temperatures recorded during the month of January as up in Basra to the station (7.7 m) (http://www.basrahcity.net/pather/report/basrah/35.html)

1.2.2.2 The wheat growth period.

The length of the total growing period of spring wheat ranges from 100 to 130 days while winter wheat needs about 180 to 250 days to mature. Day length and temperature requirements are key factors in variety selection. Varieties can be grouped as winter or spring types according to chilling requirements, winter hardiness and day length sensitivity. Winter wheat in its early stages of development exhibits a strong resistance to frost, down to - 20°C. The resistance is lost in the active growth period in spring and during head development and flowering period's frost may lead to head sterility. Because of this sometimes more damage is done to the winter crop by spring frost than by winter frost. (FAO, crop water information; FAO, irrigation and drainage paper 66)

For winter and spring wheat minimum daily temperature for measurable growth is about 5°C. Mean daily temperature for optimum growth and tillering is between 15 and 20°C. Occurrence of (spring) frost is an important factor in selection of sowing date. A dry, warm ripening period of 18°C or more is preferred. Mean daily temperatures of less than 10 to 12°C during the growing season make wheat a hazardous crop. Knowledge of genetic characteristics and
particularly the growth and development pattern of wheat varieties is essential for meeting the combination of various climatic requirements for growth development and yield formation. (FAO, crop water information; FAO, irrigation and drainage paper 66). The wheat harvest of field crops that are needs in the range of temperatures moderate or low somewhat so that growth is good, so is grown during the winter and if we know that determining the ideal period to start the process of seeding a significant impact on the growth stages of other periods. Germination and seedling emergence need between (25-31 m) as the border is ideal for thermal growth and seedling exposure to temperatures exceed (35 m) makes the growth weak.

(http://www.basrahcity.net/pather/report/basrah/35.html)

1.2.2.3 Appropriate soil for wheat crop

The crop can be grown on a wide range of soils but medium textures are preferred the soil; in Basrah which the study area the soil is clay-loam. Peaty soils containing high sodium, magnesium or iron should be avoided. The optimum pH ranges from 6 to 8.

Wheat is relatively tolerant to a high groundwater table; for sandy loam to silt loam a depth of groundwater of 0.6 to 0.8 m can usually be tolerated, and for clay 0.8 to 1 m. For short periods the crop can withstand without visible harm a minimum depth of 0.25 m. With a rise of groundwater table to 0.5 m for long periods the yield decrease is 20 to 40 percent. (FAO, Crop water information, 2013). Wheat grows well in soils that are called loam and clay loam alluvial. And the soil should contain a high content of organic matter decomposing in order to provide food for the wheat plants. If the soil is poor in certain nutrients, it can be added to the farmer in the form of fertilizer.

In many parts of the world's wheat is grown by farmers in the same land every year. As a result, the soil for several years after losing the nutrients needed to produce a good crop. In addition, the wind and water are making erosion and
carrying out the removal most of the nutrients from the soil. Usually farmers to take samples of the soil to be tested to see how they contain the necessary nutrients. Show such tests the pH of the soil. If the soil has become too acidic, the wheat does not grow well, it may even lead to the failure of germination, and then farmers can add fertilizer and lime to the soil to compensate for nutrients and lower the pH.

Some farmers do not grow wheat in the same land every year, but they grow in the cycle with crops such as alfalfa, corn, oats, soybeans, and this method restores nutrients to the soil and helps to resist diseases and pests. Farmers resort in the low rainfall areas to the cultivation of the field once every two years.

1.2.2.4 Salinity tolerance for wheat crop

The crop is moderately tolerant to soil salinity but the ECe should not exceed 4 mmhos/cm in the upper soil layer during germination. Yield decrease due to salinity is 0% at ECe 6.0, 10% at 7.4, 25% at 9.5, 50% at 13 and 100% at ECe 20 mmhos/cm. (FAO, Crop water information, 2013).

Figure N°5: Division for classifying crop tolerance to salinity
Some plants are more tolerant to a high salt concentration than others. The wheat crop is moderate tolerance

Table N°1: salinity tolerance for crops

<table>
<thead>
<tr>
<th>Highly tolerant</th>
<th>Moderately tolerant</th>
<th>Sensitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date palm</td>
<td>Wheat</td>
<td>Red clover</td>
</tr>
</tbody>
</table>

1.2.2.5 The general effects for Salinity problems (Salinization)

Irrigation water contains a mixture of naturally occurring salts. Soils irrigated with this water will contain a similar mix but usually at a higher concentration than in the applied water. The extent to which the salts accumulate in the soil will depend upon the irrigation water quality, irrigation management and the adequacy of drainage. If salts become excessive, losses in yield will result. To prevent yield loss, salts in the soil must be controlled at a concentration below that which might affect yield. (FAO, Water quality of Agriculture, 29)

Most water used for irrigation is of good to excellent quality and is unlikely to present serious salinity constraints. Salinity control, however, becomes more difficult as water quality becomes poorer. As water salinity increases, greater care must be taken to leach salts out of the root zone before their accumulation reaches a concentration which might affect yields. Alternatively, steps must be taken to plant crops tolerant to the expected root zone salinity. The frequency of leaching depends on water quality and the crop sensitivity to salinity. (FAO, Water quality of Agriculture, 29)

Salts are added to the soil with each irrigation. These salts will reduce crop yield if they accumulate in the rooting depth to damaging concentrations. The crop removes much of the applied water from the soil to meet its evapotranspiration demand (ET) but leaves most of the salt behind to concentrate in the shrinking volume of soil water. At each irrigation, more salt is added with the applied water. A portion of the added salt must be leached from the root zone before the concentration affects crop yield. Leaching is
done by applying sufficient water so that a portion percolates through and below the entire root zone carrying with it a portion of the accumulated salts. The fraction of applied water that passes through the entire rooting depth and percolates below is called the leaching fraction (LF). (FAO, Water quality of Agriculture, 29).

1.2.2.6. Leaching

Improvement of a saline soil implies the reduction of the salt concentration of the soil to level that is not harmful to the crop. During percolation, it take up part of the salt in the soil and take these along the deeper soil layers, in fact, the water washes the slat out of the root zone this washes process is called leaching.

On the other hand, water required for leaching must be removed from the root zone by means of subsurface drainage system, if not removed; it could cause a rise of groundwater table which would bring the slat back into the root zone.

Another important term is leaching fraction, the amount of extra irrigation water that must be applied above the amount required by the crop in order to maintain acceptable root zone salinity depending on the salinity of the water it is being irrigated with, to estimate the needed leaching fraction required, decide what soil salinity will be acceptable.

The salt tolerance data of Table N°2 are used in the calculation of the leaching requirement. If the exact cropping patterns or rotations are not known for a new area, the leaching requirement must be based on the least tolerant of the crops adapted to the area. In those instances where soil salinity cannot be maintained within acceptable limits of preferred sensitive crops, changing to more tolerant crops will raise the area's production potential. In case of doubt as to the effect of the water salinity on crop production, a pilot study should be undertaken to demonstrate the feasibility for irrigation and the outlook for economic success.
Table No2: CROP TOLERANCE AND YIELD POTENTIAL OF SELECTED CROPS AS INFLUENCED BY IRRIGATION WATER SALINITY (EC\textsubscript{w}) OR SOIL SALINITY (EC\textsubscript{e})

<table>
<thead>
<tr>
<th>FIELD CROPS</th>
<th>100%</th>
<th>90%</th>
<th>75%</th>
<th>50%</th>
<th>0%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EC\textsubscript{e}</td>
<td>EC\textsubscript{w}</td>
<td>EC\textsubscript{e}</td>
<td>EC\textsubscript{w}</td>
<td>EC\textsubscript{e}</td>
</tr>
<tr>
<td>Wheat (Triticum aestivum)</td>
<td>6.0</td>
<td>4.0</td>
<td>7.4</td>
<td>4.9</td>
<td>9.5</td>
</tr>
<tr>
<td>Wheat, durum (Triticum turgidum)</td>
<td>5.7</td>
<td>3.8</td>
<td>7.6</td>
<td>5.0</td>
<td>10</td>
</tr>
</tbody>
</table>

It can be used to predict or estimate soil-water salinity (EC\textsubscript{sw}) or soil salinity (EC\textsubscript{e}) using the following equations:

\[
\begin{align*}
\text{EC}_{\text{sw}} & = 3 \text{EC}_w \\
\text{EC}_e & = 1.5 \text{EC}_w \\
\text{EC}_{\text{sw}} & = 2 \text{EC}_e
\end{align*}
\]

((FAO Irrigation and Drainage Papers 29, 1994))

The Relationship for leaching fraction (Rhoades et al, 1974) for surface and sprinkler irrigation methods

\[
LR = \frac{\text{EC}_w}{5 (\text{EC}_e) - \text{EC}_w}
\]
Where is: \( EC_{iw} \) = electric conductivity of the irrigation water.

\( EC_e \) = electric conductivity of the extra of a saturated paste

Water depth necessary for the water demand and the leaching is given by:

\[
ET\ D\ AW = \frac{ET}{1-LR}
\]

where: \( AW \) (Available water), \( ET \) (evapotranspiration), \( LR \) (leaching fraction)

For example
If the EC of the irrigation water is 0.8 ds/m. The salinity of the drainage water is:

\( EC_{iw} = 0.8 \), \( LF = 0.2 \)

\( EC_{dw} = \frac{0.8}{0.2} = 4 \) ds/m

The drainage water existing the bottom of the root zone is even more concentrated, its, salinity at 4 ds/m, is five times greater than for the irrigation water. (FAO, Irrigation and Drainage Papers 29, 1994; Leaching fraction, soil salinity and drainage efficiency M. E. Grismer).

Figure No. 6: leaching concept

1.2.2.7 Water salinity

Water salinity is the amount of salt contained in the water. It is also called the "salt concentration" and may be expressed in grams of salt per liter of water (grams/liter or g/l), or in milligrams per liter (which is the same as parts per
million, p.p.m). However, the salinity of both water and soil is easily measured by means of an electrical device. It is then expressed in terms of electrical conductivity: milliohms/cm or micromhos/cm. A salt concentration of 1 gram per liter is about 1.5 millimhos/cm. Thus a concentration of 3 grams per liter will be about the same as 4.5 millimhos/cm. (Irrigation water management, Training manuals 1, 1985)

Figure N°7: A salt concentration of 10 g/l

1.2.2.8 Soil salinity

The salt concentration in the water extracted from a saturated soil (called saturation extract) defines the salinity of this soil. If this water contains less than 3 grams of salt per liter, the soil is said to be non-saline (see Table below). If the salt concentration of the saturation extract contains more than 12 g/l, the soil is said to be highly saline. (Irrigation water management, Training manuals, 1, 1985)

Table N°3: soil salinity

<table>
<thead>
<tr>
<th>Salt concentration of the soil water (saturation extract)</th>
<th>Salinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>in g/l</td>
<td>in millimhos/cm</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>0 - 3</td>
<td>0 - 4.5</td>
</tr>
<tr>
<td>3 - 6</td>
<td>4.5 - 9</td>
</tr>
<tr>
<td>6 - 12</td>
<td>9 - 18</td>
</tr>
<tr>
<td>more than 12</td>
<td>more than 18</td>
</tr>
</tbody>
</table>
Table N°4: test results for soil sample in Basra, Quran (by marine consulting bureau University. of Basra n3, at 4 January 2012)

<table>
<thead>
<tr>
<th></th>
<th>Ms /cm</th>
<th>ECe</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.9</td>
<td>%</td>
<td>Caco4</td>
</tr>
</tbody>
</table>

Note: Water-type is C3SI high-risk for salinityC3 and low-risk S1 of the sodic by Category Richardes (1954).

Or by Ayers & Weseots (1980) is low- middle sodic and salinity. ( N;3 at 4 jaunury 2012 from marine consulting bureau , university of basra , IRAQ)

Analysis of tests samples' result, in area study is:

The salinity of soil at the moderate value, and the result for soil sample is at the range of moderate

There is no need to calculate the leaching fraction at the recently moments because the result test refers its under control. Even can considering it as a poor salinity. If there is not increasing in salinity should put into account control the salinity and monitoring thorough don’t apply irrigation water without estimating the best requirements for crops , and using information technology to estimate evapotranspiration , According to the standard researches the value which is got at study Area for soil salinity ( ECe 4.39 mmhos /cm ) and Caco4 (6.9%)

They don't considering high value, allowed to cultivation in this situation with good management for irrigation.

1.2.2. 9 Irrigation water quality

The suitability of water for irrigation depends on the amount and the type of salt the irrigation water contains. The higher the salt concentration of the
irrigation water, the greater the risk of salinization. The following Table gives an idea of the risk of salinization:

Table N^0.5: irrigation water quality

<table>
<thead>
<tr>
<th>Salt concentration of the irrigation water in g/l</th>
<th>Soil salinization risk</th>
<th>Restriction on use</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 0.5 g/l</td>
<td>no risk</td>
<td>no restriction on its use</td>
</tr>
<tr>
<td>0.5 - 2 g/l</td>
<td>slight to moderate risk</td>
<td>should be used with appropriate water management practices</td>
</tr>
<tr>
<td>more than 2 g/l</td>
<td>high risk</td>
<td>not generally advised for use unless consulted with specialists</td>
</tr>
</tbody>
</table>

Discussion for table above, for search data about water indicators for water using of study area is slight to moderate risk and should be used with appropriate water management practice, (0.5-2 g/l). Irrigation practice involved irrigation scheduling (amount and interval), leaching scheduling (amount and timing), and irrigation method (for example for study area using center pivot sprinkler system).

1.2.2.10 The General affects types for Salinity

A. physiology: regulation mechanism

B. crop growth and development: different phase

C. indirect effects for soil degradation

D. productive

F. tolerance to salinity.

growth suppression is typically initialed at some threshold value of salinity , which varies with crop tolerance , external environmental factors which
influence the need of the plant for water, especially the evaporative demand of the atmosphere (temperature, relative humidity, wind speed, etc.).

The water supplying potential of root zone and increases as salinity increases until the plant dies,

The excess of alts in the salt solution can be expressed three group of effects:

1- Specific effects: a- Intoxication of plants, b- metabolic disorders growth inhibition due to some ions.

2- Effects given by the increase of the osmotic potential, originates water and nutritional deficiencies

3- Indirect effects given by the deterioration of the physical, chemical and biological.

Those effect depend on the salt type, total salinity level, climate conditions, soil type, crop species age the plant extracts water from the soil by exerting an absorptive force greater than that which hold the water to soil.

(FAO, irrigation and drainage paper 29, rome)

1.3 irrigation with saline water

More frequent irrigations may not be practical except in areas where water can be taken on Demand. A good knowledge of crop water demand as the season advances is necessary to determine proper frequency. The methods for estimating crop water demand (ET) and the periods of greatest sensitivity are discussed in Doneen (1971); Doorenbos and Pruitt (1977); Doorenbos; Kassam (1979).

Salts from higher salinity irrigation water can accumulate rapidly in the top few centimeters of the Soil due to surface evaporation during non-crop periods,
particularly if a high water table is also present and the climate is hot and dry. The extent of accumulation is influenced by salinity of both the irrigation water and the water table, if present. Under such conditions, seed germination Seedling development and yield may be seriously reduced. A pre-plant leaching irrigation is often used to remove these surface salt concentrations. If winter rainfall is insufficient to leach the accumulated salts from the topsoil, applying irrigation Before the onset of limited winter rains refills the upper soil with water and the winter rains may Then be relied upon to provide sufficient water for leaching. Rainfall is excellent in quality and Leaches salts out of the seed areas, thus eliminating germination problems. Late autumn or early winter irrigation is a good practice in a Mediterranean climate where winter rains may not provide all the necessary leaching. Winter plus pre-plant irrigations give the user of less than ideal quality all the necessary leaching. Winter plus pre-plant irrigations give the user of less than ideal quality Water greater flexibility in timing of irrigations during the growing season. When using water of moderate to high salinity (ECw > 1.0 dS/m) germination is often poor due to Salts accumulating in the seed row, especially when crops are seeded on raised beds and furrow Irrigated. A common practice among growers of lettuce, tomatoes and other sensitive annual crops Is to use sprinklers to reduce salinity to obtain better germination, to lower surface soil Temperatures and improve early seedling growth. Irrigations are applied one or more times each Day for several days and for relatively short periods of time - 1 to 3 hours' duration. After 10 to 14 Days the sprinklers are moved to another field and normal furrow or flood irrigations are applied as needed. One sprinkler system can be used for germination and early growth of several different Fields in a season. Overhead sprinklers cause problems for certain sensitive crops when chloride or sodium is relatively high. These concentrate as water evaporates between sprinkler rotations and are then absorbed in excessive amounts by the leaves wet by the sprinklers. These problems occur mostly with slowly rotating sprinkler heads and are aggravated by low rates of application. Sodium or Chloride in the water in excess of about 3 me/l causes the problem. Similar problems can occur Due to drift of spray from sprinklers applying
moderately high salinity water. The toxicity usually appears as leaf burn (necrosis) on the leaf-edges and can be confirmed by leaf analysis for Chloride and sodium. Irrigating during periods of higher humidity, as at night, has often greatly reduced or eliminated the problem. Annual crops, for the most part, are not very sensitive to low Levels of sodium and chloride but all crops will be affected if the concentration is high enough.

(FAO, Water quality for agriculture by R.S.Ayers).

There is some test result for water and soil samples of the location research south Iraq – north Basra (110km)

Table N°6 : test results of water sample in Basrah ,qurna (by marine consulting bureau UNVI of Basra n3, at 4 January 2012)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.16</td>
<td>Ms/cm</td>
<td>ECw</td>
</tr>
<tr>
<td>6.9</td>
<td>PH</td>
<td></td>
</tr>
<tr>
<td>426</td>
<td>cl</td>
<td></td>
</tr>
<tr>
<td>352</td>
<td>Na</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>K</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>Ca</td>
<td></td>
</tr>
<tr>
<td>106</td>
<td>Mg</td>
<td></td>
</tr>
<tr>
<td>329</td>
<td>Hco3</td>
<td></td>
</tr>
<tr>
<td>251</td>
<td>SO4</td>
<td></td>
</tr>
<tr>
<td>1.76</td>
<td>Mg/l</td>
<td>SAR</td>
</tr>
</tbody>
</table>

Discussion: the result test can classify as the poor salinity , we can manage irrigation by using center pivot sprinkler system to try for changing methods for irrigation because the ex- methods which is surface irrigation was destroyed land and increasing salt accumulation for long time past . to get the high efficiency , and to save soil under control should try to use another methods .the
SAR is not have risk because it is low value in sprinkler is slightly moderate, and there is no ion toxicity (Boron).

1.3.1 Factors determine water salinity

When we use water is based for irrigation purposes five factors should be considered in evaluating water quality.

a. The total salt content and chemical composition of the water.
b. The climate of the region.
c. The prevalent crops to irrigated
d. Crop cultural practices, mainly irrigation methods

Most schemes have three basic criteria:

a. Total salt content (salinity)
b. Sodium, carbonate and bicarbonate ion concentration in relation to calcium and magnesium ion concentration (sodicity)
c. Toxicity of specific ion, e.g., Cl-, and B

They have ranged from general schemes designed of average condition designed of average conditions (U.S. Salinity laboratory staff, 1954; Doneen, 1967; Rhoades and Bernestein, 1971; Rhoadee, 1972; Rhoades and Merille, 1976; Ayers and Westcott, 1976)

To specific water quality rating based on a given crop in specific region (Thron and Thron, 1954; Doneen, 1959.; FAO, Water quality for agriculture by R.S. Ayers).

1.3.2 Application rate

This is the average rate at which water is sprayed onto the crops and is measured in mm/hour. The application rate depends on the size of sprinkler nozzles, the operating pressure and the distance between sprinklers. When selecting a sprinkler system it is important to make sure that the average application rate is less than the basic infiltration rate of the soil. In this way all the water applied will be readily absorbed by the soil and there should be no runoff. (FAO, irrigation water manuals 5, 1988).
1.3.3 Infiltration rate

The infiltration rate is the velocity or speed at which water enters into the soil. It is usually measured by the depth (in mm) of the water layer that can enter the soil in one hour. An infiltration rate of 15 mm/hour means that a water layer of 15 mm on the soil surface will take one hour to infiltrate.

In dry soil, water infiltrates rapidly. This is called the initial infiltration rate. As more water replaces the air in the pores, the water from the soil surface infiltrates more slowly and eventually reaches a steady rate. This is called the basic infiltration rate (Table N° 7).

The infiltration rate depends on soil texture (the size of the soil particles) and soil structure (the arrangement of the soil particles). The most common method to measure the infiltration rate is by a field test using a cylinder or ring infiltrometer.

Table N°7: BASIC INFILTRATION RATES FOR VARIOUS SOIL TYPES

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Basic infiltration rate (mm/hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>sand</td>
<td>less than 30</td>
</tr>
<tr>
<td>sandy loam</td>
<td>20 - 30</td>
</tr>
<tr>
<td>loam</td>
<td>10 - 20</td>
</tr>
</tbody>
</table>

The infiltration rate depends on
a- soil texture (size of soil particles), b- soil structure (the way in which soil particles are grouped together), and other factors can be effect on it, are:

1- tillage conditions
2- crop cover
3- land slop
Table N°8: test results for soil infiltration for location of wua in basra-qurna

(By University. Of Basra, N69. 2/2/2014)

<table>
<thead>
<tr>
<th>Information</th>
<th>Ks cm/h</th>
<th>Depth (cm)</th>
<th>N . sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 1 depth very low</td>
<td>0.44</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>1/100 cm very low</td>
<td>0.69</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>N(1) 150cm very low</td>
<td>0.58</td>
<td>150</td>
<td>1</td>
</tr>
<tr>
<td>N(2) 50cm (22/22) low</td>
<td>2.08</td>
<td>50</td>
<td>2</td>
</tr>
<tr>
<td>N(2) 100 cm (22/22) low</td>
<td>0.68</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>N(2) 150 cm (22/22) low</td>
<td>0.55</td>
<td>150</td>
<td>2</td>
</tr>
<tr>
<td>50 -30 cm (11/31) very low</td>
<td>0.98</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td>100-3 cm (11/31) very low</td>
<td>1.53</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>15-3 cm (11/31) very low</td>
<td>1.16</td>
<td>150</td>
<td>3</td>
</tr>
<tr>
<td>50-4 cm (33/33) very low</td>
<td>0.39</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>100-4 cm (33/33) very low</td>
<td>0.42</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>150-4 cm (33/33) very low</td>
<td>0.56</td>
<td>150</td>
<td>4</td>
</tr>
</tbody>
</table>

Where is:

Ks : soil hydraulic conductivity , they are using by constant head method .

(by UNVI. Of Basra, N69. 2/2/2014)

According at the test result for soil infiltration rate is low infiltrate because the soil is approximately clay – loam, this indictors for us must put into account when be irrigate should not supply amount of water more than infiltration rate
in soil to avoid Waterlogging and raising of water table in the root zone because slow infiltration, best ways it using information technology to estimating crop water requirement to get the right amount of irrigation water to avoid accumulation slat on the land and at the same time, to saving water irrigation for loose, because this lands don’t have drainage system the farmers depend on natural one and also its irregular.

1.3.4 IRR In the process of applying irrigation water to crops water (Efficiency)

Water losses occur. These losses have to be taken into account when calculating the gross irrigation requirements of an irrigation project. This can be done through the use of an efficiency factor, which has to be estimated at the planning stage. Different types of irrigation systems have different levels of efficiency. The higher the irrigation efficiency, the larger the area that can be irrigated from a given finite water source, and the less the leaching of nutrients and damage to the soil the more environmentally friendly the irrigation system. The water that is saved can be used for other productive.

Farm irrigation efficiencies of sprinkler irrigation systems vary under different climates. FAO (1982) proposed the figures of farm irrigation efficiencies provided in Table N°9 on the basis of climate.

Table N°9: Farm irrigation efficiencies for sprinkler irrigation in different climates (Adapted from: FAO, 1982)

<table>
<thead>
<tr>
<th>Climate/Temperature</th>
<th>Farm irrigation efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cool</td>
<td>0.80</td>
</tr>
<tr>
<td>Moderate</td>
<td>0.75</td>
</tr>
<tr>
<td></td>
<td>HOT</td>
</tr>
<tr>
<td>----</td>
<td>------</td>
</tr>
<tr>
<td></td>
<td>0.70</td>
</tr>
</tbody>
</table>

* Assuming no losses in the distribution system (Ec and Eb = 1)

Conveyance efficiency (Ec) is the ratio of the water received at the inlet of a block of fields to the water released at the headwork. Field canal efficiency (Eb) is the ratio between water received at the field inlet and that received at the inlet of the block of fields. Field application efficiency (Ea) is the ratio between water directly available to the crop and that received at the field inlet. Project efficiency (Ep) is the ratio between water made directly available to the crop and that released from the headwork, or \( \text{Ep} = \text{Ec} \times \text{Eb} \times \text{Ea} \).

1.3.5 Spray irrigation

Is defined as: the application of water by a small spray or mist to the soil surface, where travel through the air becomes instrumental in the distribution of the water. It was developed to reduce the droplet evaporation and drift inherent with impact sprinklers. The sprinkler manufacturers have developed many types of spray heads and today many combinations of pressure regulators and spray heads, nozzles and deflector plates are commercially available.

Today the CP irrigation systems are mainly available in three types: a) The LEPA sock, b) The LEPA bubbler, c) The sprayer.

The bubbler mode produces an umbrella shaped pattern approximately 0.4 to 0.5 m in diameter, which minimizes wind effects and only wet part of the soil surface. This so called true LEPA system as developed and introduced by Lyle and Bordovsky (1981). The spray mode produces a horizontal spray approximately 2.5 to 3.3 m in diameter, which wets the entire soil surface. The
so-called chemigate mode produces a 60° upward spray, which sprays the underside of the leaves). Lately new sprayers have been developed.

Commercial LEPA heads and nozzles, which can operate in the three different modes by changing the pad and hood positions, are now available. So, the same product can be used for pre-irrigation and germination, irrigation with the bubbler mode and chemigation.

A standard control panel. Manufacturers offer several models of various level of control including full telemetry control with the use of cellular telephone.

(Pressurized Irrigation Techniques; chapter 10, the pivot center irrigation system; FAO).

1.3.6 Changing Methods of Irrigation

The method of irrigation directly affects both the efficiency of water use and the way salts accumulate. Flood and sprinkler irrigation are designed to apply water evenly over the entire irrigated area. This results in most of the salts accumulating in the lower root zone. The degree of accumulation depends upon the leaching fraction. (FAO, Water quality for agriculture by R.S.Ayers)

The usual method of irrigation in southern Iraq for the cultivation for wheat crop is surface irrigation. This is because this methods don’t need to skills and easy way to use; in addition low cost and free volume to uptake , But in recent times with rising of high tongue saline in the southern Iraq , the Iraqi government, represented by the Ministry of Agriculture and Ministry of Water Resources they put plan to face the salinity problem and to develop plans to avoid this problem support farmers who cultivated wheat crops to changing ex- methods for irrigation and help them to buy this technology in easier ways is A modern irrigation methods such as drip irrigation and sprinkler irrigation On the subject of our research here will try to evaluating the
performance and efficiency for center pivot sprinkler irrigation through some information technology software and reference.

1.3.7 Surface Irrigation and sprinkler Systems in comparisons

1.3.7.1 Surface irrigation

Irrigation systems are often designed to maximize efficiencies and minimize labour and capital requirements. The most effective management practices are dependent on the type of irrigation system and its design. For example, management can be influenced by the use of automation, the control of or the capture and reuse of runoff, field soil and topographical variations and the existence and location of flow measurement and water control structures. Questions that are common to all irrigation systems are when to irrigate, how much to apply, and can the efficiency be improved. A large number of considerations must be taken into account in the selection of an irrigation system. These will vary from location to location, crop to crop, year to year, and farmer to farmer. In general these considerations will include the compatibility of the system with other farm operations, economic feasibility, topographic and soil properties, crop characteristics, and social constraints (Walker and Skogerboe, 1987).

The term 'surface irrigation' refers to a broad class of irrigation methods in which water is distributed over the field by overland flow. A flow is introduced at one edge of the field and covers the field gradually. The rate of coverage (advance) is dependent almost entirely on the differences between the discharge onto the field and the accumulating infiltration into the soil. Secondary factors include field slope, surface roughness, and the geometry or shape of the flow cross-section.

The practice of surface irrigation is thousands of years old. It collectively represents perhaps as much as 95 percent of common irrigation activity today. The first water supplies were developed from stream or river flows onto the adjacent flood plain through simple check-dams and a canal to distribute water.
to various locations where farmers could then allocate a portion of the flow to their fields. The low-lying soils served by these diversions were typically high in clay and silt content and tended to be most fertile. The land slope was normally small because of the structure of the flood plain itself.

With the advent of modern equipment for moving earth and pumping water, surface irrigation systems were extended to upland areas and lands quite separate from the flood plain of local rivers and streams. These lands tend to have more variable soils and topographies, are usually better drained, and may be naturally less fertile. Thus, these lands usually require greater attention to design and operation. (Guidelines for designing and evaluating surface irrigation systems).

Photo №1: surface irrigation system

1.3.7.2 Advantages

Surface irrigation offers a number of important advantages at both the farm and project level. Because it is so widely utilized, local irrigators generally have at least minimal understanding of how to operate and maintain the system. In addition, surface systems are often more acceptable to agriculturalists who
appreciate the effects of water shortage on crop yields since it appears easier to apply the depths required to refill the root zone.

The second advantage of surface irrigation is that these systems can be developed at the farm level with minimal capital investment. The control and regulation structures are simple, durable and easily constructed with inexpensive and readily-available materials like wood, concrete, brick and mortar, etc. Further, the essential structural elements are located at the edges of the fields which facilitate operation and maintenance activities. The major capital expense of the surface system is generally associated with land grading, but if the topography is not too undulating, these costs are not great. Recent developments in surface irrigation technology have largely overcome the irrigation efficiency advantage of sprinkler and trickle systems. An array of automating devices roughly equates labour requirements. The major trade-off between surface and pressurized methods lies in the relative costs of land levelling for effective gravity distribution and energy for pressurization. Energy requirements for surface irrigation systems come from gravity. This is a significant advantage in today's economy.

Another advantage of surface systems is that they are less affected by climatic and water quality characteristics. Even moderate winds can seriously reduce the effectiveness of sprinkler systems. Sediments and other debris reduce the effectiveness of trickle systems but may actually aid the performance of the surface systems. Salinity is less of a problem under surface irrigation than either of these pressurized systems.

There are other advantages specific to individual regions that might be mentioned. Surface systems are better able to utilize water supplies that are available less frequently, more uncertain, and more variable in rate and duration. The gravity flow system is a highly flexible, relatively easily-managed method of irrigation.

1.3.7.3 Disadvantages
There is one disadvantage of surface irrigation that confronts every designer and irrigator. The soil which must be used to convey the water over the field has properties that are highly varied both spatially and temporally. They become almost undefinable except immediately preceding the watering or during it. This creates an engineering problem in which at least two of the primary design variables, discharge and time of application, must be estimated not only at the field layout stage but also judged by the irrigator prior to the initiation of every surface irrigation event. Thus while it is possible for the new generation of surface irrigation methods to be attractive alternatives to sprinkler and trickle systems, their associated design and management practices are much more difficult to define and implement.

Although they need not be, surface irrigation systems are typically less efficient in applying water than either sprinkler or trickle systems. Many are situated on lower lands with heavier soils and, therefore, tend to be more affected by waterlogging and soil salinity if adequate drainage is not provided. The need to use the field surface as a conveyance and distribution facility requires that fields be well graded if possible. Land levelling costs can be high so the surface irrigation practice tends to be limited to land already having small, even slopes.

Surface systems tend to be labour-intensive. This labour need not be overly skilled. But to achieve high efficiencies the irrigation practices imposed by the irrigator must be carefully implemented. The progress of the water over the field must be monitored in larger fields and good judgement is required to terminate the inflow at the appropriate time. A consequence of poor judgement or design is poor efficiency.

One sometimes important disadvantage of surface irrigation methods is the difficulty in applying light, frequent irrigations early and late in the growing season of several crops. For example, in heavy calcareous soils where crust formation after the first irrigation and prior to the germination of crops, a light
irrigation to soften the crust would improve yields substantially. Under surface irrigation systems this may be unfeasible or impractical as either the supply to the field is not readily available or the minimum depths applied would be too great. (Guidelines for designing and evaluating surface irrigation systems)

1.3.7.4 Topographical characteristics

Topography is a major factor affecting irrigation, particularly surface irrigation. Of general concern are the location and elevation of the water supply relative to the field boundaries, the area and configuration of the fields, and access by roads, utility lines (gas, electricity, water, etc.), and migrating herds whether wild or domestic. Field slope and its uniformity are two of the most important topographical factors. Surface systems, for instance, require uniform grades in the 0-5 percent range. (Guidelines for designing and evaluating surface irrigation systems).

1.3.8 Sprinkler irrigation system

Sprinkler irrigation is a method of applying irrigation water which is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground. The pump supply system, sprinklers and operating conditions must be designed to enable a uniform application of water.

Sprinkler irrigation is suited for most row, field and tree crops and water can be sprayed over or under the crop canopy. However, large sprinklers are not recommended for irrigation of delicate crops such as lettuce because the large water drops produced by the sprinklers may damage the crop.

Sprinkler irrigation is adaptable to any farmable slope, whether uniform or undulating. The lateral pipes supplying water to the sprinklers should always
be laid out along the land contour whenever possible. This will minimize the pressure changes at the sprinklers and provide a uniform irrigation.

It is best suited to sandy soils with high infiltration rates although they are adaptable to most soils. The average application rate from the sprinklers (in mm/hour) is always chosen to be less than the basic infiltration rate of the soil) so that surface ponding and runoff can be avoided.

It is not suitable for soils which easily form a crust. If sprinkler irrigation is the only method available, then light fine sprays should be used. The larger sprinklers producing larger water droplets are to be avoided. A good clean supply of water, free of suspended sediments, is required to avoid problems of sprinkler nozzle blockage and spoiling the crop by coating it with sediment.

A typical sprinkler irrigation system consists of the following components:

Pump unit
Mainline and sometimes sub mainlines
Laterals
Sprinklers.
Tower

The **pump unit** is usually a centrifugal pump which takes water from the source and provides adequate pressure for delivery into the pipe system.

(Irrigation water management, Training manuals, 5, 1988)
Advantages of Sprinkler Irrigation System

The advantages of sprinkler irrigation system are as follows.
1. Water measurement is easier than surface irrigation system.
2. Less interference with cultivation and less land loss.
3. Higher application efficiency.
4. High and frequent application can be effectively accomplished.
5. Easy mechanization and automation.

Disadvantages of Sprinkler Irrigation System

The disadvantages of sprinkler irrigation are listed below.
1. High initial cost.
2. High operating cost.
3. Wind drift.
4. A stable water supply is needed.
5. Saline water may cause problem.
6. Water must be free from sand, debris and large amount of salt.
In such circumstances the search area accustomed to farmers for a long time that they using method of surface irrigation without any water accounts and to the negative consequences of increased salt and waterlogging, using the method of pivot irrigation attempt by the government through the Iraqi Ministry of Agriculture to reduce wastage of water used for irrigation, as well as to reduce the accumulation of salts in the soil as well as to increase the productivity of wheat crop.

1.4 Structure of center pivot sprinkler system

The center pivot system consists of one single sprayer or sprinkler pipeline of relatively large diameter, composed of high tensile galvanized light steel or aluminum pipes supported above ground by towers move on wheels, long spans, steel trusses and/or cables. One end of the line is connected to a pivot mechanism at the center of the command area; the entire line rotates about the pivot. The application rate of the water emitters varies from lower values near the pivot to higher ones towards the outer end by the use of small and large nozzles along the line accordingly.

The center pivot (CP) is a low/medium pressure fully mechanized automated irrigation system of permanent assemble. It has become very popular in the Near East region in recent years for irrigation of most of field crops, cereals, legumes, forage and vegetables. It is also used for supplementary irrigation for rain fed grain. The cost of each system unit is relatively high and is therefore best suited to large irrigated farms. The area covered can be from 3.5 ha to 60 ha, according to the size of the CP, and the larger the area the lower is the cost of the system per unit area. (FAO, CHAPTER 10, The center pivot irrigation systems, pressurized irrigation techniques)
1.4.1 GENERAL INFORMATION FOR SYSTEM LAYOUT AND COMPONENT PARTS

The typical center pivot system consists of a single long irrigating pipeline attached to a central tower and moves slowly over the field in a circular pattern and irrigates the plants with sprayers, or sprinklers placed on it at frequent spacing. The central tower with a pivot mechanism and main control panel (electric) is anchored to a small concrete base at a fixed water supply point (hydrant) at the center of the field. The entire irrigating pipeline is supported above ground by “A” frame towers move on wheels, long spans, steel trusses and/or cables; the end of the pipe is overhung with a sprinkler gun. The whole system rotates slowly, at a typical speed (last span) of 2–3 m/min., around the fixed pivot, self-propelled, applying water in the form of overhead spray irrigation and covers the area in a circular pattern. The drive system features small individual power units mounted on each wheeled tower. These units are electric drive, but can be hydraulic (water, oil) or mechanical drive. An automatic alignment system keeps always the irrigating pipeline straight.

The typical CP systems can be fixed permanent installations or movable/towable type with the central tower based on wheels or a skid, easily move from one field to another. The Linear Center Pivot is another common type towable system, which can irrigate rectangular or square shaped fields using a canal water resource parallel to the travel direction. Computer aided management systems (CAMS) models (MULTICENTER) and self-propelled are now available and the whole installation can be managed through a remote control for towing from one place to another. Corner systems are also available for irrigation of square, rectangular and odd shaped fields. Monospan systems are also available for small fields. (FAO, CHAPTER 10, the center pivot irrigation systems, pressurized irrigation techniques)
1.4. 2 The Pipeline

The long irrigating pipeline (Lateral) with water emitters (sprinklers, bubblers, or sprayers) can be from 140 to 250 mm diameter, according to the system flow and the length; standard sizes of approximate 160 mm (6 inches) and 200 mm (8 inches) are very common. The length of the pipeline can be from 50 to 750 meters according to the design. It is made for high tensile material galvanized light steel, or aluminum, with extra strong couplers to stand the system operating pressures.

The pipeline is placed on wheeled “A frame” towers of typically 3 meters minimum height above ground and spaced 35–55 meters distance apart length of spans). The common or “standard” length of spans is 40 m. Truss rod arches maintain the even distribution of weight and loads between the towers. On level ground the ground clearance varies from 2.75 to 4.5 meters for high profile machines. The spans are equipped with flexible joints at the ends allowing the pipeline to articulate and to allow side-to-side, up and down and rotational movement with no stress on the pipeline. (FAO, CHAPTER 10, the center pivot irrigation systems, pressurized irrigation techniques)

1.4.3 The water emitters

The water emitters, computerized sized and spaced for high uniformity of application, are mounted on the pipeline at spacing of 1.5 to 3.0 m, and 6 m approx. according to the type and coverage of the sprayer emitters, and operate when the system is in motion. The emitters in the past were full circle rotating sprinklers. Since the early eighties the Low Energy Precision Application (LEPA) mode is using sprayers, bubblers or angle mist sprayers, fitted on flexible “hose drops” hanging down from the lateral at a height above ground of about 20 to 45 cm for the bubblers and 1.0–1.8 m for the sprayers. The “hose drops” are connected to the pipeline by a “gooseneck” or furrow arm and operate at lower pressures of about 0.5 to 1.5 bars. Goosenecks and drops are usually installed alternately on each side of the Lateral to even stresses on the line when used on high profile crops. There are several models of sprayers with
excellent performance, long radius and uniform rain precipitation. Pressure/flow regulators are used in most cases. The discharge rate of the emitters along the pipeline is not the same along the line, but varies from lower values near the center to higher ones towards the outer end by the use of small and large nozzles along the line accordingly and sometimes variable spacing. Good overlapping is essential. Part circle sprayers are used near the towers to avoid over wetting the area. Along the wheels. The most common sprayers in use the last few years are the Senninger’s wobblers and the Nelson’s rotators and down and rotational movement with no stress on the pipeline. (FAO, CHAPTER 10, the center pivot irrigation systems, pressurized irrigation techniques)

1.4. 4 The Central Tower

This is a pyramidal structure of about 3.5–4.5 m height, built up with galvanized steel angular profiles and anchored on a concrete square platform. This structure has an access ladder. It is the head of the system and carries all equipment necessary for the control of the system, such as the system water fed up-going piece of pipe with the elbow on the top and inlets for fertilizer injection; the Collector ring, the Central Control Panel.

1.4. 5 The CP System Control

A modular control panel, protected in a cabinet, is installed on the pivot central tower and enables handling of the irrigation machine and the programming of irrigation, thus the control of flow and pipeline movement–operation time and speed/time per lap. A voltmeter and several pilot lights indicate control tension, support tower alarm and luck of pressure. Automatic starter, position stop device, automatic shut-off and hour counter are included too in a standard control panel. Manufacturers offer several models of various level of control including full telemetry control with the use of cellular telephone.
(FAO, CHAPTER 10, the center pivot irrigation systems, pressurized irrigation techniques).

1.4.6 Center pivot structure for study area

This pivot sprinkler supply by ministry of agriculture by agricultural initiative for Iraqi government to give to the farmer with low cost and Payment in installments to farmers. It's made by Senninger’s irrigation company, ORLANDO, FL.

Information

The center pivot consist of the:

1. 5 spans as it show in sketch below and total length is 312.2m
2. Machine (flow 229.2 m\(^3\)/h) and power Pressure 2.12 bar, end pressure is 1.38 bar.
3. Pipes
4. Sprinkler model (LDN\(^R\)) Low Drift Nozzle as photo below

Photo N\(^0\)3: Sprinkler model (LDN\(^R\)) Low Drift Nozzle
4- Regs (postion Bottom 113 PSR-15)

The delivered flow is (229.4 m$^3$h), Length is 312.2 m, area 30.8 hectare, distance to the last tower is 303.8 m, time for coverage 8.4 hours
Chapter II

Using information technology for checking IWR of center pivot sprinkler
2. **Software for checking Irrigation water requirements of center pivot sprinkler system**

The objective of this chapter is to checking the efficiency of the pivot sprinkler system which is using in farm for wheat crop in south Iraq –Basra, under conditions of salinity water irrigation, throughout the last chapter we are get some indictors and data for the range of water irrigation salinity (ECw; 2.16 ms/cm) . at this point of view, the salt water is under control and should be mongering and avoiding increasing the accumulation salt on the soil .The main concept of irrigation is How to irrigate, How much to irrigate; When to irrigate Using some of software for information technology to guide us to estimate climate, soil, crop data and to evaluating the efficiency for center pivot sprinkler and determine the best efficiency for it by use some software.(itirrigation.thematrix.it)

Figure N° 9: Software (programs)
### 2.1 Google earth

Through the software of Google Earth can determining the research area (field wheat), and measuring the size and slop of the field under study, this is the first step to establish data base of project (study area). Area is (30.6 hectares), (122.4 dunum).

Figure No 10: study area

### 2.2. NEW-LocCLIM

Using NEWCLIM software to estimate the climate data for project area and should depends on the area for project (ASIA, Iraq, Basrah, Basrah station), and after that save its on desktop to using its in CWR program to estimate crop water requirement for wheat crop.
2.3 HWSD (Harmonized world soil database viewer) version 1.2

Using (HWSD) software to get database of soil for region project to put those data in the soil water characteristics software to estimate water and soil characteristics, for example for the result of (HWSD), THE data is, sand (36...
% ), salt is (4.39 ms/cm) got it from actual test, clay (21), gravel (6), organic carbon (0.53 %).

Table N010: HWSD

2.4 Soil water characteristics

Using this software to get the texture class (loam) and WP (14.1 %), FC (27.1 %), saturation (41.1 %), Available water (0.12 cm/cm = 120 mm/meter) and hydraulic conductivity (7.0 mm/hr = 168 mm/day).
2.5 Crop water requirement (CWR 8.0)

CROPWAT 8.0 for Windows is a computer program for the calculation of crop water requirements and irrigation requirements based on soil, climate and crop data. In addition, the program allows the development of irrigation schedules for different management conditions and the calculation of scheme water supply for varying crop patterns. CROPWAT 8.0.

Using this program to estimate the right crop water requirements for crop, this software developed by the land and water Development Division of FAO. It is a management and planning irrigation support tool.
2.5.1 Climate / ETo

Should import from the nearest station climate for study area (farm wheat), depends on the Basrah station, export data to own desktop and put it inside CWR, this is the first step in use CWR.

Table N°12: Climate / ETo

<table>
<thead>
<tr>
<th>Month</th>
<th>Min Temp</th>
<th>Max Temp</th>
<th>Humidity</th>
<th>Wind</th>
<th>Sun</th>
<th>Rad</th>
<th>ETo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>°C</td>
<td>°C</td>
<td></td>
<td>m/emp</td>
<td>hours</td>
<td>M/m²/day</td>
<td>mm/emp</td>
</tr>
<tr>
<td>January</td>
<td>6.6</td>
<td>17.3</td>
<td>88</td>
<td>200</td>
<td>5.6</td>
<td>11.2</td>
<td>1.81</td>
</tr>
<tr>
<td>February</td>
<td>8.4</td>
<td>20.0</td>
<td>78</td>
<td>233</td>
<td>6.7</td>
<td>14.2</td>
<td>2.30</td>
</tr>
<tr>
<td>March</td>
<td>12.5</td>
<td>24.6</td>
<td>66</td>
<td>253</td>
<td>6.9</td>
<td>17.0</td>
<td>3.09</td>
</tr>
<tr>
<td>April</td>
<td>17.3</td>
<td>30.6</td>
<td>57</td>
<td>253</td>
<td>7.3</td>
<td>19.7</td>
<td>5.29</td>
</tr>
<tr>
<td>May</td>
<td>23.1</td>
<td>37.1</td>
<td>46</td>
<td>281</td>
<td>8.6</td>
<td>22.7</td>
<td>7.40</td>
</tr>
<tr>
<td>June</td>
<td>30.0</td>
<td>41.2</td>
<td>30</td>
<td>323</td>
<td>9.7</td>
<td>24.6</td>
<td>9.09</td>
</tr>
<tr>
<td>July</td>
<td>27.7</td>
<td>43.2</td>
<td>37</td>
<td>285</td>
<td>8.7</td>
<td>24.4</td>
<td>9.75</td>
</tr>
<tr>
<td>August</td>
<td>26.7</td>
<td>43.3</td>
<td>38</td>
<td>366</td>
<td>9.7</td>
<td>23.4</td>
<td>9.11</td>
</tr>
<tr>
<td>September</td>
<td>25.1</td>
<td>40.8</td>
<td>44</td>
<td>222</td>
<td>9.1</td>
<td>20.8</td>
<td>7.26</td>
</tr>
<tr>
<td>October</td>
<td>18.4</td>
<td>34.9</td>
<td>55</td>
<td>193</td>
<td>6.2</td>
<td>16.7</td>
<td>5.00</td>
</tr>
<tr>
<td>November</td>
<td>13.2</td>
<td>26.3</td>
<td>72</td>
<td>188</td>
<td>6.6</td>
<td>12.4</td>
<td>2.92</td>
</tr>
<tr>
<td>December</td>
<td>8.3</td>
<td>19.3</td>
<td>87</td>
<td>188</td>
<td>5.7</td>
<td>10.4</td>
<td>1.56</td>
</tr>
<tr>
<td>Average</td>
<td>17.6</td>
<td>31.6</td>
<td>59</td>
<td>240</td>
<td>7.8</td>
<td>10.1</td>
<td>5.46</td>
</tr>
</tbody>
</table>

2.5.2 Rain

Rain data for the area study this is the second step for CWR program, Table N°13 Rain data, which is got it from the previous software (BASRA station)

Estimate rain by data which export from new-locCLIM software for area study (Basrah station is the nearest one) the result refer the rain (141.4mm), and the effective rain is 136.1 mm). there is no a large amount for rain in south Iraq, Basrah, the region Classified into a dry and semi-dry.
Table N013: RAIN data

<table>
<thead>
<tr>
<th>Month</th>
<th>Rain</th>
<th>Eft rain</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>28.0</td>
<td>27.7</td>
</tr>
<tr>
<td>February</td>
<td>15.9</td>
<td>12.2</td>
</tr>
<tr>
<td>March</td>
<td>17.3</td>
<td>18.8</td>
</tr>
<tr>
<td>April</td>
<td>16.9</td>
<td>15.5</td>
</tr>
<tr>
<td>May</td>
<td>2.6</td>
<td>3.5</td>
</tr>
<tr>
<td>June</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>July</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>August</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>September</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>October</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>November</td>
<td>22.2</td>
<td>21.4</td>
</tr>
<tr>
<td>December</td>
<td>31.0</td>
<td>29.5</td>
</tr>
<tr>
<td>Total</td>
<td>141.4</td>
<td>136.1</td>
</tr>
</tbody>
</table>

2.5.3 Crop

The next step put the crop data (name and planting date, kc value, four stage of crop should put in this sub-step. The following table gives us the values of Kc and duration of different stages of vegetative cycle for the wheat and the planting and harvest times.

Table N014: crop (wheat)
2.5.4 SOIL

At this step will put soil information which is got it from soil water characteristic software (soil name, total available soil moisture rate (FC-WP), maximum rooting rate, maximum depth, and initial soil moisture depletion as % TAM). The soil parameters important for irrigation scheduling and required for irrigation scheduling using the FAO CROPWAT program are described below:

- Total available soil moisture content (TAW), defined as the difference in soil moisture content between field capacity (FC) and wilting point (PWP). This is the total amount of water Available to the crop and depends on texture, structure and organic matter content.

- Initial soil moisture depletion indicates the dryness of the soil at the start of irrigation. This is expressed as a depletion percentage from FC;

- Maximum rooting depth will in most cases be determined by the genetic characteristics of the plant. In some cases the root depth can be restricted by limiting layers.

- Maximum rain infiltration rate allows for an estimate of the surface runoff for the effective rain calculation. This is a function of rain intensity, soil type and slope class. [www.itirrigation.thematrix.it](http://www.itirrigation.thematrix.it)

Table N015: soil for (study area) which is a loam

<table>
<thead>
<tr>
<th>Soil name</th>
<th>Total available soil moisture (FC - WP)</th>
<th>Maximum rain infiltration rate</th>
<th>Maximum rooting depth</th>
<th>Initial soil moisture depletion (as % TAM)</th>
<th>Initial available soil moisture</th>
</tr>
</thead>
<tbody>
<tr>
<td>loam</td>
<td>1200 mm/meter</td>
<td>166 mm/day</td>
<td>900 cm</td>
<td>100%</td>
<td>0.0 mm/meter</td>
</tr>
</tbody>
</table>
2.5.5 CWR

This table below shows us the crop water requirement for wheat crop south Iraq, Basrah. That we are needed 287.4 mm/year. Basrah climate for March and April faced rising for temperature and humidity. The ETc is 409.2 mm/year. and effective rain is 121 mm/year.

Table N\textsuperscript{1}6: CWR for wheat crop south Iraq Basrah

<table>
<thead>
<tr>
<th>Month</th>
<th>Decades</th>
<th>Stage</th>
<th>K\textsubscript{c}</th>
<th>ET\textsubscript{c}</th>
<th>ET\textsubscript{a}</th>
<th>ET\textsubscript{p}</th>
<th>R\textsubscript{m/dec}</th>
<th>R\textsubscript{r/m}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov</td>
<td>2</td>
<td>Late</td>
<td>0.70</td>
<td>2.04</td>
<td>12.3</td>
<td>4.6</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td>3</td>
<td>Late</td>
<td>0.70</td>
<td>1.73</td>
<td>17.3</td>
<td>8.4</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td>1</td>
<td>Late</td>
<td>0.70</td>
<td>1.37</td>
<td>13.7</td>
<td>9.2</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td>2</td>
<td>Late</td>
<td>0.72</td>
<td>1.06</td>
<td>10.6</td>
<td>10.3</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td>3</td>
<td>Late</td>
<td>0.79</td>
<td>1.18</td>
<td>11.0</td>
<td>9.8</td>
<td>3.1</td>
<td></td>
</tr>
<tr>
<td>Jan</td>
<td>1</td>
<td>Late</td>
<td>0.88</td>
<td>1.34</td>
<td>13.4</td>
<td>9.6</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Jan</td>
<td>2</td>
<td>Late</td>
<td>0.95</td>
<td>1.44</td>
<td>14.4</td>
<td>9.5</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>Jan</td>
<td>3</td>
<td>Late</td>
<td>1.64</td>
<td>1.94</td>
<td>20.2</td>
<td>8.5</td>
<td>11.7</td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>1</td>
<td>Late</td>
<td>1.12</td>
<td>2.28</td>
<td>22.8</td>
<td>7.2</td>
<td>15.6</td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>2</td>
<td>Mid</td>
<td>1.17</td>
<td>2.69</td>
<td>26.3</td>
<td>6.2</td>
<td>26.7</td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>3</td>
<td>Mid</td>
<td>1.17</td>
<td>3.23</td>
<td>35.0</td>
<td>6.0</td>
<td>19.5</td>
<td></td>
</tr>
<tr>
<td>Mar</td>
<td>1</td>
<td>Mid</td>
<td>1.17</td>
<td>3.27</td>
<td>37.7</td>
<td>5.0</td>
<td>21.9</td>
<td></td>
</tr>
<tr>
<td>Mar</td>
<td>2</td>
<td>Mid</td>
<td>1.17</td>
<td>4.31</td>
<td>43.1</td>
<td>5.6</td>
<td>32.5</td>
<td></td>
</tr>
<tr>
<td>Mar</td>
<td>3</td>
<td>Late</td>
<td>1.10</td>
<td>4.65</td>
<td>50.2</td>
<td>5.5</td>
<td>45.6</td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td>1</td>
<td>Late</td>
<td>0.64</td>
<td>4.09</td>
<td>40.5</td>
<td>5.0</td>
<td>34.1</td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td>2</td>
<td>Late</td>
<td>0.50</td>
<td>3.06</td>
<td>30.6</td>
<td>0.0</td>
<td>24.5</td>
<td></td>
</tr>
<tr>
<td>Apr</td>
<td>3</td>
<td>Late</td>
<td>0.34</td>
<td>2.05</td>
<td>16.4</td>
<td>3.5</td>
<td>12.6</td>
<td></td>
</tr>
</tbody>
</table>

2.5.6 Crop irrigation schedule

This step shows us irrigation schedule, and give us total gross irrigation and total net irrigation and there is so many important data to put into account when start to irrigate. Figure below shows the result for schedule total annual gross irrigation (389.9 mm) and the total net irrigation is (339.2 mm). By divided net irrigation / total gross irrigation to get efficiency (87 %)

Efficiency = 339.2/389.9 = 0.869 = 87 %
2.5.7 Schemes

This last step to get net scheme irrigation requirements for wheat crop in south Iraq –Basrah. Total gross irrigation is (389.9 mm) and total net irrigation is (339.2 mm) (by divided net irrigation / total gross irrigation to get efficiency (87 %)). The table below show us that in the march is the highest net irrigation requirement reach to 3.7 mm/day because increasing temperatures at March.
Table N°18: scheme supply

<table>
<thead>
<tr>
<th>Precipitation deficit</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet season (mm)</td>
<td>3.21</td>
<td>6.4</td>
<td>19.4</td>
<td>73.5</td>
<td>45.6</td>
<td>22.2</td>
<td>11.4</td>
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<td>0.0</td>
<td>0.0</td>
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</tr>
<tr>
<td>Rainfall (mm)</td>
<td>5.7</td>
<td>2.3</td>
<td>3.7</td>
<td>2.4</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Irrigation water</td>
<td>20.1</td>
<td>10.6</td>
<td>11.9</td>
<td>19.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Actual area</td>
<td>100.0</td>
<td>110.0</td>
<td>100.0</td>
<td>100.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Irrigated area</td>
<td>100.0</td>
<td>110.0</td>
<td>100.0</td>
<td>100.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Irrigation water</td>
<td>20.1</td>
<td>10.6</td>
<td>11.9</td>
<td>19.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

2.6 Applied irrigation water and distribution

The goal of irrigation spraying method is to convert irrigation water to water droplets and then distributed evenly over the irrigated area. The depth of the water is usually added one of the largest machine gun near the sprinkler then at least in the direction of ocean wetness is due to the unity of the irrigated area per machine increases as we move away from the center of the circle wetness. The uniformity of water distribution over the surface of the soil an accurate guide to the extent of the homogeneity of the distribution of water in the root zone. Rating as this cannot take into account the distribution of water in the root zone, because its influence of soil type and slope surface of the soil irrigated water distribution (Hart 1961, 1972).

As well as the uniformity differ in the case of a vegetation cover of whether or not due to loss of water drops it directly instead of falling on the soil surface.

The researcher (Hart 1961, 1972) has an assessment of the distribution of the water above and below the soil surface and found that there is a difference between the two because of the Rating Factors that affect the way each system (conventional spray).
2.7 Coefficient of Uniformity (Cu)

To measure the degree of homogeneity of the distribution of water in the sprinkler system on the irrigated area has to be to find a coefficient uniformity (contrast) and calculates the factor of field measurements of the depths of the water accumulated in containers (cans) measuring placed at regular intervals within the affected area sprinkler .they have Been through several years to find and develop a lot of equations interested in measuring the uniformity and distribution of water for the irrigation sprinklers during the study is carried out by the ( Christiansen ,1942)of the first studies that deal with the distribution and uniformity of irrigation water above the soil surface during the process of conventional sprinkler irrigation. Was assisted by Hart in 1972 the relationship earlier in the assessment of the distribution of water above the soil surface and comparing it with the distribution of water under the surface of the soil of the irrigation system spraying traditional depends coefficient uniformity the variable characteristics of the system that describes when designing (Pereira, et al., 2002)usually be rate added to a spray irrigation pivotal variable standing, the rate of the value added minor axis near to the maximum value at the end of the line where the device is a circular motion so the coefficient of the distribution system, expressing the circular part of the area under the spray, which represents the cans in the assembly which took into consideration.

\[
C_{uc} = \left[ 1 - \frac{\sum_{i=1}^{N} W_i \left( \frac{X_i}{D_{w}} - 1 \right)}{\sum_{i=1}^{N} W_i} \right] \times 100
\]

2.8 Distribution Uniformity (Du).

Can calculate the uniformity of distribution in the fourth quarter at least for the sprinkler system in relation to the traditional distribution coefficient of uniformity ( Merriam and keller , 1978), Are used to Identify the degree of uniformity of water distribution on the irrigated Area in the fourth quarter at least as well as the amount of distribution Problems in the irrigation system
when the value goes down (Du) This Indicates an increase of water losses, such as infusion deep and thus Poor distribution of water to the irrigated area, although the coefficient Uniformity (Cu) is more the importance and useful in the assessment of The performance of devices pivot irrigation but the ratio for uniformity Of distribution is the guide useful to know the size of the disparity in the distribution of water from the sprinklers in the area that received the distribution of water from the sprinklers in the area that received the less amount of irrigation water (JENSEN,1981) When the value of (Du) less than (67%) is considered Unsatisfactory The maximum that Can be obtained in the field is (90%) and the low value of (Du) gives a clear indication that there are places of irrigated area have added water plus more than required and there are places of the area did not get water for irrigation to the extent required .

Generally, can be judged on the uniformity in the distribution of water from the sprinklers by value (Cu), (Du) If the (Cu) less than 80% and (Du) the value of less than 67% is considered the distribution of water in a non-pathological and this indicates the existence of problems in the system are either design or operational, (Keller and Bliesner 1990) they have found a relationship between (Du) and(Cu) can find one of them instead of the other;


2.9 Evaluate coefficient uniformity of center pivot (low drift nozzles sprinkler)
According to the paper who published (G. A. Clark, K. Srinivas, D. H. Rogers, R. Stratton, V. L. Martin) which belonged to the company for manufacture the center pivot sprinkler ), can estimate the coefficient of uniformity (CU) values
For low drift nozzle (LDN) model, measured CU values were typically lower in value for the lower operating pressure systems and for sprinkler packages with wider spacing's. Measured single–sprinkler distribution patterns were then used in an overlapping sequence with specific sprinkler spacing scenarios.

To simulate multiple–sprinkler distribution patterns. Simulated patterns and CU values compared well with field–measured patterns and CU values for the respective sprinkler size, spacing, and operating pressure combinations. CU values from simulated patterns were highest for closer sprinkler spacing scenarios (<2.4 m) and higher operating pressures (104 and 138 kPa; still in the low range for sprinkler systems). However, evaporative and wind losses could be higher than with the lower operating pressures, thus reducing the overall application efficiency. Based on the spacing, nozzle size, and operating pressure scenarios tested in this research, sprinkler spacing to wetted diameter ratios should not exceed 0.20 in order to achieve coefficients of uniformity.

Typical performance characteristics of center–pivot systems include rate of water application, depth of water application with respect to system rotational speed, and system pressure distribution, in addition to the droplet size, trajectory, and distribution characteristics of the sprinkler package. The Christiansen (1942) uniformity coefficient (CU) has been extensively used as a means to assess irrigation system performance by characterizing the distribution of water from sprinklers. Because the area of influence associated with individual sprinklers and locations along a center pivot varies with radial position, the Christiansen (1942) CU relationship was modified for use on center–pivot irrigation systems (Heermann and Hein, 1968; ASAE Standards, 2000). Catch depths associated with increasing radial position locations from the pivot point were provided with an increased weighting factor to account for the associated increased area of influence related to that position. Because environmental factors (wind, temperature, vapor pressure deficit) that influence sprinkler system distribution patterns (Bilanski and Kidder, 1958; Edling, 1985; DeBoer et al., 1992; Thompson et al., 1997; Tarjuelo et al., 1999) vary from day to day, composite uniformities (from several irrigation
Events) can provide an improved indication of system performance and should range from 90 to 94 for well–designed systems (Keller and Bliesner, 1990).

Figure: N°12: for test center pivot in laboratory(Catch pan configurations for the laboratory tests on sprinkler distribution patterns)

Figure N°13: Relative depths of measured water applications from the pivot II system with 2.4 m sprinkler spacing. The coefficient of uniformity (CU) was 87%.

They tested tree type of spacing for sprinkler and they got variable value, the reference guide us according to the efficiency which got it through software before (87%) and total gross requirement is (389.9 mm), and for the little data
of center pivot sprinkler which was work in the farm of wheat crop in south Iraq, Basrah, Qurnah.

Table N0 19: Distance for sprinkler in center pivot (LDN)

<table>
<thead>
<tr>
<th>Nozzle</th>
<th>Rate mm/s</th>
<th>Distance m</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0.0059444</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0.0009444</td>
<td>2.5</td>
</tr>
<tr>
<td>4</td>
<td>0.0004167</td>
<td>5</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>6.6</td>
</tr>
<tr>
<td>6</td>
<td>0.0026944</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>0.0011389</td>
<td>2.5</td>
</tr>
<tr>
<td>8</td>
<td>0.0006389</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
<td>6.6</td>
</tr>
<tr>
<td>10</td>
<td>0.0066667</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>0.0011111</td>
<td>2.5</td>
</tr>
<tr>
<td>12</td>
<td>0.0008333</td>
<td>5</td>
</tr>
<tr>
<td>13</td>
<td>0</td>
<td>6.6</td>
</tr>
</tbody>
</table>

The figure above show us the distance between sprinklers and depending of reference for manufactory (esnninger irrigation), the coefficient uniformity for this pivot is (87 %), for example for the first nozzle number (6) at the distance 2.5 m the value of CU is (87%) this for Nozzle Combination (16S06(2)[a] and for another distance at 1.6 m is the cu (92%) for the same nozzle model, that’s mean in the cause of reducing spacing for sprinkler the cu will be increasing and the opposite result if the spacing be increasing.

The reference that depending on to simulating the CU and efficiency for center pivot sprinkler give us the closer sprinkler spacing is required with lower operating pressures to maintain CU > 90%, the figure below will show us the simulation.
Figure N0 14: Average coefficient of uniformity values for the various simulated operating pressure and sprinkler spacing combinations and the analysis of variance results.

<table>
<thead>
<tr>
<th>Operating Pressure (kPa)</th>
<th>Sprinkler Spacing (m)</th>
<th></th>
<th></th>
<th></th>
<th>Significance[a]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.85</td>
<td>2.45</td>
<td>3.05</td>
<td>3.66</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>93</td>
<td>**</td>
<td>87</td>
<td>84</td>
<td>84</td>
</tr>
<tr>
<td>69</td>
<td>97</td>
<td>91</td>
<td>89</td>
<td>87</td>
<td>NS</td>
</tr>
<tr>
<td>104</td>
<td>97</td>
<td>94</td>
<td>92</td>
<td>88</td>
<td>**</td>
</tr>
<tr>
<td>138</td>
<td>98</td>
<td>97</td>
<td>94</td>
<td>93</td>
<td>*</td>
</tr>
</tbody>
</table>

Significance[a] ** *** * NS

[a] Significance is expressed as p < 0.10 (*), p < 0.05 (**), p < 0.001 (***), or not significant (NS) using analysis of variance procedures.
CONCLUSION

The agricultural sector is one of the largest consuming sectors for water and this requires and need to rationalize the use of water for irrigation, in countries with desert climate and dry as it is in Iraq; As a result of agricultural expansion and the adoption of the frequent use of modern irrigation system, such as a pivot sprinkler system, which requires that the axial knowledge of the performance and efficiency of the use of this system during the operation as well as the characteristics of the distribution of water added to the irrigated area. In addition; to the knowledge of the problems and constraints faced by farmers as a result of the use of the sprinkler system axial and through this research found that the shift from the use of surface irrigation method and replace irrigation pivot sprinkler is the best way to prevent to losses water as well as contribute to reducing the proportion of the salts in the soil, especially on the surface, although that Basrah province suffers from high tongue salt, but the search area it has acceptable salinity according for test result.

about 110 kilometers from the city center (north of the city of Basrah) by using software, the information technology to checking irrigation water requirements and the theoretical efficiency of sprinkler system which was use in field of wheat in the province of Basrah (Qurna). We got that the efficiency of the performance of the system depending on the theoretical results obtained through the use of reference for
manufactory company which made CP, the coefficient uniformity estimated (87%) get this percentage is not very high for several reasons, and with compassion with surface irrigation system (60 – 70 %) that’s means must better to change for the modern methods, almost for not got the high percentage in cp due for several reasons:

**Reasons:**

- Irregularity of the overlap between the circles wetness.
- May occur clogging and corrosion in some sprays as a result of interaction happening between the metal ions and salts from factory pipes.
- May occur as a result of losses in the irrigation water leakage from pipes and sprinklers
- Lack of expertise in the maintenance of such systems thus contributes to the lack of efficiency of the performance of a pivot irrigation
- Low pump efficiency and low operating pressure resulting
- High wind contribute significantly to the performance of the center pivot sprinkler it was negatively affects the regularity of irrigation
**Recommendations**

To obtain a higher methodology to rationalize consumption and improve the performance and management of irrigation water and a pivot irrigation system in particular and in order to give the highest efficiency and uniformity in the distribution of water to the irrigated area and the long periods of time in the field must follow the recommendations of the following:

- To be regular periodic maintenance and this requires constant maintenance because there are moving parts in the device, as well as the presence and flexible joints and electric motors work on the movement of the machine.
- Sprays must check and control sprays during and after each irrigate, and to be sure to discharge for each spray and circles wetness resulting from each spray.
- Pump: be sure to give the pump discharge pressure and required during the process of irrigation.
- In the case of clay soils with low infiltration rate, such as clay soils will affects so to a significant increase in runoff in some low slop locations, the field (note that the soil in the search area are soil Tine) so it is advisable to increase the speed of the machine axial and thus can add the required depth on the number of more than irrigations.
- Prefer to contact in case of maintenance specialists who have experience.
- Avoid irrigate during times of high temperatures (afternoons from 1-3).
Avoid irrigate during the existence of high wind

Irrigation lines must be washed to get rid of any impurities in the end of the season

Should be sure that the base of sprinklers in a horizontal position parallel to the surface of the ground and not in a sloping position, which affects the portions of wetness and thus uniformity and distribution of water.

Preferably before you start to irrigate should on irrigation pump and the device is not moving until the complete line of spray uniformity in all Sprays.
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