

# CHAPTER 19: An outline for engineering investigation for a pressurized irrigation system

## INTRODUCTION

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The choice of the system of irrigation sometimes is predetermined by specific limiting factors, which leave no alternatives. In other cases, where more than one system is theoretically possible, the final choice is made on the basis of sound criteria, as:

- The suitability/adaptability under the prevailing conditions,
- The cost,
- The efficiency (water savings),
- The layout flexibility,
- The yield and profit potential,
- The sustainability

A minimum engineering investigation is required to enable the successful planning, designing and implementation of every irrigation system at the farm level.

## DATA COLLECTION

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The collection and preparation of the necessary information are related to the kind and the type of the irrigation system and its techniques. A thorough study of the systems description and technical characteristics is of major importance for the selection criteria of the irrigation systems. Detail plans and designs with maps, installation instructions, jointing drawings and irrigation programs and schedules are prepared after the selection of the systems and crops to irrigate. The suppliers of the systems should always provide user manual.

The data needed for each individual field for the installation of the irrigation system must be recorded on a Datasheet form as follows:

### Farm Datasheet

- a) *Farm identification*: Name of the farm, location, ownership (private or Government), size (ha or m<sup>2</sup>) and cropping pattern.
- b) *Topography*: Topographic map of the area on a large scale, or drawing sketch with dimensions illustrating – North point, plots arrangement

and dimensions, location of water source, farm roads, premises etc. – Contour lines, or elevation points and direction of slopes.

- c) *Crops*: Kind, area and location of each crop on the map - Age if perennials. Cropping pattern for annuals – planting spacing along and between the rows – direction of rows – Height of plants - Growing season/irrigation period - kc factors (crop coefficient).
- d) *Soil*: Type and physical characteristics, e.g. sandy, sandy loam, silt loam, clay loam – Permeability, internal drainage – water holding capacity – depth of top soil – existence of hardpan – Potential problems of salinity, toxicity, alkalinity.
- e) *Climate and altitude*: Height of farm above sea level – Rainfall (monthly totals averaged over the last five years) and effective rainfall – Temperature (monthly average maximum) – Relative humidity – Winds prevailing (direction and velocity) - ETo values
- f) *Water*: Source of water supply and type (deep borehole, spring, river, other) - Location (distance apart and difference in elevation) - Flow available (m<sup>3</sup>/h or l/s) and quantity per day when at lowest levels – Quality, physical (foreign suspended particles content such as sand, silt, impurities, algae etc), chemical (complete ionic analysis plus boron and nitrates) and biological if treated wastewater - Depth of borehole, static water level, draw down and safe capacity – Type, capacity and output of existing pumping unit available.
- g) *Existing conditions*: Existing water conveyance network - Present irrigation method (frequency of applications, operating hours and quantities applied) – Equipment available.
- h) *Labour availability* and average working hours in the fields – Maximum recommended daily operating hours of the improved irrigation installations.
- i) *Remarks and recommendations*: Any other information of particular importance, Remarks and recommendations.

As it is concerned with the water availability it must be noted that in cases where the source of water is far from the command field to be irrigated, then a conveyance pipeline should be installed from the source to the field. The distance and the difference in elevation in no one case should affect the pressure needed for the normal operation of the systems. A Booster pump can either be placed at the beginning of the conveyance pipeline or at the beginning of the system. Arrangements should be planned according to the site conditions.

## **SELECTION CRITERIA AND PARAMETERS FOR VARIOUS SYSTEMS**

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The criteria and data collected are examined and evaluated in accordance with the various irrigation systems technical characteristics and performances. Here below are the main parameters considered for the selection of a kind of system. Additional parameters and factors are examined too, such as, easy accessibility, protected area, organized farm, labour availability, operation and maintenance facilities etc.

Note:

Description and characteristics of the systems are given in the related chapters.

### ***The center pivot (CP) irrigation systems***

#### *Kind of crops*

Nearly all crops can be grown under CP irrigation. The field crops mostly recommended are the cereals, agro-industrial, leafy vegetables and the forage crops.

#### *Area, size and shape*

The area should be a plain agricultural field of a relatively large size 15–100 ha. Pivot systems can be tow able and moved to a next position nearby and so on. This practice is usually applied in cereals for supplementary irrigation during drought periods.

#### *Topography*

These CP irrigation systems can operate on uneven ground; however, level lands are recommended and uniform sloping fields with slopes up to 3 percent. Undulating topography may produce a lot of difficulties especially where runoffs occur.

#### *Soil*

The soil should be of medium texture with high infiltration rate >15 mm/hour good internal drainage and water holding capacity.

#### *Water availability*

The source of water can be a tube-well, a river, a small water tank. But the CP systems, like all circular CP systems, will always be fed from a hydrant placed at the centre of the irrigable area near the pivot. So a buried water conveyance pipeline should be installed from the source of

the water to the pivot. At the end of the pipeline, in the middle of the area near the pivot the hydrant should be installed to deliver irrigation water at pressure of about 3.0 Bars. The system inlet will be connected to the hydrant through a quick coupling flexible hose. For every CP position a hydrant is needed.

#### *Water quality*

The water should be clean and free from suspended solids and other impurities, of normal pH 6.5 to 8.4, with no salinity hazard, sodium hazard and toxicity problems caused by bicarbonates, nitrates or boron. TDS should not exceed 1 500 mg/l (ppm), SAR < 12, RSC < 1.25 meq/l, Boron content < 0.7 mg/l, Chlorides < 200 mg/l, Nitrates (NO<sub>3</sub>) < 100 mg/l and low content Bicarbonates (HCO<sub>3</sub>).

#### *Fuel requirements*

The CP systems are equipped with generators for driving the towers and booster pumps, both diesel engine driven. Arrangements should be made so that the fuel tanks to be connected with additional bigger tanks placed nearby for long uninterrupted operation of the CP systems.

### ***Traveller irrigation machines spray boom carts***

#### *Kind of crops*

The field crops to be grown, among others, under Spray boom irrigation are the same as with the Center pivots such as wheat, barley, chickpeas, lentils, potatoes, industrial crops soybeans, maize, sunflower, leafy vegetables, water melons, alfalfa, perennial etc. Their largest application is for supplementary irrigation of cereals (wheat and barley) during the winter months. The height of the plants is considered for the boom "ground clearance".

#### *Area, size and shape*

The area should be a plain agricultural field of at least 1.8 ha. The system is tow able it can be towed and moved to a next position nearby and so on. This practice is usually applied in cereals for supplementary irrigation during drought periods.

#### *Topography*

The Spray boom irrigation systems can operate on uneven ground, however, level lands are recommended and uniform sloping fields with slopes up to 1 percent. Undulating topography may produce a lot of difficulties especially where runoffs occur.

### *Soil*

The soil should be of medium texture with high infiltration rate >15 mm/h good internal drainage and water holding capacity.

### *Water availability*

The source of water can be a tube-well, a river, a small water tank. The system can be fed with water from hydrants placed at various points on the farm plot boundaries. The system inlet is connected to the hydrant or the pump outlet through a quick coupling flexible hose. For every Spray boom position a hydrant is needed. The water source should be as near as possible too the field. The water pressure should be from 3.5 to 5.0 Bars.

### *Water quality*

The water should be clean and free from suspended solids and other impurities, of normal pH 6.5 to 8.4, with no salinity hazard, sodium hazard and toxicity problems caused by bicarbonates, nitrates or boron. TDS should not exceed, if possible, 1 500 mg/l (ppm), SAR < 12, RSC < 1.25 meq/l, Boron content < 0.7 mg/l, Chlorides <200 mg/l, Nitrates (NO<sub>3</sub>) < 100 mg/l and low content Bicarbonates (HCO<sub>3</sub>).

## ***The drip irrigation system***

### *Kind of crops*

The field crops, which can be grown, among others, under Drip irrigation techniques are all crops planted in rows and mainly vegetables in winter and summer time and water melons. Deciduous trees give excellent results with drip irrigation.

### *Area, size and shape*

The area can be any farm planted with field crops in rows of any length from 40 to 150 meters length located in the mountains or in the plains. The size of plots can be from 0.2 to 1.0 ha. The shape should be of normal rectangular or square shape.

### *Topography*

The drip irrigation systems whether with normal dripper emitters or with the pressure compensated ones that can operate on uneven ground, level lands are recommended and uniform sloping fields with slopes up to 3 percent.

### *Type of soil*

The soil can be of any texture, preferably medium and/or fine and with infiltration rate < 20 mm/h. Very light sandy soils with high permeability are not recommended.

### *Water availability*

The source of water can be a tube-well, a river, a small water tank. In cases of a booster pump, this should be placed at the beginning of the system before the Head control unit. The system operating pressure is around 3.0 Bars.

### *Water quality*

The water should be, as clean as possible although there must be a complete filtration system. Chemically it must be of normal pH 6.5–8.4, with low to medium salinity, low sodium hazard and toxicity problems caused by bicarbonates, nitrates or boron. TDS can be from 500 up to 2 000 mg/l (ppm), SAR < 12, RSC < 1.25 meq/l, boron content < 0.9 mg/l.

## ***Mini-sprinklers irrigation systems (for fruit trees)***

### *Kind of crops*

Any fruit trees, which can be grown in the area.

### *Area, size and shape*

The area can be any agricultural field located in the mountains or in the plains and it is or will be planted with fruit trees in rows of a maximum length of 80 to 90 meters even ground. The size of separate plots can be from 0.5 to 1.0 ha. The shape should be of normal rectangular or square shape.

### *Topography*

The Mini-sprinkler irrigation systems normally operate on smooth even ground, so level lands are recommended and uniform sloping fields with slopes ranging from 0.25 percent to 5 percent. In sloppy lands the length of the rows and the Mini-sprinkler lines vary accordingly.

### *Type of soil*

The soil can be of any texture, preferably medium and/or fine, but with infiltration rate > 6 mm/h. Very light sandy soils with high permeability are suitable too.

### *Water availability*

The source of water can be a tube-well, a river, a small water tank. The system operating pressure should be 2.5–3.0 bars.

### *Water quality*

The water should be, as clean as possible although there is a disc-filter. Chemically it must be of normal pH 6.5–8.4, with low to medium salinity, low sodium hazard and toxicity problems caused by bicarbonates, nitrates and especially chlorides and boron. TDS can be from 500 up to 1 500 mg/l (ppm), SAR < 12, RSC < 1.25 meq/l, Cl < 12 meq/l, boron content < 0.7 mg/l.

## ***Pipe distribution system***

### *Kind of crops*

The field crops, which can be grown, among others, under the Pipe Distribution irrigation techniques are nearly all winter and summer crops annual and perennial, i.e. vegetables, cereals, melons, forage crops and fruit trees.

The system consists of a water conveyance and distribution pipe network for surface irrigation methods in-plot. It is actually the replacement of the open channels with a properly designed closed piping network to convey and distribute the irrigation water from the source to the field plots without any losses.

### *Area, size and shape*

The area can be any agricultural farm, planted with field crops irrigated with furrows, borders, basins or any other method of water application, located preferably in more or less plain areas. The size of the field plots can be from 0.1 to 1.0 ha, planted with one or more cultivations. Normally rectangular or square shapes are recommended.

### *Topography*

The Pipe Distribution irrigation systems network can be installed and operate on uneven ground, however, the systems hydrants should be placed at the highest points of each plot. The method of application is surface, so level lands and uniform sloping fields with regular slopes of 0.1 to 0.25 percent are recommended.

### *Type of soil*

The soil can be of any texture, but preferably of medium and with infiltration rate < 20 mm/h. Very light sandy soils with very high permeability are not recommended.

### *Water availability*

The source of water can be a tube-well, a river, a small water tank. The pressure of the system is 1.0 to 2.0 Bars.

### *Water quality*

The water should be, as clean as possible. Chemically it must be of normal pH 6.5–8.4, with low to medium salinity, low sodium hazard and toxicity problems caused by bicarbonates, nitrates or boron. TDS can be from 500 up to 2 500 mg/l (ppm), SAR < 12, RSC < 1.25 meq/l, boron content < 0.75 mg/l.

## ***Hose-move sprinkler irrigation system***

### *Kind of crops*

Alfalfa and other forage crops, maize, sunflower, and other dense planted crops. This system can be installed successfully for nurseries.

### *Area, size and shape*

The area can be any agricultural levelled farm located in the mountains or in the plains planted with agricultural crops. The plots size can be from 0.5 to 1.0 ha. The shape should be of normal rectangular or square shape.

### *Topography*

The Hose-move sprinkler irrigation systems normally operate on smooth even ground, so level lands are recommended and uniform sloping fields with slopes ranging from 0.25 percent to 0.2 percent.

### *Type of soil*

The soil can be of any texture, preferably medium and/or fine, but with infiltration rate > 8 mm/h and good internal drainage. Very light sandy soils with high permeability are suitable too.

### *Wind Conditions*

Wind directions and velocities must be recorded and classified accordingly, (0–0.7 m/s nil wind, 0.7–2.5 m/s light, 2.5–3.5 m/s moderate to strong, and > 3.5 m/s very strong). Sprinkling is not recommended under strong wind conditions.

### *Water availability*

The source of water can be a tube-well, a river, a small water tank. The designed flow of the system at 3.5 bars pressure.



### *Water quality*

The water should be of good quality suitable for irrigation purposes. Chemically it must be of normal pH 6.5–8.4, with low to medium salinity, low sodium hazard and toxicity problems caused by chlorides, bicarbonates and nitrates. TDS can be from 500 up to 2 000 mg/l (ppm), SAR < 12, RSC < 1.25 meq/l, boron content < 1.0 mg/l.

### ***Low-cost (family kid) drip irrigation systems***

#### *Kind of crops*

The field crops, which can be grown, among others, under Drip irrigation techniques in N. Iraq and their growing season are mainly vegetables in winter and summer time and water melons.

#### *Area, size and shape*

The area can be any agricultural farm, planted with field crops in rows of short lengths from 12 to 24 meters located in the rural areas on the mountains or in the plains. The size can be from 250 m to 1 000 m. The shape should be of normal rectangular or square shape.

#### *Topography*

These drip irrigation systems operate at very low pressures level lands are recommended and uniform sloping fields with slopes < 0.5 percent.

#### *Type of soil*

The soil can be of any texture, preferably medium and/or fine and with infiltration rate < 20 mm/h. Very light sandy soils with high permeability are not recommended.

#### *Water availability*

The source of water can be a small well, a tub, a garden hose or anything that can fill the system's water tank regularly. The designed flow of the Family drip irrigation systems is around 1.1 m/h at 1.5 m head.

#### *Water quality*

The water should be, as clean as possible although there is a complete filtration system. Chemically it must be of normal pH 6.5–8.4, with low to medium salinity, low sodium hazard and toxicity problems caused by bicarbonates, nitrates or boron. TDS can be from 500 up to 2 000 mg/l (ppm), SAR < 12, RSC < 1.25 meq/l, boron content < 0.9 mg/l.