CHAPTER ONE

1.1 Introduction

In agriculture and industry there is a requirement to filter water to avoid blockages of discharges passages. This would result in system inefficiency. It is necessary to consider the various water sources and the impurities that occur within the sources over time in order to select a filtration system that suits the irrigation system, operator and budget **(**Bucks and Nakayama 1980).
Hydro cyclones, also known as liquid cyclones, are an important device for the separation of solid-liquid suspensions (Svarovsky, 1984). The principle employed is centrifugal separation, i.e., the particles in the suspension are subjected to centrifugal forces, which cause their separation from the fluid. Like centrifuges, which make use of the same principle, hydro cyclones do not have moving parts, require a low installation and maintenance investment and are simple to operate. Hence, these devices are widely utilized in mineral, chemical, petrochemical, textile and metallurgical industries. Aiming at combining two separation processes, researchers in the Chemical Engineering Department at the Federal University of Uberlandia proposed a modification of the conventional hydro cyclone (Barrozo et al., 1999). The conical section of a hydro cyclone of Bradley's design was replaced by a conical filtering wall. The resulting equipment was denominated in the filtering hydro cyclone. The hydro cyclone separates solid and liquid or liquid and liquid by the difference in density between the fluid and the material to be separated in this equipment. Due to the spiraling motion acquired the fluid and caused by the tangent feeding, the material of larger density is thrown against the wall of the hydro cyclone and dragged to the underflow while the one of smaller density proceeds to the overflow, forming a free vortex (outer vortex) and a forced The filtering hydro cyclone, which is the subject of this study, and the trajectory of suspension for the conventional hydro cyclone (Svarovsky, 1984, Rietema, 1961). In agriculture and industry there is a requirement to filter water to avoid blockages of emitters which would result in system inefficiencies. It is necessary to consider the various water sources and the changes that occur within the sources over time in order to select a filtration system that suits the irrigation system, operator and budget. This unit has been developed to cover the common types of filtration systems in use and the situations in which each would be applied. The unit briefly looks at the advantages and disadvantages of each method and serves to provide a platform for the reader before commencing the more detailed.

1.2 Research problem:

1. Expanded use of modern irrigation systems which are adversely influenced by silt load in river water, necessitated filtration of irrigation water to avoid blockage in the irrigations network.
2. In Sudan and during the rainy season the Nile water silt load is very high. a turbidity reading reach 1.7 NTU. Hence there is a serious need for silt removable to avoid problems associated is heavy silt load. High silt load in the Nile water requires partial removal of silt load. Different types of filters are used for this purpose which include sand, screen and hydro cyclone filters. The hydro cyclone filters have many advantages over the screen and sand filter represented in low initial and operational costs. The relatively trouble free operation gives hydro cyclone filter an extra merit. These are the main reasons behind the selection of this topic.

1.3 Objectives:

1. To design a hydro cyclone filter that can remove the maximum possible amount of river water silt load.
2. Construct the designed hydro cyclone filter from locally available material.
3. To test the degree of infiltration that can be obtained from the model.

CHAPTER TWO

Literature Review

2.1. Water Quality

The quality of water is the most difficult parameter to define.

One must differentiate between relating the quality from physical aspects and the quality from the chemical composition .In the chemical composition, interest is its ability to be corrosion proof (bracken water, corrosive waste water etc). And to certain extent the hardness. Water quality has been found to significantly affect soil physical properties and Solid mineral materials (inorganic) and Large micro-organisms (organic).

2.1.1. Water Quality Guidelines

Guidelines for evaluation of water quality for irrigation .They emphasize the long-term influence of water quality on crop production, soil conditions and farm management, and are presented in the same format as in the 1976 edition but are updated to include recent research results. This format is similar to that of the 1974 University Of California Committee Of Consultant's Water Quality Guidelines which were prepared in cooperation with staff of the United States Salinity Laboratory.

The guidelines are practical and have been used successfully in general irrigated agriculture for evaluation of the common constituents in surface water, groundwater, drainage water, sewage effluent and wastewater. They are based on certain assumptions which are given immediately following the table. These assumptions must be clearly understood but should not become rigid prerequisites. A modified set of alternative guidelines can be prepared if actual conditions of use differ greatly from those assumed.

Ordinarily, no soil or cropping problems are experienced or recognized when using water with values less than those shown for ‘no restriction on use’. With restrictions in the slight to moderate range, gradually increasing care in selection of crop and management alternatives is required if full yield potential is to be achieved. On the other hand, if water is used which equals or exceeds the values shown for severe restrictions, the water user should experience soil and cropping problems or reduced yields, but even with cropping management designed especially to cope with poor quality water, a high level of management skill is essential for acceptable production. If water quality values are found which approach or exceed those given for the severe restriction category, it is recommended that before initiating the use of the water in a large project, a series of pilot farming studies be conducted to determine the economics of the farming and cropping techniques that need to be implemented.

As with many such interpretative tools in agriculture, it is developed to help users such as water agencies, project planners, agriculturalists, scientists and trained field people to understand better the effect of water quality on soil conditions and crop production. With this understanding, the user should be able to adjust management to utilize poor quality water better. However, the user of Table 1 must guard against drawing unwarranted conclusions based only on the laboratory results and the guideline interpretations as these must be related to field conditions and must be checked, confirmed and tested by field trials or experience.

The guidelines are a first step in pointing out the quality limitations of a water supply, but this alone is not enough; methods to overcome or adapt to them are also needed. Therefore, in subsequent sections, management alternatives are presented and several examples are given to illustrate how the guidelines can be used.

The guidelines do not evaluate the effect of unusual or special water constituents sometimes found in wastewater, such as pesticides and organics. However, suggested limits of trace element concentrations for normal irrigation water are given in section 5.5. As irrigation water supplies frequently serve as a drinking water source for live-stock, salinity and trace element in drinking water limitations for livestock.

This is important, because irrigation supplies are also commonly used, either intentionally or unintentionally, as human drinking water. The World Health Organization (WHO) or a local health agency should be consulted for more specific information.

Laboratory determinations and calculations needed to use the guidelines are given in Table 2 and Figure 1, along with the symbols used. Analytical procedures for the laboratory determinations are given in several publications: (Richards.etal.1954), and Standard Methods for Examination of Waters and Wastewaters (APHA 1980). The method most appropriate for the available equipment, budget and number of samples should be used. Analytical accuracy within ±5 percent is considered adequate.

Our main interest is in the physical composition of the water i.e, the type and quality of suspended solids.

The mesh size is not the only parameter that defines the filtration efficiency on the minimal size of this particle that have to the remove from the water. These filtration elements, Characteristics and determined and depended on additional parameters.

The selection of filter depends upon the water quality and pressure required by the irrigation system.

The details are given in table 2.1(a,b)

Table 2.1a. Classification of irrigation water(Krish Slyengar- etal.2011)..

S.NO	Types	Specification	Salt Availability
1.	Excellent	<175ppm	Dissolved Salts.
2.	Good	175- 525ppm	Dissolved Salts.
3.	Permissible	525- 1400ppm	Dissolved Salts.
4.	Un permissible	<2100ppm	Dissolved Salts.

Table 2.1b. Classification of irrigation quality.

USDA Classification of irrigation quality				
S.NO.	Salinity Class	EC at 25C^{o} Micromhos/cm	ds/m	Salt concentration
1.	Low salinity	0 – 250	< 0.25	<200
2.	Medium salinity	250 – 750	0.25 – 0.75	200 – 500
3.	High salinity	750 – 2250	0.75 – 2.25	500 - 1500
4.	Very high salinity	2250 – 5000	>2.25	>1500

2.1.2. Water Quality Criteria for Irrigation

The following chemical properties shall be considered for developing water quality criteria for irrigation:

- Total salt concentration.
- Sodium adsorption ratio.

Residual sodium carbonate or bicarbonate ion concentration, and Boron content(Bureau of India Standard ,1997).

For these reasons, a water quality index was developed that would be based on the attainment of water quality objectives for the water column, sediment and aquatic life. The main advantages to an objectives-based system are as follows:

- Objectives have been developed for more than 140 separate bodies of water.
- The objectives focus on the most important characteristics at risk in a body of water.

- The degree to which objectives are attained reflects directly how well the most sensitive water uses will be protected.

The attainment of water quality objectives is a measure of water quality impairment caused by human activity, excluding random events such as spills unless these are long-lasting or relatively frequent. The index is not bound by any limits on data use because objectives exist for variables from simple water column chemistry to complex biological measurements.

The use of objectives allows consistent application of the index to fresh water, marine water, or ground water.

The system allows great flexibility since it will accommodate changes due to new scientific information or due to the need to examine new water quality characteristics.

The index is founded on three factors involving the measurement of the attainment of water quality objectives. The factors measure the following:

- The number of objectives that are not met.
- The frequency with which objectives are not met.
- The amount by which objectives are not met.

These three factors are combined to form the index which can fall into one of the following five rankings: excellent, good, fair, borderline or poor. These rankings describe the state of water quality compared to its desirable or natural state.

Water quality is the determining factor for selecting a filter in irrigation system. Some filters work well on inorganic particulate, such as sand and sediment. Others function batter when dealing with organic contaminants such as algae knowing the water quality, coupled with the basic understands on the available filter types make the filter selection process easier.

2.1.3.Turbidity

Turbidity is the cloudiness or haziness of a fluid caused by suspended solids that are usually invisible to the naked eye. The measurement of Turbidity is an important test when trying to determine the quality of water. It is an aggregate optical property of the water and does not identify individual substances; it just says something is there.

Water almost always contains suspended solids that consist of many different particles of varying sizes. Some of the particles are large enough and heavy enough to eventually settle to the bottom of a container if a sample is left standing (these are the settleable solids). The smaller particles will only settle slowly, if at all (these are the colloidal solids). It's these particles that cause the water to look turbid.

2.1.4. The Meaning of the Rankings

The following brief descriptions related to water use and natural conditions are helpful in interpreting the meaning of each water quality ranking.

We recognize six uses of water: drinking, recreation, irrigation, livestock watering, use by aquatic life, and use by wildlife. The first four uses are related to human use and are only considered in the rankings when they are naturally sustainable. The uses by aquatic life and wildlife are usually always naturally sustainable in BC waters. Note that drinking water in this context always refers to the quality of the raw water source, as it exists in the environment before it is delivered to a consumer's tap. Such raw water, even if ranked as excellent, always needs, at the least, disinfection before drinking.

Natural water quality conditions refer to conditions that exist in the absence of any human interference. Desirable conditions are those which will sustain the most sensitive water uses. Natural and desirable are usually synonymous, although they may differ when human activity has brought permanent change.

2.1.5. The rankings are described as follows:

Excellent: all uses are protected with a virtual absence of threat or impairment no uses ever interrupted conditions very close to natural or pristine levels.

Good: All uses protected with only a minor degree of threat or impairment no uses ever interrupted conditions rarely depart from natural or desirable levels.

Fair: Most uses protected but a few threatened or impaired a single use may be temporarily interrupted conditions sometimes depart from natural or desirable levels.

Borderline: Several uses threatened or impaired more than one use may be temporarily interrupted conditions often depart from natural or desirable levels.

Poor: Most uses threatened or impaired conditions often depart from natural or desirable levels.

2.1.6. Background information on the Blue Nile River Basin

The Nile River is the longest river in the world; the river originates from two distinct geographic zones (Equatorial lakes plateau and Ethiopia high plateau). The main branches of the Nile River are the White Nile River, the Blue Nile River and the Atbra River as presented in Figure 2.1. The Blue Nile provides the greater part, about 60% of the flow of the main Nile River with a mean annual discharge of 50 billion m3 (Elfaki,2008). The Blue Nile originates from the Ethiopia high plateau at elevations of 2000-2008). The Blue Nile originates from the Ethiopia high plateau at elevations of 2000-3000 m+MSL (mean sea level) with several peaks up to 4000 m+MSL or more (Sutcliffe and Parks, 1999). The high rainfall over the Ethiopia highlands in a single season and the steep topography give rise to a relatively high and concentrated runoff. The plateau drops steeply to the Sudan plains where there are many isolated outlaying hills and the vegetation cover is relatively sparse because of the short rainy season.

Figure 2.1. Nile River Basin *(*Hagos, *2005)*

Figure 2.2 demonstrates that the Blue Nile River transports a huge amount of sediment compared to the other rivers originating from the Ethiopia highlands. The upstream of the Blue Nile River Basin witnesses severe erosion and loss of top soils, with sedimentation and morphological changes in the downstream of the basin. These are attributed to the degradation in the upper basin that leads to high velocity of the flow and increases the flood hazard, as well as the sediment load downstream. Figure 2.3 illustrates the problem analysis upstream and downstream of the Blue Nile River Basin. About 140 million tons of the sediment are annually transported by the Blue Nile River to Sudan (Hagos, 2005). This high sediment load has a major influence on the design and operation of the reservoirs built across the river (Sinner and Rosaries dams) and the irrigation schemes. Sinner and Rosaries reservoirs have lost 60% and 34% of their storage capacities of 0.93 and 3.02 BCM (billion cubic meters) respectively due to sediment deposition (Gismalla, 2009). Consequently, this reduction in the storage capacity has affected the water supply to the irrigation schemes, which was the main purpose of the construction of these dams besides hydropower generation.

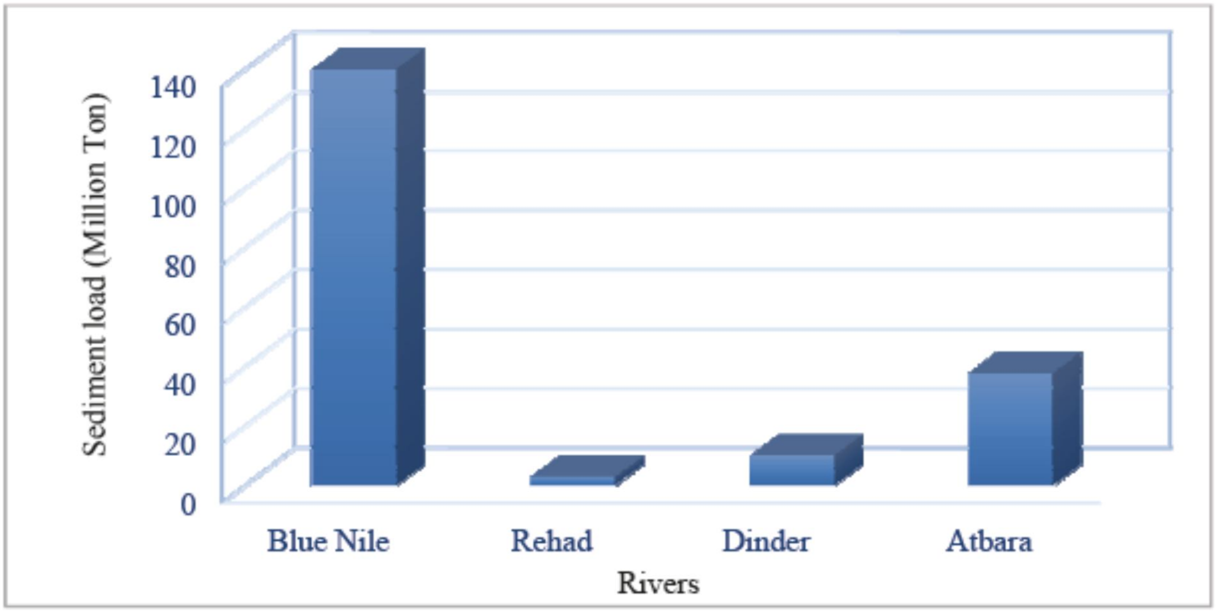

Figure 2.2. Total annual sediment load (million tons)

for different rivers those responsible for the operation and maintenance of these canals in Sudan. This The problem of sediment deposition in irrigation canals represents a challenge to research focuses on the impact of the sediment downstream of the Blue Nile River Basin and how it affects the irrigation system as is shown in Figure 2.3. This study is a part of the 'In Search of Sustainable Catchments and Basin-wide Solidarities; Trans-boundary Water Management of the Blue Nile River Basin' project The aim of this project is to generate a better understanding of the agronomic, hydrological, environmental and socio-economic impacts of the improved land management along the Blue Nile River. It focuses on the impact of land use management upstream (Ethiopia) on sedimentation rates downstream (Sudan). In this study, the Gezira Scheme has been chosen as a sink of eroded sediment from upstream of the Blue Nile. The scheme acts as a model for other large and small scale schemes and its significant role in the economy and socio economy of Sudan. Operation and maintenance procedures in Gezira Scheme have been investigated in order to find an appropriate strategy to reduce the sediment accumulation in the canal systems. Through links with other researchers this research leads to better understanding of the downstream impact of the improvement of land use management.

2.2.1. What is a filter?

Filters are component made of mild steel, plastic restricts, examiner and prevents flow of obstructions contaminants moved the water(Krish Slyengar- Alok Mishra- Mohil Dutt 2011).

The principle methods for the separation of such mixtures could be classified as:

i. Cyclone separator.
ii. Gas-Liquid separator.
iii. Liquid-Liquid separator.
iv. Gravity separator.
v. Centrifugal separator.
vi. High speed tubular centrifuge.
vii. Scrubbers.
viii. Electrostatic precipitator.
ix. Hydro cyclone.

The total area of the filter medium is exposed to flow and is usable for the filtration process**(**Krish Slyengar- Alok Mishra- Mohil Dutt 2011).

2.2.2. Reasons for Filtration

The major purpose of filtration in Agricultural irrigation is to remove suspended material from the water supply.

The suspended material only includes particles usually larger than 0.45 micron. We do not have to remove all such tiny particles for our micro irrigation systems but if the particles that affect us are not filtered then the resulting problems that occur are:

- Scouring and wearing of nozzles by sand, leading to inefficiencies and excessive emitter flows.
- Blockage or clogging of both drip and sprinkler emitters, usually by organic material, but also by inorganic material.
- Malfunction of valves and associated equipment that are hydraulically activated in any above event the irrigation system’s integrity is endangered and this could result in water, energy and

fertilizer wastage plus loss of crop all of which cost money. The net result can be minor losses to a major catastrophe. (Netafim School of Irrigation) Netafim Australia.

2.2.3. Need for a filter:

Filters are essential due to small cross section of nozzle, emitter, dripper used in the micro-irrigation systems. Which are uses susceptible to clogging?

Clogging of nozzles, emitter /drippers reduces system efficiency crop yield and increase energy consumption along with maintenance cost of irrigation system (Krish Slyengar- Alok Mishra- Mohil Dutt 2011).

Filtration prevents solids from clogging of valves or accumulating in the water distribution piping system. Irrigation – filtration equipment can broadly be classified in four different types:

A. Screen filters.
B. Centrifugal separator/ Hydro cyclone filter.
C. Disc filters.

D. Sand media filters.

(Krish Slyengar- Alok Mishra- Mohil Dutt 2011).

2.2.4. Filtration Methods:

There are many filtration methods. For irrigation purposes concentration is on the common methods for macro particles filtration. These are acceptable in one form or another, in industry, irrigation and municipal water supply systems.

The filtration method has to be chosen according to quality of the water and the specific needs of the consumer, after examining the advantage and disadvantages of every method(Krish Slyengar- Alok Mishra- Mohil Dutt 2011).

2.2.5. Factors considered when selecting the filtration methods:

a) The required filtration degree.
b) The characteristics of the suspended solids (organic or inorganic).
c) Load of suspended solids (TSS).
d) Hydraulic data of the given water system (flow rate, pressure, pipe network, topography).
e) Availability of water supply (electricity, water pressure, compression, etc).
f) Cost of purchase.
g) Cost of operation.

h) Availability of manpower and their qualifications.

The choice of the best filtration solution will be based on the above factors together with weighing up of the advantages and disadvantages of the various.

Table 2.2.Suggested Filter Types Based on Water Sources (Krish Slyengar- Alok Mishra- Mohil Dutt 2011).

S.NO Water Source	Suggested Filter Types
1. Municipal WS.	Screen filter, hydro cyclone or Disc filter.
2. Well.	Screen filter, hydro cyclone or Disc filter.
3. River or Creek.	Disc filter, Media filter and Screen filter , Hydro cyclone filter and Media filter.
4. Pound or Lake.	Disc filter, Media filter and Screen filter , Hydro cyclone filter and Media filter.
5. Spring or Artesian.	Screen filter, Centrifugal filter or Disc filter.
6. Organic Material in Water.	Disc filter, Media filter and Screen filter , Hydro cyclone filter.
7. Sand in Water.	Screen filter, Hydro cyclone filter or Disc filter.

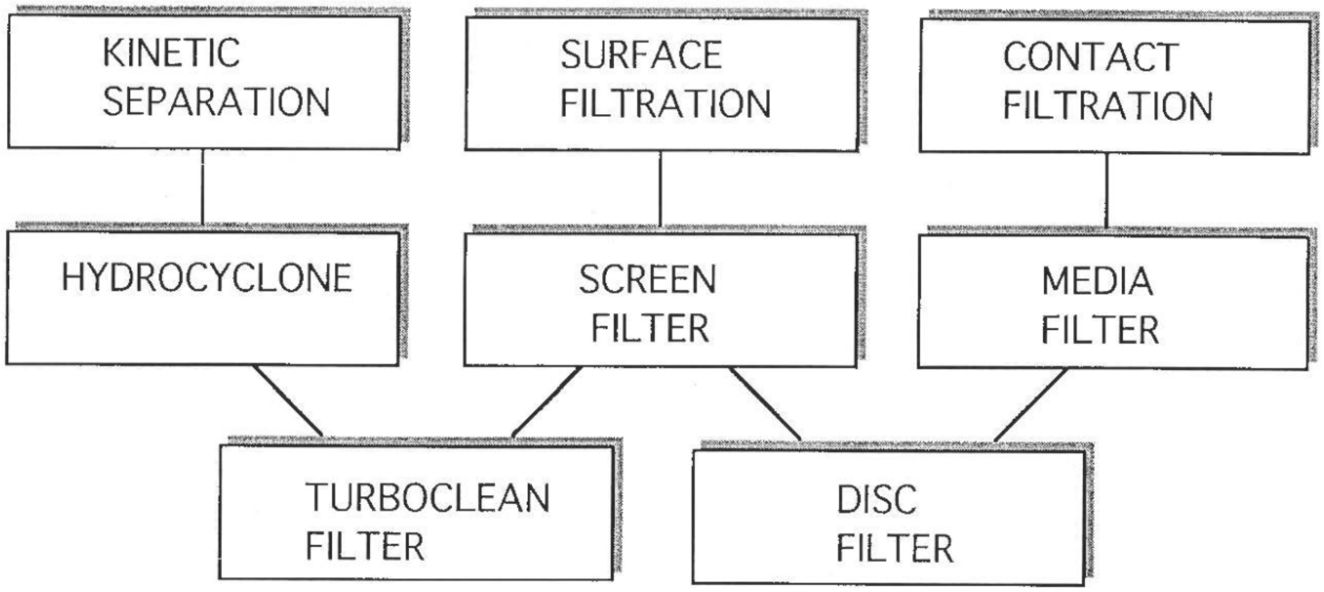

Figure 2.3 Showing the types of filtration methods

2.2.6. Following are the major types of irrigation filters used in the micro – irrigation system:

i. **Screen filters:**

These are simple and economical filtration devices of various shape and sizes. Most frequently used for the removal of physical contaminants. They can be made of metal, plastic or synthetic cloth enclosed in special housing.

Screen filters are recommended for removal of very fine sand or large sized. Inorganic debris. If is normally not effective to use screen filter for the removal of heavy loads of algae or the organic material. Ministry of Rural Development (MoRD, 2011).

Table 2.3 Particle Size in Relation to Mesh Equivalent and Micron.

Material	Size in Microns (μ)	Mesh equivalent
Very coarse sand	1000 – 2000	10 –18
Coarse sand	500 – 1000	18 – 35
Medium sand	250 – 500	35 – 60
Fine sand	100 – 250	60 – 160
Very fine sand	50 –100	160 – 270
Silt	2 – 50	
Clay	< 2	

Note how very fine Clay particles are. They cannot be filtered out by normal agricultural filters – despite how many times the grower may ask.! (Bucks and Nakayama 1980)

Table 2.4 Representative Screen Mesh Number And The Corresponding Standard Opening Size Equivalents.

S.NO.	Screen Size	Opening Size	
	Mesh	Mm	Microns
1	4	4.79	4760
2	10	2.00	2000
3	20	0.711	711
4	40	0.42	420
5	80	0.18	180
6	100	0.152	152
7	120	0.125	125
8	150	0.105	105
9	180	0.089	89
10	200	0.074	74
11	270	0.053	53
12	325	0.044	44

Table 2.5 The minimum size of particle retained by a screen filter with certain mesh can be determined as follows:

S.NO. Soil Classification	Particle Size			
	Mm	Microns	Inches	Screen mesh number
1. Very coarse sand.	1.00 – 200	1000 – 2000	0.0393 – 0.0786	18 – 10
2. Coase sand.	0.50 – 1.00	500 – 1000	0.197 – 0.0393	35- -18
3. Media sand.	0.25 – 0.50	250 – 500	0.0098 – 0.0197	60 – 35
4. Fine sand.	0.10 – 0.25	100 – 250	0.0039 – 0.0098	160 – 60
5. Very fine sand.	0.5 – 0.10	50 -100	0.0020 – 0.0039	270 – 160
6. Silt.	0.002 – 0.05	2 – 50	0.0008 – 0.0020	-----------------
7. Clay.	0.002	2	0.00008	--------------

2.2.7.Sication of Screen Filter

- Recommended Head loss: 4.5 - 7.5 psi
- Maximum Operating Pressure: 120 psi

Maximum Pressure: 150 psi

- Circulation Plate: 6 directional holes and rubber stoppers for precise flow rate adjustment for 2", 3", 4" and 6" sizes (4 directional holes for 8" size).
- 2", 3", 4" and 6" End connections: Grooved.
- 8" End Connections: Flanged.
- Screen Mesh Sizes: 080, 120, 150, 200.
- Screen Thickness: 0.9 mm.

Table 2. 6 Specification of Screen Filter

Size	Inlet/Outlet	Screen Area	Maximum Flow
2 inch	2 inch	205 SQ.IN	128 GPM
3 inch	3 inch	269 SQ.IN	172 GPM
4 inch	4 inch	376 SQ.IN	308 GPM
6 inch	6 inch	456 SQ.IN	968 GPM
8 inch	8 inch	1.520 SQ.IN	1.300 GPM

Table.2. 7_Flow rate in gallons per minute

Open Holes	3.5 psi	7.1 psi
2	48	70
3	62	88
4	70	97
5	79	114
6	97	128

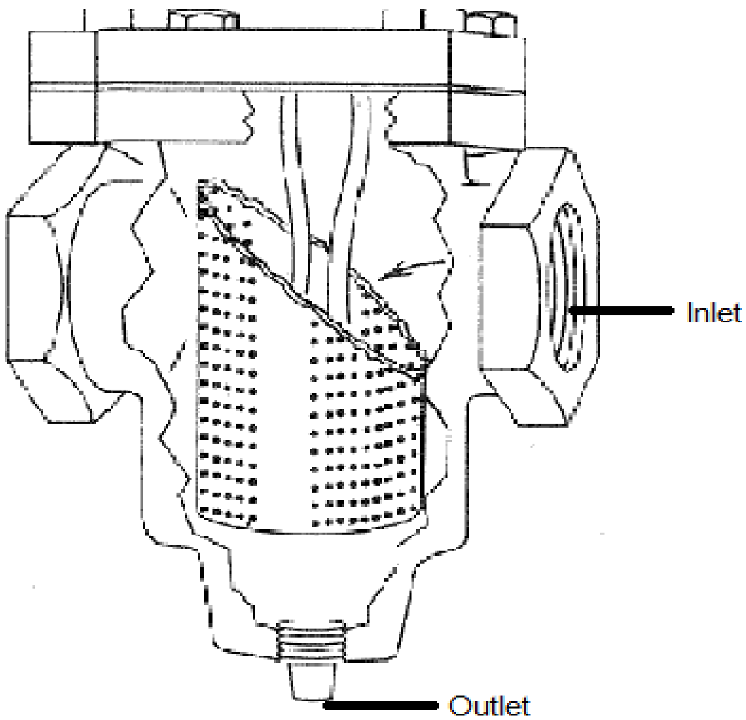

Fig 2.4 Showing screen filter diagram

ii. Disc Filter:-

Disc filters are across between screen and media filter, having clean larges of both. Disc filter are good at removing both sand and organic matter present in the water. A disc filter consist of a stack of round devices The face of each disc it covered with small bumps of different sizes .A close view of the bumps reveal each has a sharp point on the top of water.

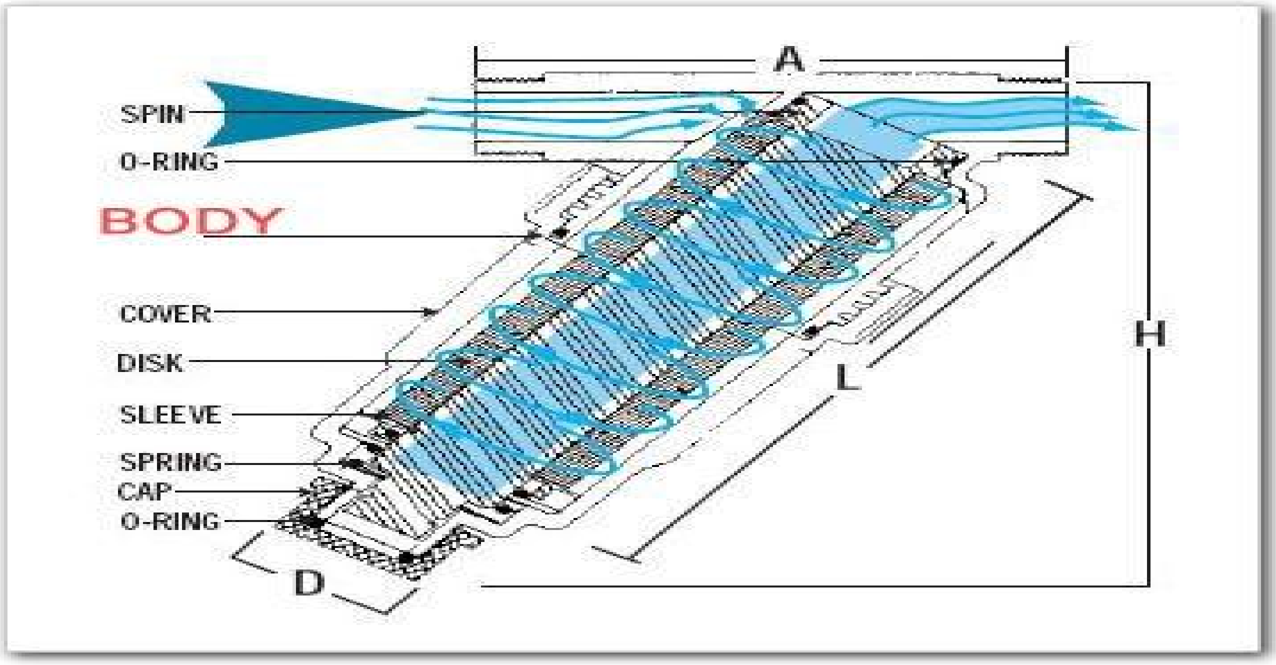

Fig 2.5 Showing disc filter diagram

iii. Sand Media Filter:-

Media filter clean the water by forcing it through a container filter with small and sharp edge (media) in most cases the media materials used is uniform sized crushed sand. The water passed through the small spaces between the media grains. The debris are stopped as they cannot pass through the spaces. Media filter are used for removing organic material .The filtration media is crushed silica sold / quartz gravely at particle size in range 0.7mm to 1.2mm (0.027 to 0.047 inch).

The effective filtration is 75 micron (200 mesh). The maximum pressure rating is 10 $kg/cm^{2.}$ The force of the water going backwards through the filter lifts the media which frees the debris and washes them though a flush valve. (Denver, 1995).

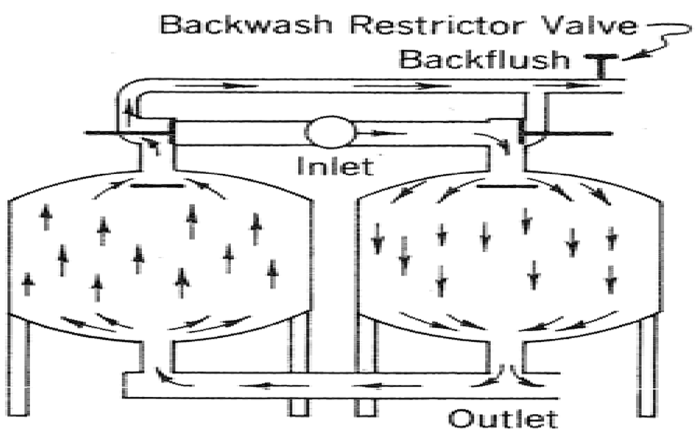

Fig 2.6 Showing sand filter diagram

iv. Centrifugal Filter (Hydro cyclone):

The solid particles need to have a specific gravity greater than water i.e. greater than 1. A head loss must be generated between the tangential entry port and vertical exit port which forces particles by a centrifugal or vortex action outwards and downwards. Sediments are collected in a chamber at the bottom of the separator and are purged periodically. The principle and mechanism is simple and effective with no moving parts, although “wear plates” need to be replaced from time to time. Separation efficiency is determined by flow and head loss – generally speaking the higher the head loss and smaller the diameter of the separator the better the efficiency. The pressure drop is constant with a given flow as there is no filter element to “block up” – but remember to purge the collection chamber regularly.
NB Organic material will not be removed, and nor will clay or silt. Hydro cyclones can also be used to mix air into water and to incorporate fertilizers or chemicals effectively.

This is also known as (sand separators) centrifugal filter are primary used for removing particulates such as sand present in the sand water. It is most effective when lot of sand is present in the water and do not allow clogging in the system.

The dirty water when enters the filter where it is swirled around the inner of cylinder. The centrifugal force causes the sand particles to remove towards the other edge of the cylinder where gradually slides down to a holding tank place at the bottom. Centrifugal filters are less expensive and simple and are very effective for removing sand from water.

Normally it is used when water is pumped from the well. Generally it the diameter of well is more than 2.5 inches then centrifugal filter is installed inside the well. These filters typically are attached to the bottom of submersible pump. It is not unusually to observe small amount of sand passing through the centrifugal filters. In case of drip irrigation system centrifugal filter is used in combination with sand media filters which minimize clogging in the system.

The centrifugal filter remove the sand, while the media filter separates the organic impurities present in the water.

Selection of centrifugal filter must match with the rate of discharge to have optimum system efficiency. Always consult manufacture, technical guidelines for selecting a centrifugal filtration for irrigation .To get maximum efficiency and optimum result, it is necessary to prevent emitter’s mini-sprinklers and lateral clogging.

Thus filtration system is the heart of irrigation system. Properly maintenance filters will ensure minimum efficiency of irrigation system. by avoiding clogging(Krish Slyengar.etal.)

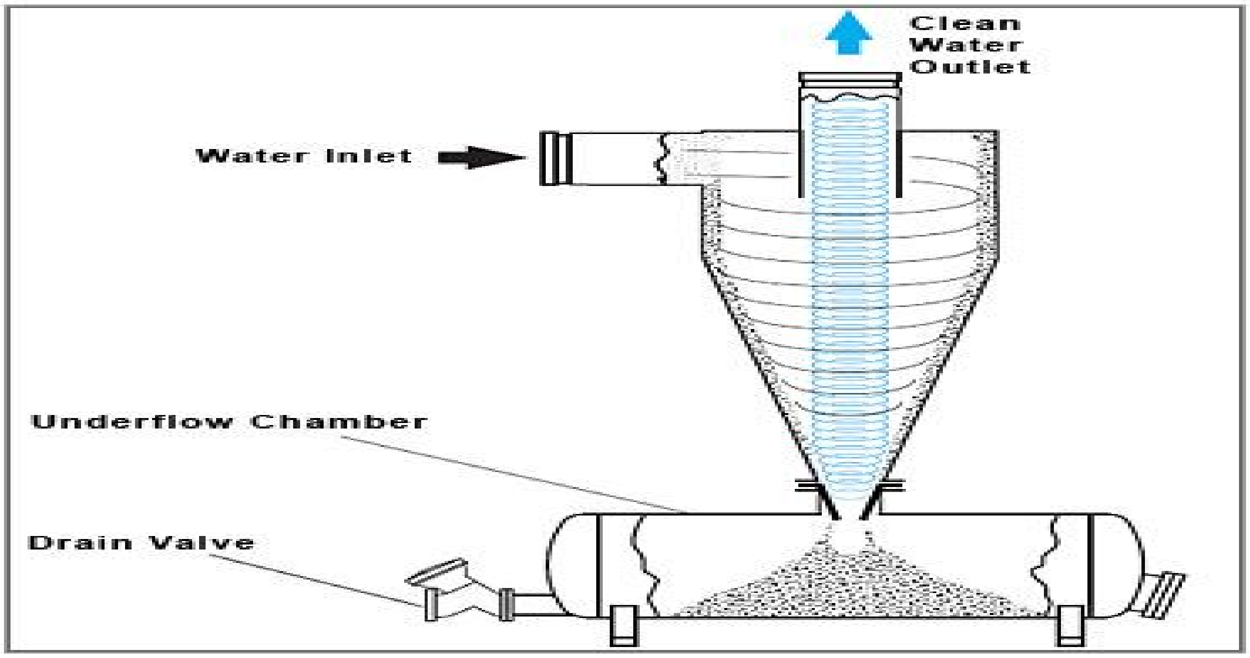

Fig 2.7 Showing hydro cyclone filter diagram

Maintenance of Hydro cyclone:-

Hydro cyclone filter requires minimum maintenance. if cleaning the dirt , inside the under flow chamber is done at periodic interval, flush the chamber by opening the flush valve , cap or main valve , for proper cleaning . It is observed that the hydro cyclone filter becomes ineffective one the collection chamber is filter with dirt.

As a general "Rule of Thumb" it is accepted that:

- Drip Irrigation requires a particle size 1/6 to 1/10 of the emitters smallest opening.
- Micro sprinkler, jet etc require a particle size 1/3 to 1/6 of the emitters smallest opening(Krish Slyengar- Alok Mishra- Mohil Dutt 2011).

2.2.8. Clogging Factors

Clogging factors are documented under three categories

- Inorganic suspended solids.
- Sediments generated by chemical reaction.
- Organic (biological) mater such as bacteria and algae.

2.2.9. Methods of cleaning filters: Criteria for filter flushing maintenance.

- Flushing according to time.
- Flushing according to the amount of water.
- Flushing according to Differential pressure.
- A combination of flushing according to differential pressure.

In water system which has a constant flow rate , the accumulation of filtrate layer on the surface of the filtration element will create differential pressure between the inlet and out let of the filter.

This certain is the only the reliable shows the clogging of the filter.

Flushing according to time or according to the amount has to be based on tried and error. If there are changes in the quality of the water during the season, the operator has to adjust every often the frequency of the flushing as required.

The best criteria are a combination of flushing according to time and differential pressure. So that our criteria backed up the other at gives a good solutions to system which have varying flow rate in a wide ranges. Or for systems in which the quality of the water is usually good and the frequency of

2.2.10. Various methods for cleaning flow:

- Manual cleaning: manual filter by definition, have to be cleaning manually. This is usually done by a jet of water. Sometime or the filter has also to be soaked in chlorine or detergent.
- Mechanical cleaning: some filters the cleaning is done by a brush, knife for scraping or take .the mechanically mechanism can be operation automatically, by meter or manually. This method of cleaning is suitable for coarse filtration only.
- Forced back flushing**:** This flushing is accepted in automatic screen filter.
- Direct flushing: The method cause the water to flow at a high velocity at tangent to the screen and remove the filter cake the filter element by its movement(Krish Slyengar- Alok Mishra-Mohil Dutt 2011).

2.3.Irrigation:

Irrigation is defined as the artificial application of water to soil for the purpose of supplying the moisture essential to plant growth. Irrigation may be accomplished in different ways, by flooding, by means of furrows, larger or small by applying water underneath the land surface by sub-irrigation and thus causing the ground water to rise or by sprinkling.

Irrigation, the addition of water to lands via artificial means, is essential to profit-able crop production in arid climates. Irrigation is also practiced in humid and sub-humid climates to protect crops during periods of drought. Irrigation is practiced in all environments to maximize s production and, therefore, profit by applying water when the plant needs it... (**USDA-** 1997).

2.3.1. Irrigation methods:

Various types of irrigation techniques differ in how the water obtained from the source is distributed within the field. In general, the goal is to supply the entire field uniformly with water, so that each plant has the amount of water it needs, neither too much nor too little(Hoogeveen. etal. (2006).

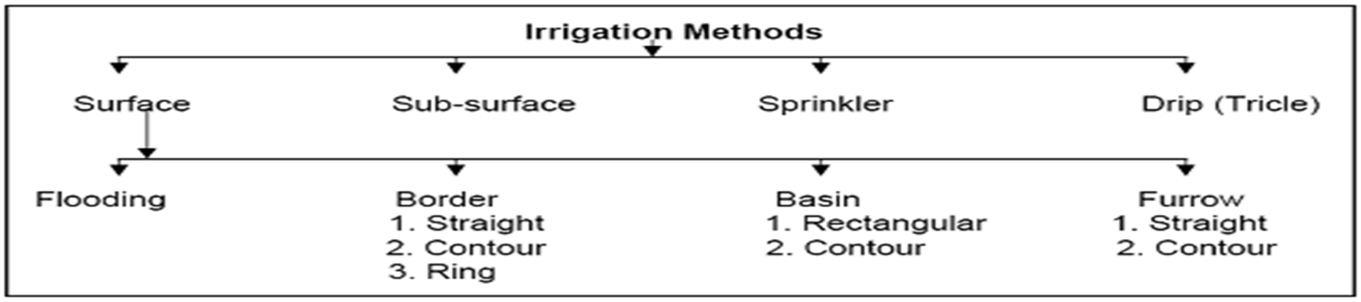

Fig. 2.8The various irrigation techniques

1. **Surface Irrigation:**

In surface irrigation systems, water moves over and across the land by simple gravity flow in order to wet it and to infiltrate into the soil. Surface irrigation can be subdivided into furrow, border strip or basin irrigation. It is often called flood irrigation when the irrigation results in flooding or near flooding of the cultivated land pattern, and applied as a small discharge to each plant or adjacent to it. Drip irrigation, spray or micro-sprinkler irrigation and bubbler irrigation belong to this category of irrigation methods.

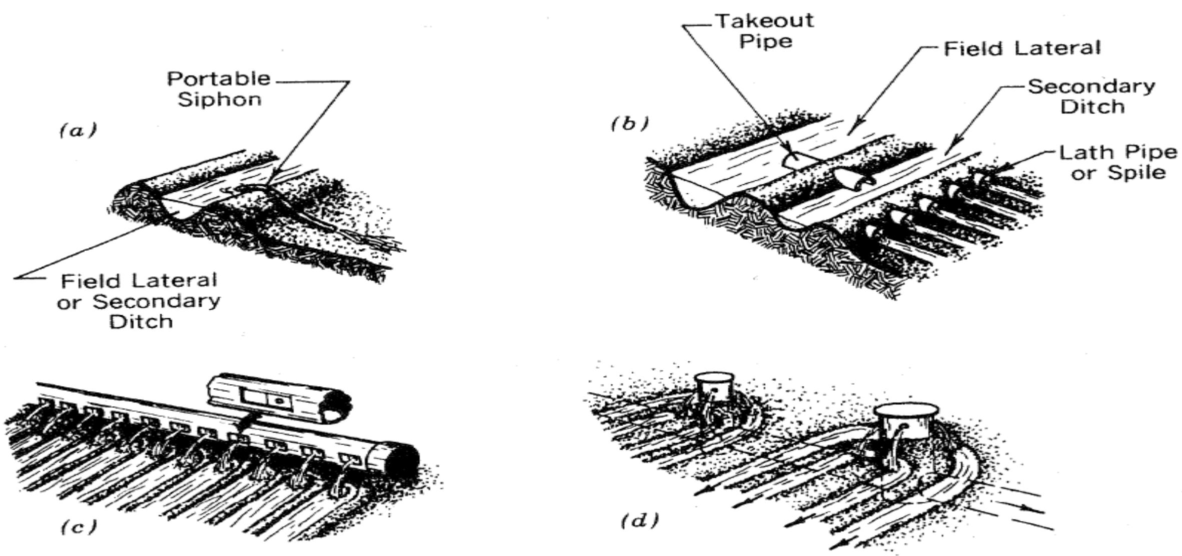

Fig 2.9 Showing Surface Irrigation diagram

2. Sub-irrigation:

Sub-irrigation also sometimes called seepage irrigation has been used for many years in field crops in areas with high water tables. It is a method of artificially raising the water table to allow the soil to be moistened from below the plants' root zone. Often those systems are located on permanent grasslands in lowlands or river. Valleys and combined with drainage infrastructure. A system of pumping stations, canals, weirs and gates allows it to increase or decrease the water level in a network of ditches and thereby control the water table. Sub-irrigation is also used in commercial greenhouse production, usually for potted plants. Water is delivered from below, absorbed upwards, and the excess collected for recycling. (Aridpoop. *2012).*

3.Drip Irrigation:

Drip irrigation, also known as trickle irrigation, functions as its name suggests. Water is delivered at or near the root zone of plants, drop by drop. This method can be the most water efficient method of irrigation, if managed properly, since evaporation and runoff are minimized. In modern agriculture, drip irrigation is often combined with plastic mulch, further reducing evaporation, and is also the means of delivery of fertilizer.(Adhikari, Deepak**.** 2000)

Drippers. The drippers are small-sized emitters made of high quality plastics. They are mounted on small soft Polyethylene (PE) pipes (hoses) at frequent spaces. Water enters the dripper emitters at approximately 1.0 bar and is delivered at zero pressure in the form of continuous droplets at low rates of 1.0-24 liters/h. Drippers are divided into two main groups according to the way they dissipate energy (pressure):

• Orifice type, with flow areas of 0.2-0.35 mm^2.
• Long-path type, with relatively larger flow areas of 1-4.5 mm^2.

Both types are manufactured with various mechanisms and principles of operation, such as a vortex diode, a diaphragm or a floating disc for the orifice drippers, and a labyrinthinepath, of various shapes, for the long-path ones. All the drippers now available on the market are turbulent flow ones. Drippers are also characterized by the type of connection to the lateral: on-line, i.e. inserted in the pipe wall by the aid of a punch; or in-line, where the pipe is cut to insert the dripper manually or with a machine. On-line multi-exit drippers are also available with four to six ‘spaghetti’ type tube outlets. A. Phocaides,(FAO Consultant, ROME, 2006).

Emitters: Drip Emitters, Drippers: Emitters distribute water droplets at a specified flow rate when used as part of a drip irrigation system. Emitters come in a variety of sizes, styles, and flow rates. They have barbed or threaded bases. Barbed ends are either poked directly into 1/2" drip tubing or inserted into the end of 1/4" tubing. Threaded bases are screwed into micro tubing stakes and risers(URBAN Farmer Store, INC. All Rights Reserves 2006).

Types of Emitters:

• Pressure Compensating Emitters: Pressure compensating emitters deliver a consistent output of water, even with changes in pressure due to long drip tubing runs or changes in elevation.

- Button Emitters, Turbo Style Emitters, Self Piercing Emitters with 1/4" barbed inlets.
- Multi Outlet & Retro Fit Emitters with 1/2" FPT inlets.

- Flag Emitters, Turbo Key Style Emitters, and Inline Emitters with 1/4" barbed inlets (URBAN Farmer Store, INC. All Rights Reserves 2006).

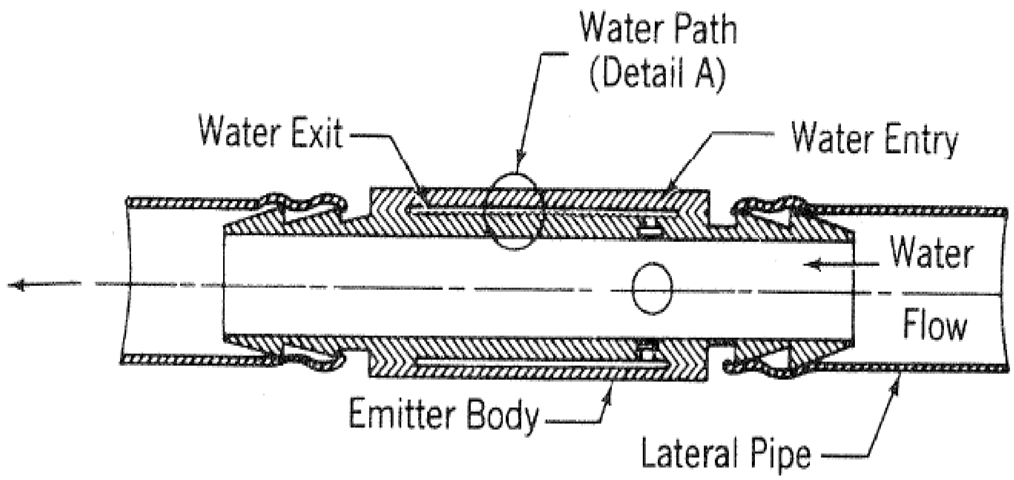

Fig 2.10 Showing Pressure Compensating Emitters diagram.

- **Non Pressure Compensating Emitters**: Non pressure compensating emitters output will vary with changes in elevation and pressure. These emitters are best used where the watering zone is level (URBAN Farmer Store, INC. All Rights Reserves 2006)

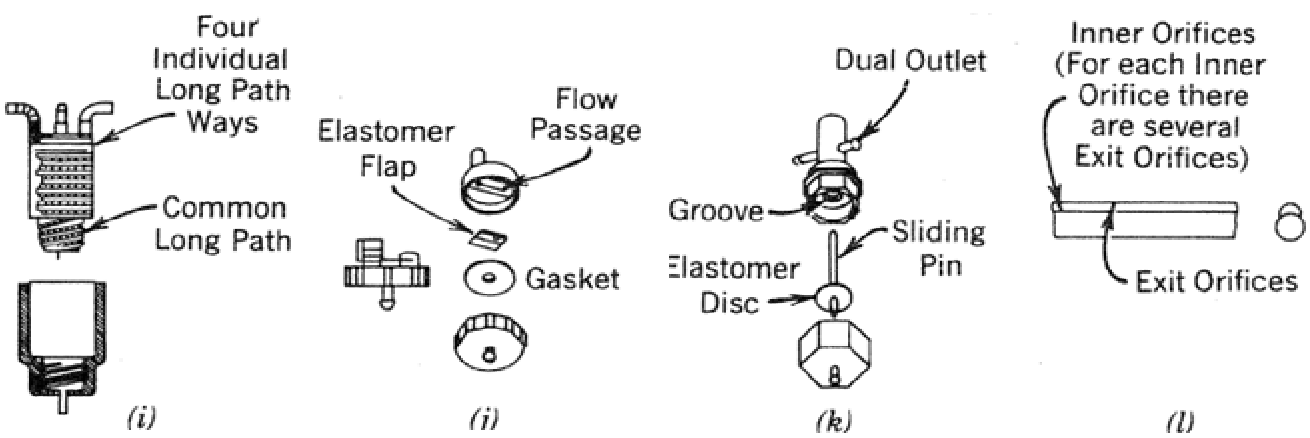

Fig 2.11 Showing Non Pressure Compensating Emitters diagram

Table 2.8_Potential risk of Blockage in Drip Irrigation Systems(*Food and Agriculture Organization* 2007).

Water quality	Indicators	Potential Risk		
		Little	Slight to Moderate	Severe
Physical	Suspended solids (mg/L)	< 50	50 – 100	> 100
Chemical	pH	< 7.0	7.0 – 8.0	> 8.0
	TDS (mg/L)	< 500	500 – 2000	> 2000
	Manganese (mg/L)	< 0.1	0.1 – 1.5	> 1.5
	Iron (mg/L)	< 0.1	0.1 – 1.5	> 1.5
	Hydrogen Sulphide (mg/L)	< 0.5	0.5 – 2.0	> 2.0
Biological	Bacteria (No/100mL)	< 1 x 10/	1 – 5 x 10/	> 5 x 10/

(after Bucks and Nakayama 1980)

4. **Sprinkler Irrigation**

In sprinkler or overhead irrigation, water is piped to one or more central locations within the field and distributed by overhead high-pressure sprinklers or guns. A system utilizing sprinklers, sprays, or guns mounted overhead on permanently installed risers is often referred to as a solid-set irrigation system. Higher pressure sprinklers that rotate are called rotors and are driven by a ball drive, gear drive, or impact mechanism. Guns are used not only for irrigation, but also for industrial applications such as dust suppression and logging. Sprinklers can also be mounted on moving platforms connected to the water source by a hose. Automatically moving wheeled systems known as traveling sprinklers may irrigate areas such as small farms, sports fields, parks, pastures, and cemeteries unattended.

Sprinklers are still dominating agricultural and landscape irrigation worldwide. They are available from lots of different manufacturers, and are used for a variety of applications. The most common type of sprinkler is the spray head. Spray heads can be fixed, and cover only a certain angle of watering, or it can have a rotating element, which allows It to cover a full circle.
Also, the rotating element allows for a bigger variation in drop sizes, distribution, etc. One of the advantages with spray heads is their ability also t distributes small amounts of water. They can be adjusted to deliver only a fine mist of water; however, the wind drift makes their use limited to areas where there is no or little wind. Greenhouses are a good example for the spray head application. This is also an application, where large drops of water may damage the crops, or they will splash dirt on them. Spray heads feature a radius of approximately 15 m. When they are used in the open land, they

should always be used as close to the ground as possible, in order to minimize wind drift. At best they should be installed just above the ground. When used properly the efficiency of spray heads can be quite high. All spray heads require a minimum pressure to function properly. To maintain an efficient of the water, it is important to control flow and head within certain narrow limits, and the use of a pump to maintain this makes irrigation much more efficient. Another widely used sprinkler type is the impact sprinkler. This sprinkler type has a spring loaded inertia element, which is forced to turn by the water jet. The spring makes the inertia element return to the original position, and it hammers on the sprinkler and forces it to turn a certain angle. It can be adjusted to cover almost one full circle of watering. The throw of this type of sprinkler is typically up to 25 m. A very large and special type of impact sprinkler is called rain gun, or end gun, and some of them can distribute more than 100 m3 per hour in a radius up to 70 m. These sprinklers are mounted above the ground throughout the season. A certain renumber of sprinklers per hectare make sure that every square meter of the ground receives a minimum amount of water. This approach requires a lot of sprinklers, and the water is not Fixed sprinklers are typically used on slopes and in hilly areas, where travelling irrigators are restricted. Another typical application for fixed sprinklers is frost protection of crops the pop-up sprinkler is a fixed sprinkler variant. These sprinklers are hidden below the surface when not in operation, and rise when in use. The water pressure makes them pop up, following which they function like other sprinklers. This function makes them perfect for irrigation of recreational grass. (FAOConsultant2005)

Table 2.9 Different Sprinkler Types ,wetted Radius (m) and Flow (m^3/h). (Kiryat-Arye, Petach-Tikva 2004)

Sprinkler types	Radius(m)	Flow(m^3/h)
Nozzles/spray heads	0.6 – 5.5	0.1 – 1.2
Pop-up sprinkler	4– 30	>1 – 15
Rotating sprinkler	4 – 35	>1 – 30
Rain guns	30 - 70	30 -120
Drip irrigation, per dripper		0.01- 0.025

2.4.1. Types of Sprinklers Irrigations:

A. **Portable system**
Portable system has portable mainline system, sub mains, laterals, and a portable pumping, the entire system can be moved from to field (Larry.G.L 1985).

B. **Semi-Portable system**: A Semi- portable system is similar to a fully portable except that the location of the water source and pumping plant is fixed. Such as system may be used on more than one field .where there is extended mainline. But may not be used on more than one farm unless there are additional pumping plants (Larry.G.L 1985).

C. **Semi-permanent system** A semi- permanent system has portable lateral lines, permanent lines, and a stationary water source and pumping plant. The mainlines are usually buried with risers (located at suitable intervals for connected laterals.

D. **Permanent system**: A fully permanent system has buried mainlines, sub mains, and lateral with a stationary pumping plant and/ or water source, sprinklers are permanently located or each riser. Such system are costly and suite to automations(Larry.G.L 1985).

E. **Set – Move system;** A Set-move sprinkler system is moved from one set (irrigation) position to another by hand or mechanically. Set-move systems remain stationary as water is applied. When the desired amount of water has been applied. The water is shut off and the sprinkler laterals are drained and moved to the next set position. When the move is complete the water is turned on and irrigation resumed at the set position. This sequence is repeated until the entire field has been irrigated. Set-move system commonly have a single mainlines laid though the center of the field with one or more laterals on each side of the mainline, multiple laterals equally spaced so that when lateral reach the starting position of the lateral a head of it, the entire field has been irrigation one (Hand-move, Tow-move, Side- roll, Gun- type) . (Larry.G.L 1985).

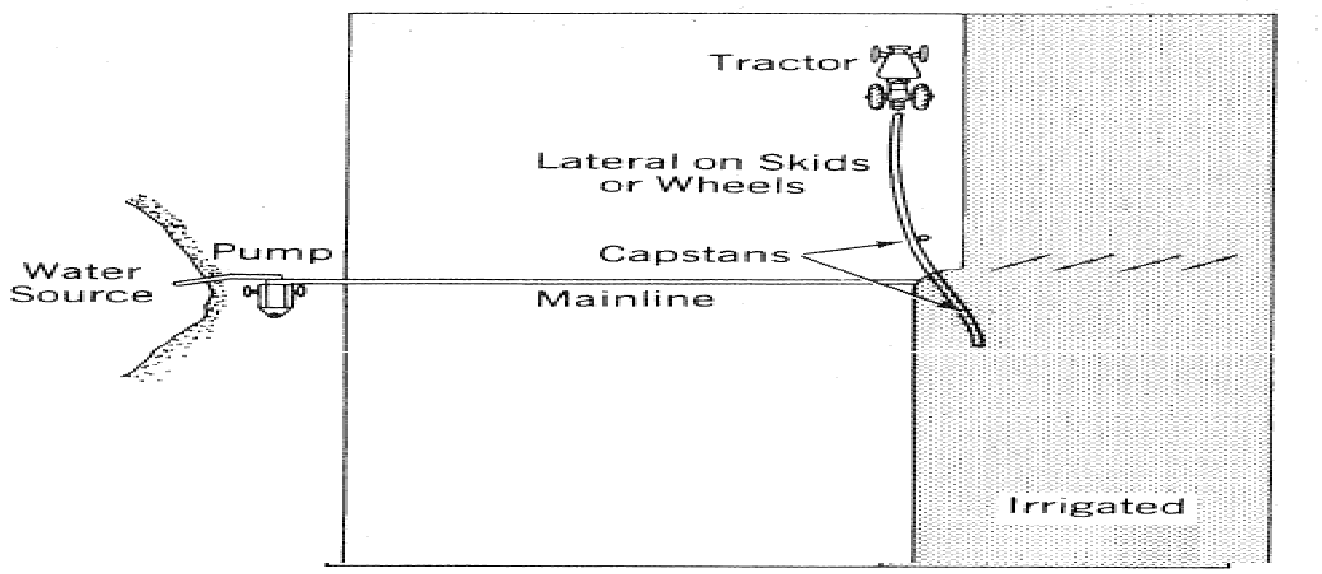

Fig 2.12 Showing diagram components of Set – Move system

F. Solid – set system: A solid –set system has enough laterals and sprinklers to irrigate the entire field simultaneously (although simultaneous operation all sprinkler, usually accrues only during frost protection. These systems can be portable, semi-portable, semi-permanent o permanent. Portable semi-portable and semi-permanent solid –set system usually have aboveground aluminum laterals that are placed in the field at the start of the irrigation. Season and left until harvest. Permanent system have underground mainlines and laterals with only the sprinklers and a portion of the risers a above ground.(Larry.G.L 1985).

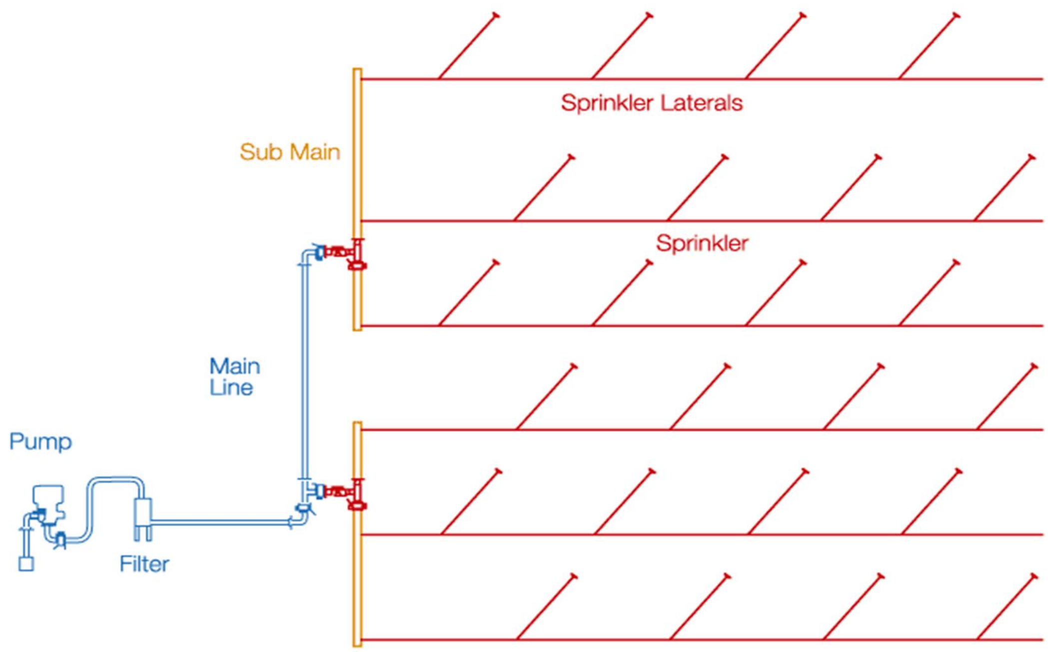

Fig 2.13.diagram showing components of a solid – set sprinkler irrigation system

G. **Continuous- move system**; Continuous have laterals and sprinklers that remain connected to the mainlines and move continuously as water is supplied. The popularity costs have steadily increased as labor for continually moving sprinkler system are discussed here. These are (Center- pivot sprinkler, Travel –move, Linear-move system).(Larry.G.James 1985).

- **Center-Pivot Systems:** Center pivot systems consist of a single lateral supported by towers with one end anchored to a fixed pivot structure and the other end continuously moving around the pivot point while applying water. This system irrigates a circular field unless end guns and swing lines are cycled on in corner areas to irrigate more of a square field. The water is supplied from the source to the lateral through the pivot. The lateral pipe with sprinklers is supported on drive units. The drive units are, normally powered by hydraulic water drives or electric motors. Various operating pressures and configurations of sprinkler heads or nozzles (types and spacing) are located along the lateral. Sprinkler heads with nozzles may be high or low pressure impact, gear driven, or one of many low pressure spray heads. A higher discharge, part circle gun is generally used at the extreme end (end gun), of the lateral to irrigate the outer fringe of the lateral. Each tower which is generally mounted on rubber tires, has a power device designed to propel the system around the pivot point. The most common power units include electric motor, hydraulic water drive, and hydraulic oil drive.

Towers are spaced from 80 to 250 feet apart, and lateral lengths vary up to ½ mile. Long spans require a substantial truss or cable to support the lateral pipe in place. , agricultural operators are converting from portable sprinkler systems and travelers to install center pivot systems. Many improvements have been made over the years. This includes the corner arm system. Some models contain an added swing lateral unit that expands to reach the corners of a field and retracts to a trailing position when the system is along the field edge. When the corner unit starts, discharge flow in all other. (Amend. NJ1, 2005).

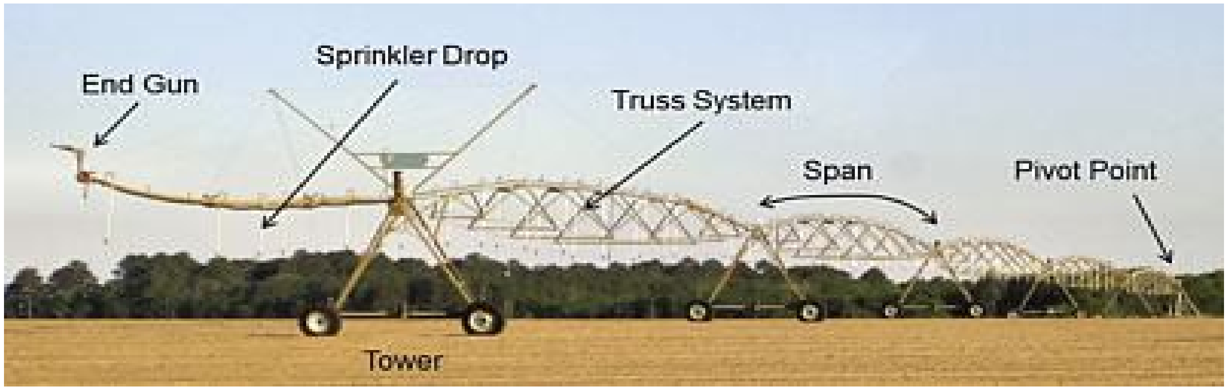

Fig 2.14.diagram showing components of a centre- pivot sprinkler irrigation system

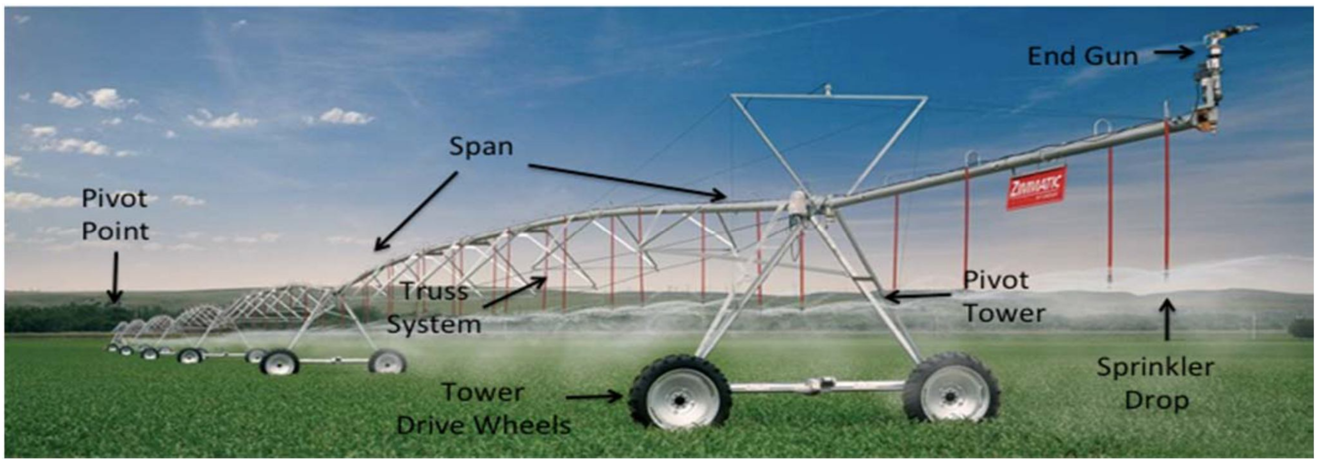

Fig 2.15. Lindsay Center Pivot with End Gun

- **Traveling Gun Sprinkler**

A traveling gun system (traveler, gun, big gun), consists of a high capacity single nozzle sprinkler mounted on a chassis to which a flexible hose, usually 3 to 5 inches in diameter and up to 1320 feet long, is connected. There are three general types of traveling gun sprinklers. These are cable reel, hose reel, and self–powered/propelled. With a traveling gun system, the gun is mounted on a 4-wheel chassis and is pulled along selected travel lanes by a cable or the hose wrapping on a rotating reel. The reel or winch can be powered by a water turbine, water piston, or engine drive and reels in the anchored cable or hose through the field in a straight line. Application depth is regulated by the speed at which the hose or cable reel is operated or by the speed of the self-contained power unit. As the traveler moves along its path, the sprinkler wets a strip of land 200 – 400 feet wide. After the unit reaches the end of the travel path, it is moved and set to water an adjacent strip of land. The overlap of adjacent strips depends on the distance between the travel paths, wetted diameter of sprinkler, average wind speed, and application pattern of the sprinkler. After one travel path (towpath) is completed, the sprinkler is reset by towing it to the edge of the field (Amend. NJ1, 2005).

Advantages:
• Odd shaped fields can be irrigated with automated equipment.
• Minimum manual labor.
• Suited to sandy soils or high intake rate soils.
• Well adapted to tall crops such as corn.
• Suitable for irrigating several different fields in a crop rotation.

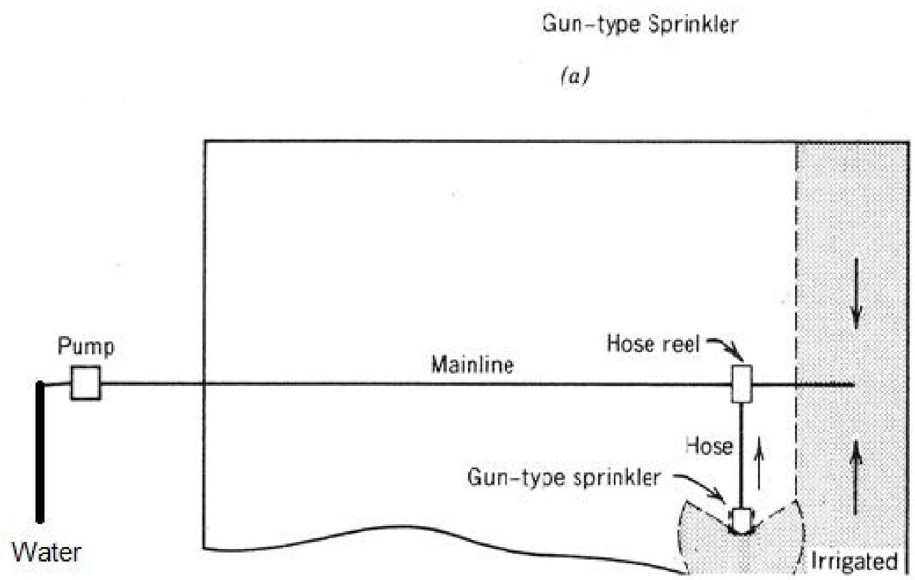

Figure 2.16. diagram showing Traveling gun type sprinkler system

- **Travelling Boom Sprinkler Systems**

  A traveling boom system is similar to a traveling gun except several nozzles are used. These systems have higher distribution uniformity than traveling guns for the same diameter of coverage. the traveling gun system provide options when a grower prefers a lower volume and pressure systems to reduce the high energy costs associated with a traveling gun system. The boom can be designed with low pressure and low flow nozzles that operate at higher efficiency and uniformity. The traveling boom usually is rotated by back pressure from fixed nozzles, or may be fixed. It is typically moved by a self-contained continuously moving power unit by dragging or coiling the water feed hose on a reel. A boom can be nearly 100 feet long with uniformly spaced nozzles that overlap (similar to a linear move lateral).

Advantages:
• Lower energy requirement than traveling gun.
• Higher uniformity than traveling gun.
• Can be fabricated locally in any good farm machine shop.
• Labor saving after initial installation.
• Better on high value specialty crops than traveling gun (Amend. NJ1, 2005).

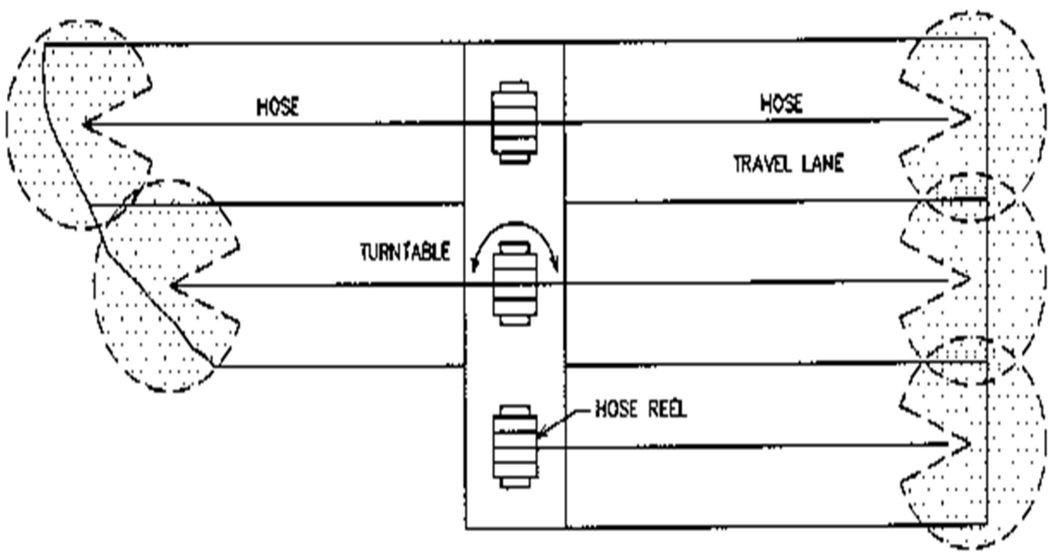

Fig 2.17. diagram showing Traveling Boom type sprinkler systems

Linear Move Sprinkler System:
A linear move sprinkle system is a continuous, self moving, straight lateral that irrigates a rectangular field. It is similar to the center pivot in that the lateral is supported by trusses, cables, and towers mounted on wheels. Most linear move systems are driven by electric motors located in each tower or is hydraulic driven. A self aligning system is used to maintain near straight line uniform travel. One tower is the master control tower for the lateral where the speed is set, and all other towers operate in start-stop mode to maintain alignment. A small cable mounted 12 to 18 inches above the ground surface along one edge or the center of the field guides the master control tower across the field. variety of sprinkle or spray heads. Drop tubes and low pressure spray heads located a few inches above the ground surface or crop canopy can be used instead of sprinkler heads attached directly to the lateral (Amend. NJ1, 2005)..

Advantages:
• The entire field is irrigated.
• High application uniformity because the laterals are nearly continuously moving.
• Chemigation can be practiced.

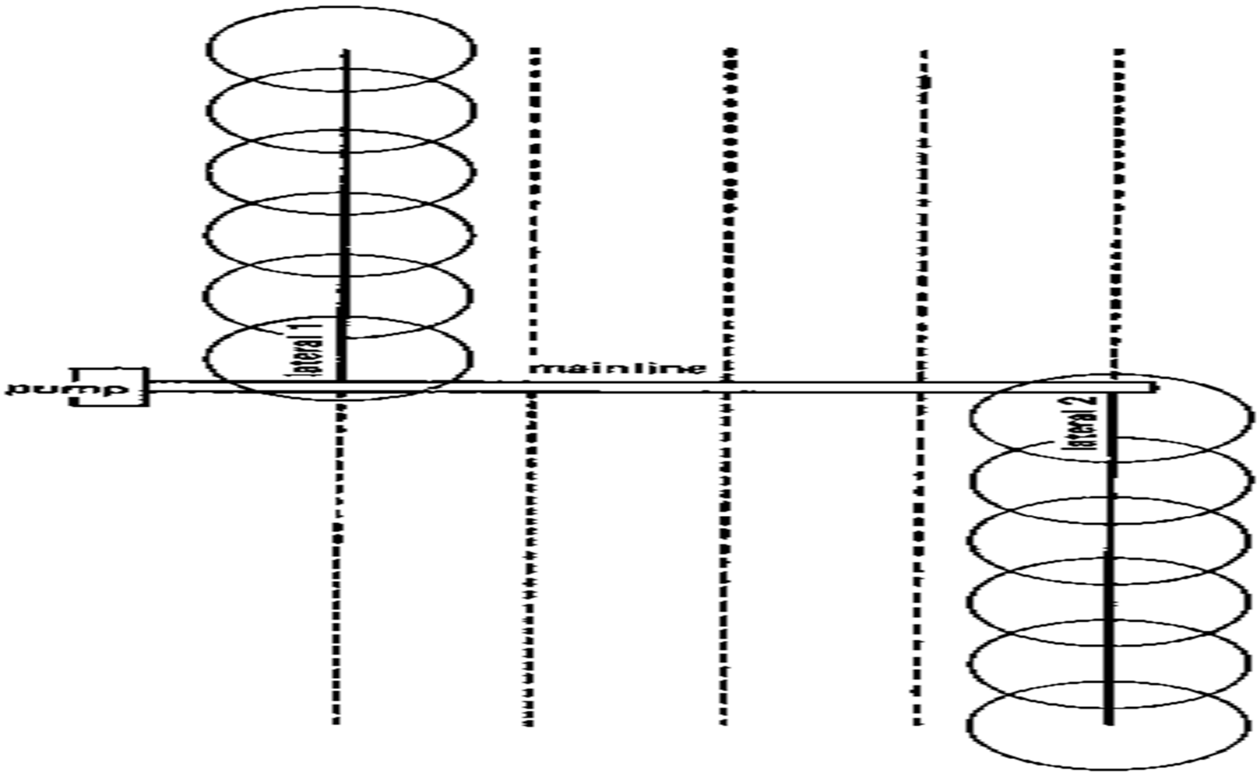

Fig 2.18.diagram showing linear – move system

CHAPTER THREE
Materials and Methods

3.1. Study Area

This is study was conducted at the Department of Agricultural Engineering- College of Agricultural Studies- Sudan University Science and Technology (LAT:15^0 40 N Long: 32^0 32 E Alt:380m) ,on 2014 – 2015. The mean daily temperature is 29.3c^0, average maximum temperature is 47.3c^0 may while the minimum temperature is 5.5c^0in February. The mean relative humidity is 28% and shows some variation range from 16%in April to 45% in August. The average annual rainfall is about 147.5/mms. The average wind speeds is about 11m/s and increase to maximum in the not dry (April – May).(Shambat Meteorological Observatory Station-2010).

The Hydro cyclone was designed and implemented at the department workshop.

3.2. Principles Design

The contaminants which create clogging in an irrigation system will also cause problems for filters. The filtration system must be designed with the relevant flows and water qualities in mind. A filter system which is under specified will block quickly and require constant cleaning. A system which is heavily over specified will not only be excessive costly but may also under perform because the flow through the filter media is not sufficient to guarantee adequate back washing. The filtration system must be seen as a safeguard to protect the micro-irrigation equipment from clogging and to ensure that it continues to operate properly through its designed lifetime. It must be born in mind what it is designed to protect and select the filter to suit. For instance drip irrigation requires a higher level of filtration than does impact sprinklers – Refer to the later" Gravel Filter” section in the “Filtration” module.

Hydro cyclone filters mainly consist of two parts; a separator and a collector .The separator is formed by cylindrical and conical sections that are attached together. The cylindrical section has inlet and outlet pipes welded onto these sections with different outside diameters. Inlet pipes are attached to the cylindrical section tangentially in order to create the vortex. The length of vortex finder pipe depends on the size of the hydro cyclone and it is located on the centre line of the forces. Particles separated from the water are collected in chamber and then removed by the use of a valve.

The hydro cyclone filter. D_i, inside diameter of inlet pipe; D_o, inside diameter of outlet pipe; Dc, cylindrical section diameter of the filter; inside diameter of inlet pipe (D_i is considered to be equal to D_o since the inlet and outlet pipe diameters of the hydro cyclone used in experiments were the same). D_c, cylindrical section diameter of the filter; D_a, apex diameter of the conical part; L_c, cylindrical section length of the filter; C_L, conical section length of the filter body; J_C, length of the vortex finder pipe.

3.3. Materials

Many different materials are used in the construction of filters used today. It would be fair to say. That with the advancement of plastic technology a high proportion of filters is made of plastic materials. Traditionally filters were made of metal but the corrosive nature of some types of water led to a breakdown of filter bodies and inserts. Advantages of plastic units are:

a) That they can be more economical to purchase and maintain.
b) Their light weight makes them friendlier and easier to transport and install.
c) Normal agricultural water does not corrode them.

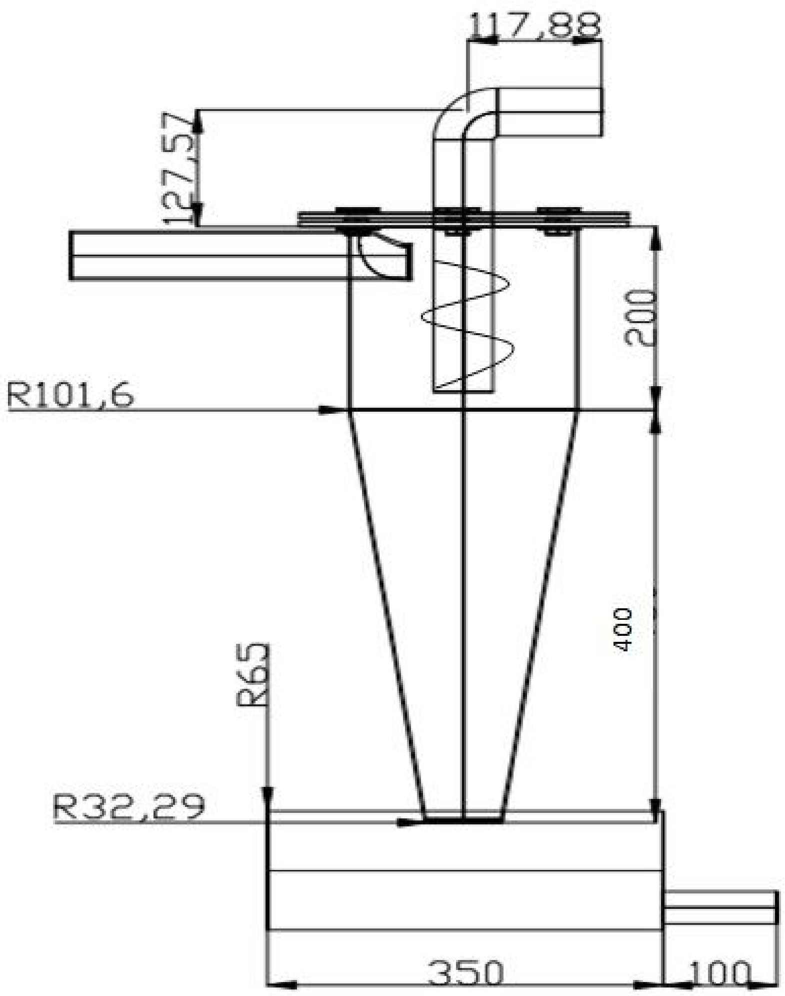

Fig 3.1.diagram showing hydro cyclone filter

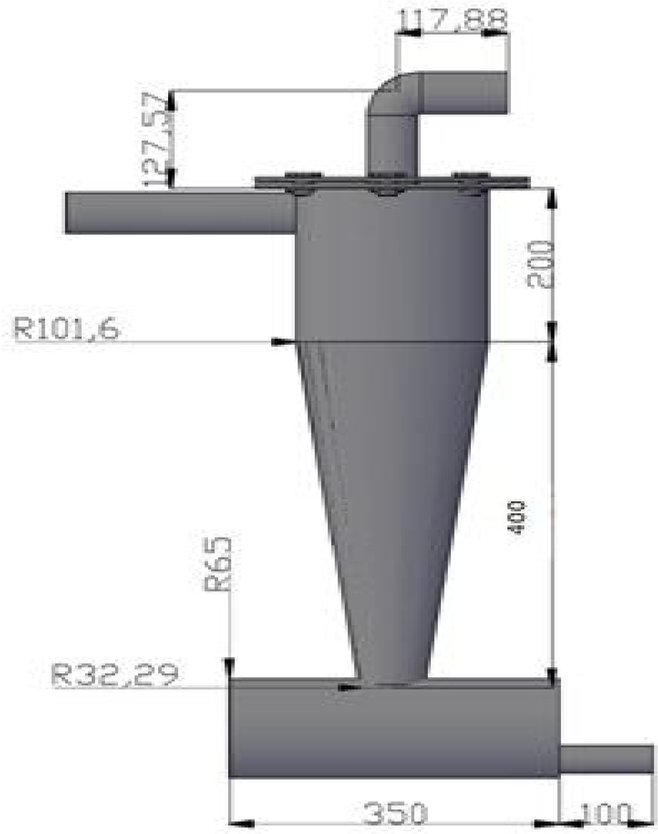

Fig 3.2. diagram showing hydro cyclone filter

3.4. Equipments and tools:

- Arc welding machine.
- Arc welding rods.
- Argon welding machine.
- Pipe bending implement.
- Drill.
- Grinding stone.
- Grinding disc.
- Cutting disc.
- Pipe wrench.
- Open end spanner.
- Two Inch pipe.
- 176 litters water reservoir.
- 500 ml measuring cylinder.
- Water turbidity device (spectrophotometer -Jenway 6305).
- Two Inch flow- meter.

- Two Inch centrifugal pump.

3.5. Proportional dimension:

D_C = 203.2 mm.

$D_I = D/4$ ……………………………………………….. (3.1)

$D_O = D/4$ ……………………………………………….. (3.2)

$L_C = 1 * D_C$ ……………………………………………….. (3.3)

$Z_C = D_C * 2$ ……………………………………………….. (3.4)

$J_C = D/4$ ………………………………………………… (3.5)

$C_L = Z_C + L_C$ ………………………………………………… (3.6)

$\alpha = D_I/D_C$ or D_O/D_C …………………………………… (3.7)

Where:

$D_C \equiv$ Main body cylinder diameter.

$D_I \equiv$ Inlet pipe diameter.

$D_O \equiv$ Outlet pipe diameter.

$L_C \equiv$ Cylindrical length.

$Z_C \equiv$ Cone length.

$J_C \equiv$ Cone outlet diameter.

$C_L \equiv$ Total length.

$\Theta \equiv$ Theta (Degree of angle).

3.6. Specification dimensions of data design

Table No.12. Specification dimensions of data design

D_C (mm)	D_I (mm)	D_O (mm)	L_C (mm)	Z_C (mm)	C_L (mm)	θ (degree)	J_C(mm)	Flow (m^3/h)	Pressure (bar)
203.2	50.8	50.8	200	400	600	50	50.8	5.9	10

3.7. Determination Silt Load of Nile Water before and after Hydro cyclone Filtration:

a. Taking the size of the sample in the beaker and weighing it.
b. Place in oven at temperature 105 ° C for 24 hours.
c. Calculate the weight of silt load for the sample (gm/0.5liter).

Silt load(g/l) = Sample weight before - sample weight after. (3.8)

3.8. Determination of Nile Water Turbidity on 16/9/2015:

3.8.1. Equipment and tools used:

- 176 liters water reservoir.
- 0.5 liter measuring cylinder.
- Water turbidity device (spectrophotometer).

3.8.2. Experiment Measurement:

1. A 176 liters of Nile water samples were taken during flood season from Blue Nile Water.
2. Three 0.5litrs sample were taken from the reservoir.
3. Samples were shaken to keep silt suspended.
4. The samples were tested for turbidity using spectrophotometer device to determine water turbidity. Filtration test reading were given in (NTU).

3.3.9. Determination of the filtration level of the hydro cyclone:

Water samples were taken before and after filtration and turbidity level were measured as described before. Degree of turbidity in NTU was determined before and after filtration.

3.10. Determination of the hydro cyclone Filtration System Discharge:

3.10.1.Equipment and tools:

- Reservoir of 176 liters capacity.
- Two inch diameter centrifugal pump.
- Two inch diameter Connection pipes.
- Two horse power Electric motor.
- Two inch flow meter.
- Stop watch.

3.10.2(a).Experiment steps:

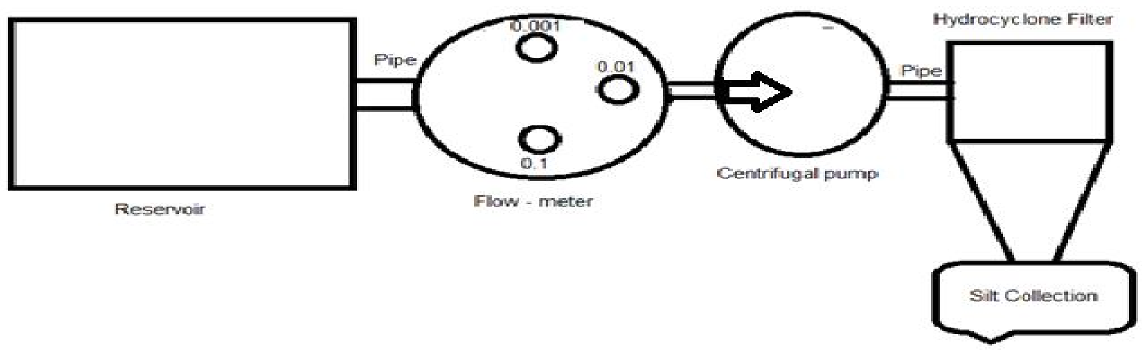

Fig 3.3. Filtration device diagram

The turbid agitated Nile water was pumped from the reservoir by a two inch centrifugal pump, through the hydro cyclone device. To be poured in the drain.

Discharge was determined from flow-meter readings and checked by volumetric discharge measurement.

Filtered water was collected in a176 liters container.

The flow time was recorded by stop water.

Discharge =$Volumecollected/Time$ …………………………(3.9).

Water volume collected= 49.7 liters.

Time = minute.

Discharge (Q) = 49.7/1= 49.7liter/min.

3.10.2(b). Experiment steps:

The turbid agitated Nile water was pumped from the reservoir by a two inch centrifugal pump, though the hydro cyclone device. Discharge was determined from flow-meter readings.

Discharge (Q) = 5.9 m^3/h = 5900 l/h =98.3 l/min.

3.11. Silt Collection Cylinder Cleaning Interval:

Cleaning time = Volume of the cylinder /silt collected per hour ………………………..(3.10)

Volume of the cylinder =1092 cm^3.

One Liter from Nile water contents 6.6 grams.

Q = 98.3 (l/min)*6.6 gram contents 943.9 grams.

Silt collection cylinder per hour = 943.9 grams

Cleaning Time = 943.9/1092= 0.864 minute.

3.12. Determination of the filtration Rate of the hydro cyclone using simulated one kilo gram (kg) silt load water:

1. One kilo gram of silt was mixed in 176 liters of water.
2. The mixture was well stirred.
3. Three 0.5liters sample were taken from the mixture.
4. The water samples were tested for turbidity by spectrophotometer device to determine water turbidity.

3.13. Determination of the filtration level of the hydro cyclone:

Samples were taken before and after filtration and turbidity level was measured as described before. Degree of turbidity in parts per million was determined before and after.

3.14. Determination of the filtration capacity of the hydro cyclone using simulated silt load water kilo and half (1.5 kg):

The same procedure was followed with regarded to the 1.5 kilo gram samples.

3.15. Determination of the filtration level of the hydro cyclone for the simulated silt load:

Samples were taken before and after filtration and turbidity level was measured as described before. Degree of turbidity in parts per million was determined before and after.

3.16. SPSS for Windows:

SPSS for Windows is a widely used statistical package of computer programs designed to generate descriptive statistics and to perform inferential statistical analyses, it provides a wide variety of data manipulation capabilities, file creation, graphics, and reports in addition to both simple and highly complex statistical procedures. Output comes with helpful plot/chart/graphics information. (Computer Services 2001).

CHAPTER FOUR

Results and Discussion

Table 4.1.Percent Silt Removed from Nile water after hydro cyclone filtration

NO	Silt Concentration Before(gm/l)	Silt Concentration After (gm/l)	Silt removed(gm/l)	Percent Silt removed
1	8.6	2.0	6.6	76
2	8.7	2.0	6.7	77
3	8.7	2.0	6.8	77
Av	8.6	2.0	6.6	76

The table shows silt concentration in Blue Nile Water before and after Hydro cyclone Filtration and percent silt removed.

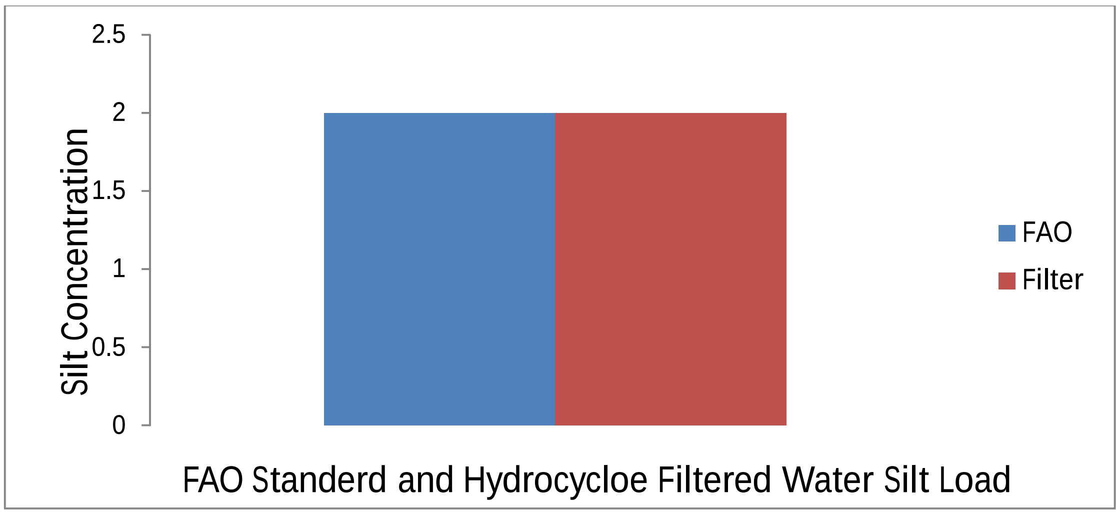

Fig 4.1 Comparison allowable silt concentration in irrigation water as published in FAO: Irrigation Water Management: Introduction to irrigation.2013 is 2.0 gm/l.

Silt load in Blue Nile water after hydro cyclone filtration is equivalent to the allowable silt load for modern irrigation systems as stated by FAO.

Table 4.2. The statistical analysis (t-test) result of the silt concentration in Blue Nile Water before and after Hydro cyclone Filtration.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	95% Confidence Interval of the Difference: Upper			
Pair 1	Before - After	6.63333	.05774	.03333	6.48991	6.77676	199.000	2	.000

Statistical analysis using pair t-test table (4.2) reveals high significant differences between silt concentration before and after.

Table 4.3. Percent remove simulated silt load(simulation one and simulation two)

Percent remove simulated silt load (simulation one)					Percent remove simulated silt load (simulation two)			
NO	Silt Concentration Before(gm/l)	Silt Concentration After (gm/l)	Silt remove (gm/l)	Percent Silt removed %	Silt Concentration Before(gm/l)	Silt Concentration After (gm/l)	Silt remove(gm/l)	Percent Silt removed %
1	6.3	2.7	3.9	61%	8.6	3.6	5.4	41%
2	6.5	2.4	3.9	60%	8.6	3.8	5.4	44%
3	6.6	2.5	3.9	59%	8.8	3.8	5.5	43%
Av	6.4	2.5	3.9	60%	8.6	3.7	5.4	42%

The table shows Silt Concentration in (gm/l) before and after filtration for simulation (one and two) and percent silt removed .

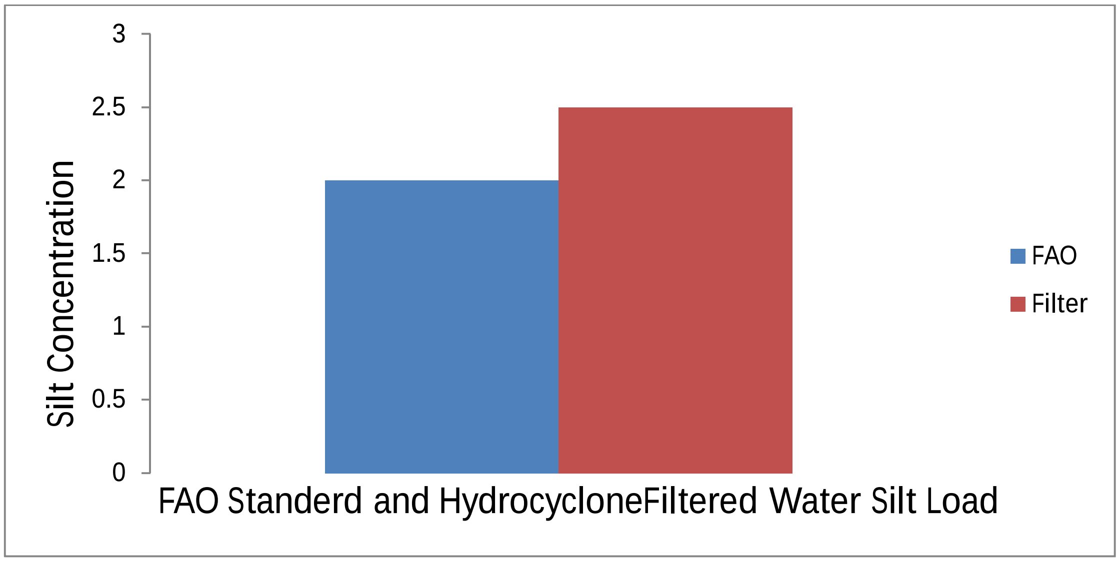

Fig 4.2 Comparison between allowable silt load in irrigation water and simulation one

The allowable silt concentration in irrigation water(simulation one) is 6.4 gm/l.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Before - After	3.93333	.28868	.16667	3.21622	4.65044	23.600	2	.002

Statistical analysis using t-test table (4.4) reveals high significant differences between silt concentration before and after filtration.

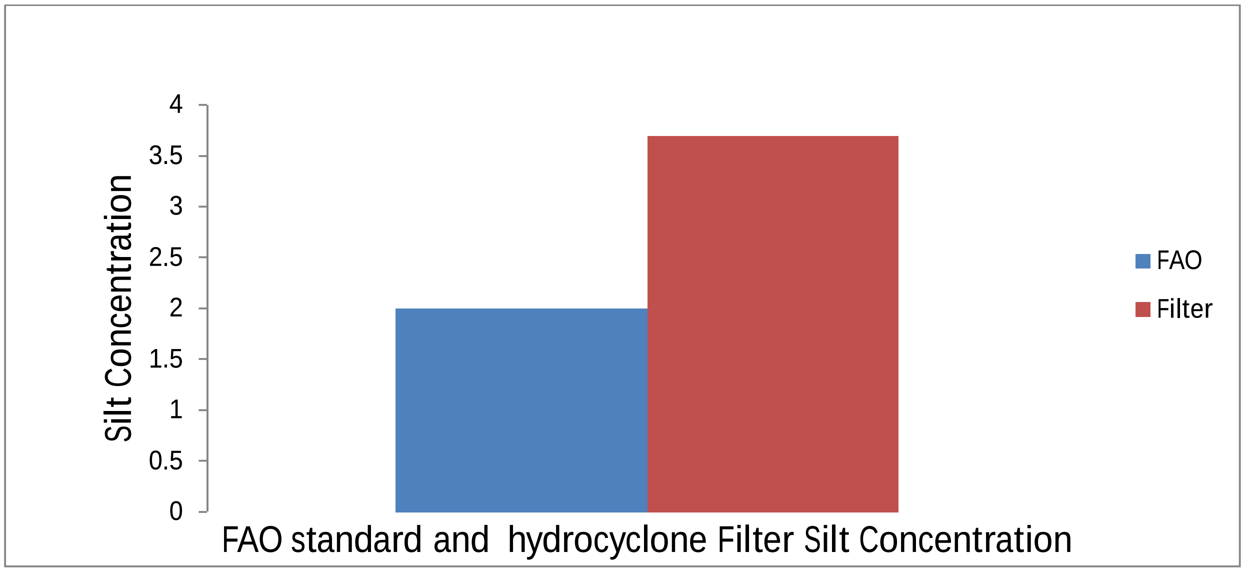

Fig 4.3 Comparison allowable silt concentration in irrigation water (simulation two) (8.6 gm/l).

The allowable silt concentration in irrigation water(simulation two) is 8.6 gm/l.

For simulation one and two the silt load in Blue Nile water after filtration is slightly higher than allowable standards and this is attributed to the fact the soil samples used in simulation contain higher portion of clay particles which are less subject to centrifugal separation. Clay content(45%).

Table 4.4. The statistical analysis pair (t-test) of the simulated silt load before and after Hydro cyclone Filtration.

Table 4.5. The statistical analysis (t-test) of the simulated silt load before and after Hydro cyclone Filtration.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Before - After	4.90000	.10000	.05774	4.65159	5.14841	84.870	2	.000

Statistical analysis using pair t-test table (4.6) reveals high significant differences between silt concentration before and after filtration.

Table 4.6. Level of turbidity before and after filtration for Blue Nile Water.

No	Turbidity before filtration	Turbidity after filtration	Different between before and after filtration	Percent Turbidity difference level
1	3.2	1.7	1.4	54%
2	3.1	1.7	1.4	54%
3	3.1	1.6	1.4	54%
AV	3.1	1.7	1.4	54%

The table shows the turbidity level of the Blue Nile water before and after the hydro cyclone filtration in September.

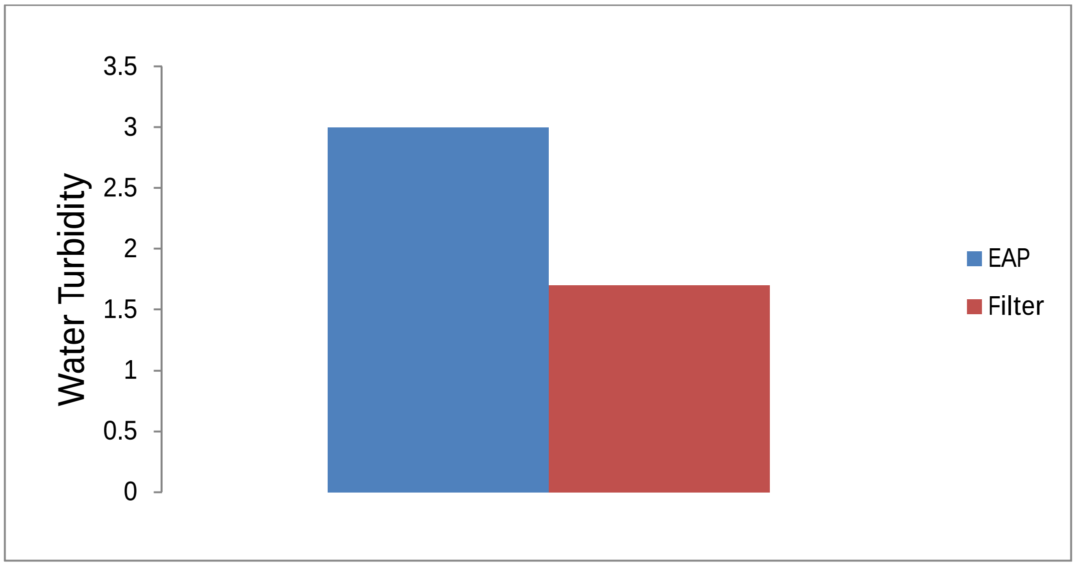

Fig 4.4 Comparison between water turbidity level in Blue Nile water after hydro cyclone filtration and United Stated Environmental Protection Agency Standard(EAP)

The allowable water turbidity in irrigation water as adopted by EAP and the average water turbidity in hydro cyclone filtered Blue Nile water.

As to turbidity readings hydro cyclone filtered Blue Nile water showed better results. This may be attributed to the nature of the suspended particles and soluble materials.

Table 4.7. The statistical analysis (t-test) of the water turbidity before and after Hydro cyclone Filtration.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	95% Confidence Interval of the Difference Upper			
Pair 1	Before - After	6.43333	.37859	.21858	5.49285	7.37381	29.432	2	.001

Statistical analysis using pair t-test table (4.8) reveals significant differences between water turbidity before and water turbidity after**.**

Table 4.8.Turbidity Level in simulated silt load (one and two)before and after hydro cyclone filtration:

	Turbidity Level in simulated silt load (one)				Turbidity Level in simulated silt load (two)			
No	Turbidity before filtration	Turbidity after filtration	Different between before and after filtration	Percent Turbidity difference level %	Turbidity before filtration	Turbidity after filtration	Different between before and after filtration	Percent Turbidity difference level %
1	3.0	1.7	1.3	56%	3.1	1.7	1.3	43%
2	3.0	1.7	1.3	56%	3.0	1.7	1.3	43%
3	2.9	1.6	1.3	54%	3.0	1.7	1.3	43%
AV	3.0	1.6	1.3	55%	3.0	1.7	1.3	43%

The table shows the level of turbidity when using the simulated silt load(one and two) before and after the hydro cyclone filtration.

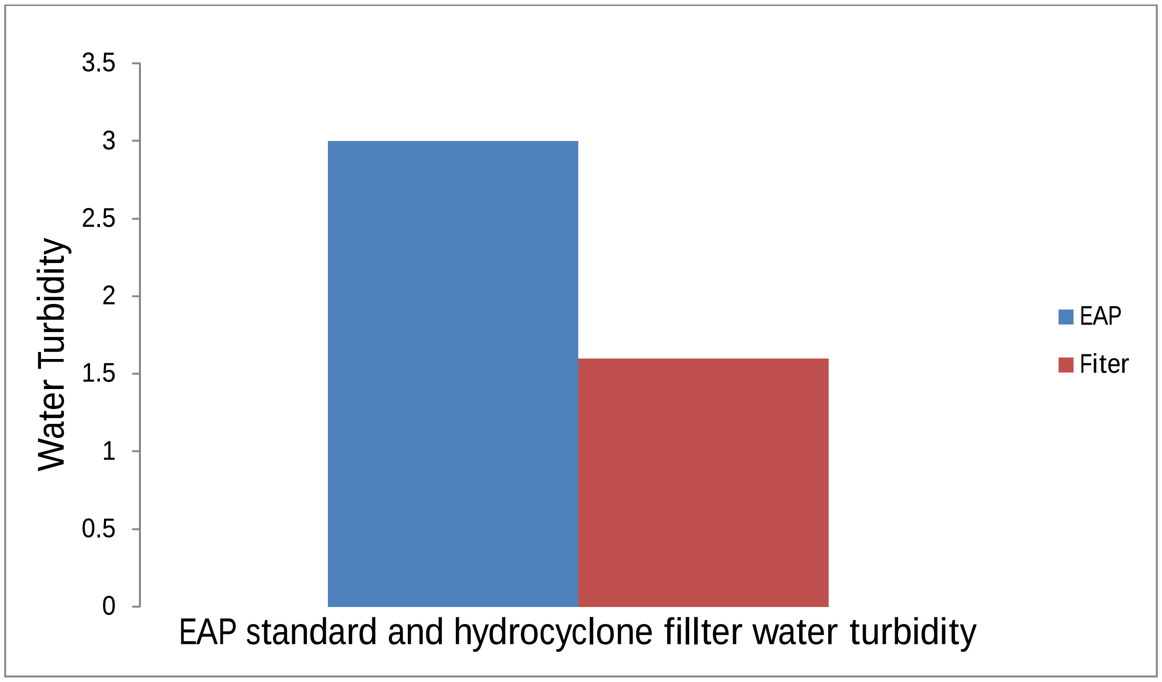

Fig 4.5 Comparison between water turbidity level (simulation one) after hydro cyclone filtration and United Stated Environmental Protection Agency Standard(EAP)

The allowable water turbidity in irrigation water as adopted by EAP is 3.0 Nephelometric Turbidity Unit (NTU) and the average water turbidity in hydro cyclone filter in(simulation one)1.6(NTU).

As to turbidity readings hydro cyclone filtered water turbidity simulation showed better results. This may be attributed to the nature of the suspended particles soluble materials.

Table 4.9.statistitical analysis using pair t-test reveals highly significant differences between water turbidity before and after filtration.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Before - After	1.46667	.05774	.03333	1.32324	1.61009	44.000	2	.001

Table 4.12. The statistical analysis (t-test) of the water turbidity simulated silt load(one) before and after Hydro cyclone Filtration.

The table shows the level of turbidity when using the simulated silt load(two) before and after the hydro cyclone filtration.

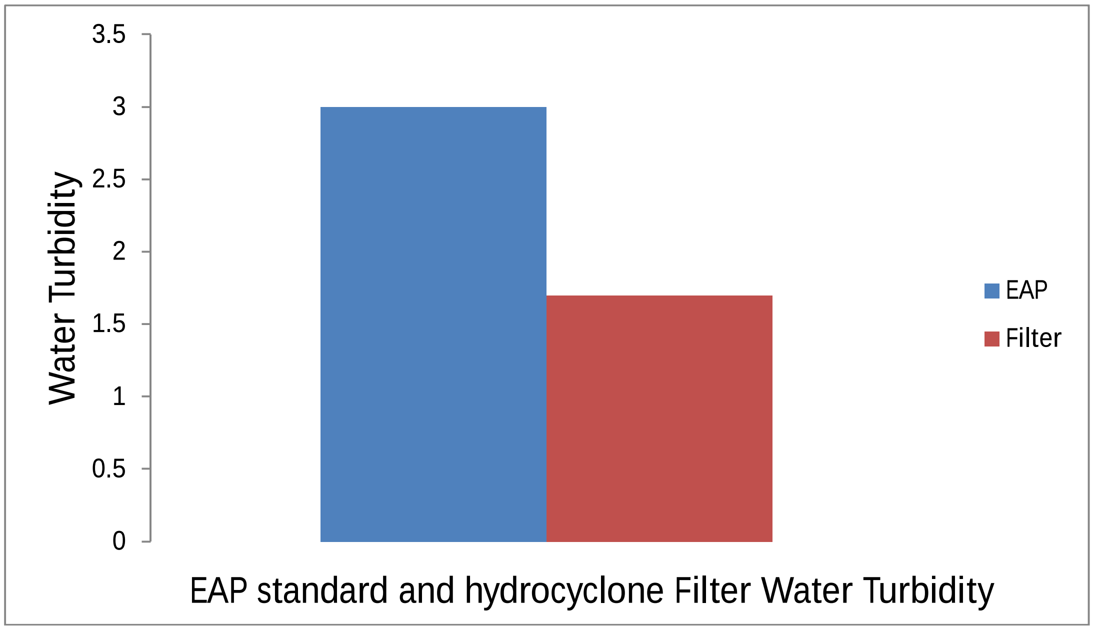

Fig 4.6. Comparison between water turbidity level simulation(two) after hydro cyclone filtration and United Stated Environmental Protection Agency Standard(EAP).

The allowable water turbidity in irrigation water(simulation two) is 1.7 NTU as adapted by EAP and the average water turbidity in hydro cyclone filtered. As to turbidity readings hydro cyclone filtered water turbidity simulation showed better results. This is can be attributed to the nature of the suspended particles.

Table 4.10. The statistical analysis (t-test) of the water turbidity simulated silt load(two) before and after Hydro cyclone Filtration.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Before - After	1.33333	.05774	.03333	1.18991	1.47676	40.000	2	.001

Statistical analysis using pair t-test table (4.10) reveals high significant differences between water turbidity before and after**.**

CHABTER FIVE

Conclusion and Recommendations

5.1.CONCLUSION

Silt load in the Blue Nile water during the flood season is high silt concentration in Blue Nile water during this time reached an average of 8.6 gm/l, while the allowable silt load as reported by FAO 2.0 gm/l . This is facted necessitate is process of filtration to avoid problem associated with silt load filtration can be done in many methods of which the simplest and chap rest is hydro cyclone centrifugation.

4.2. RECOMMENDATIONS:-

1. The results of this is study reveals that a locally designed and constructed hydro cyclone filter can effectively mead this required.
2. The geometry of the filtration model is one of areas that can be subjected to further research as the studied model followed the most common used dimensional proportions.
3. The separation efficiency for the smallest soil particles in the irrigation water is still a challenge to be overcome.
4. The two inches designed model inlet and outlet total cost was 2610 SDG , while the two inches inlet and outlet imported filter total cost was 3499 SDG.
5. Further research on the particle size distribution of the separated material and the particle size which could not be separated is recommended.

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APPENDIX (A)

Table (4.2) The statistical analysis (t-test) of the Silt Concentration in Blue Nile Water between before and after Hydro cyclone Filtration.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Before	8.6333	3	.05774	.03333
	After	2.0000	3	.00000	.00000

.

Table (4.4) The statistical analysis (t-test) of the simulated silt load between before and after Hydro cyclone Filtration.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Before	6.4667	3	.15275	.08819
	After	2.5333	3	.15275	.08819

Table (4.6) The statistical analysis (t-test) of the simulated silt load before and after Hydro cyclone Filtration.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Before	8.6667	3	.11547	.06667
	After	3.7667	3	.05774	.03333

Table (4.9) The statistical analysis (t-test) of the Blue Nile water turbidity before and after Hydro cyclone Filtration.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Before	8.4333	3	.37859	.21858
	After	2.0000	3	.00000	.00000

Table (4.11) The statistical analysis (t-test) of the water turbidity before and after Hydro cyclone Filtration.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Before	2.9667[a]	3	.05774	.03333
	After	1.6667[a]	3	.05774	.03333

a. The correlation and t cannot be computed because the standard error of the difference is 0.

Table (4.3) The statistical analysis (t-test) of the water turbidity before and after Hydro cyclone Filtration.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Before	3.0333	3	.05774	.03333
	After	1.7000	3	.00000	.00000

Appendexs(B)

Screw Digram

Hydro cyclone Diagram

Appendexs(c)

Spetecrophotometre Device

Flow-meter Device

Argon Welding Machine