RESADE

Improving Agricultural Resilience to Salinity Through the Development and Promotion of Pro-Poor Technologies

Technical Hands-on training on the drip irrigation system

Prepared by

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RESADE project

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Investing in rural people

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AGRICULTURE FOR TOMORROW

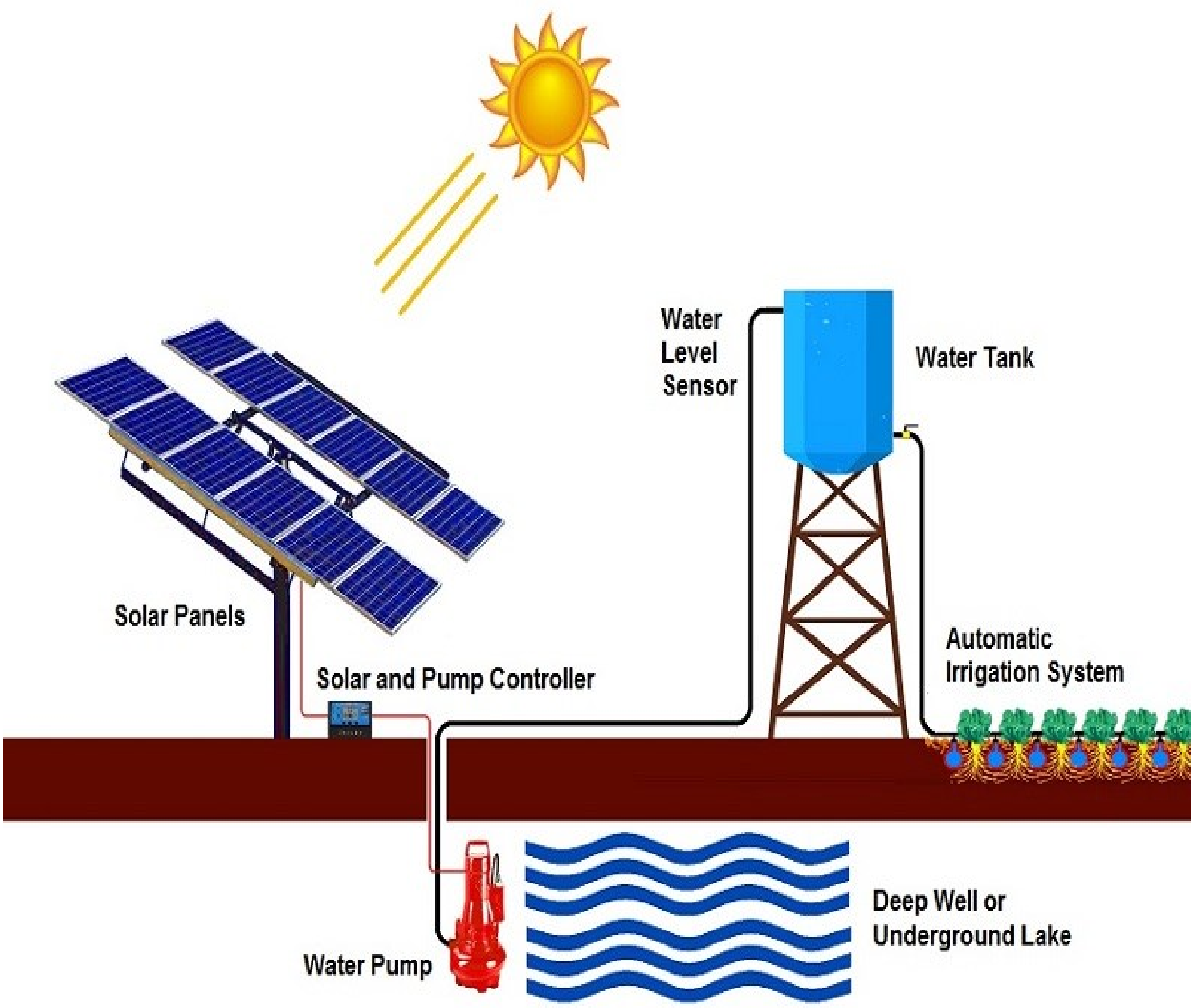
Contents

1- Small scale irrigation system

Small scale irrigation system design based on water availability, source of water and local crop water requirements. Main principle of this technique is to use the green energy to pump the water (from well or other source) to irrigate the farm. Solar energy is an abundant resource, especially in the regions were

- Rainwater scarcity makes irrigation essential to food security and international trade.
- Poor access to reliable electricity or fossil fuel supplies (in remote rural areas).

A solar based irrigation system supplies power to the pump, which delivers water either directly into an irrigation system or to an elevated reservoir.



System Configuration:

The most common configuration is when solar panels are installed on a fixed mounting structure provides electricity for a submersible pump installed in a borehole. The water is then pumped to a reservoir elevated to a specific height, where it is stored at a constant pressure. The reservoir provides stable pressure and water supplies to the drip irrigation system in order to make water distribution as uniform as possible. The performance of drip irrigation decreases when the drippers get clogged by small particles in the water. Filters prevent this, but only when properly designed for the particular water quality and irrigation system and regularly cleaned.

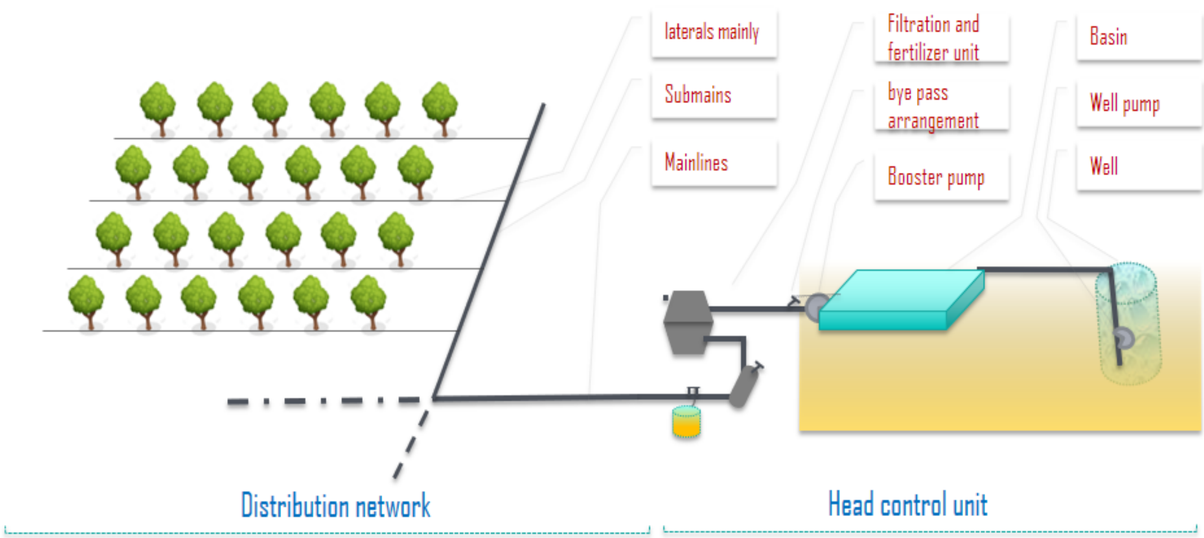
It is strongly recommended to use the filters when using surface water (i.e. from rivers or open reservoirs). Furthermore, it is recommended to have a monitoring system installed between the pump and the reservoir to measure the water flow and pressure.

Advantages of drip irrigation system:

- Minimum maintenance
- Maximum reliability
- Water saving as well as resource efficiency
- Minimum conveyance, application & evaporation losses
- Less manpower required

2- Components of drip irrigation system (small scale irrigation system)

The drip irrigation system can be grouped into two main parts: 1) head control unit, and 2) distribution network. The water audit aims to check the functionality of all parts of the irrigation systems with more focus on the distribution network and the drippers.



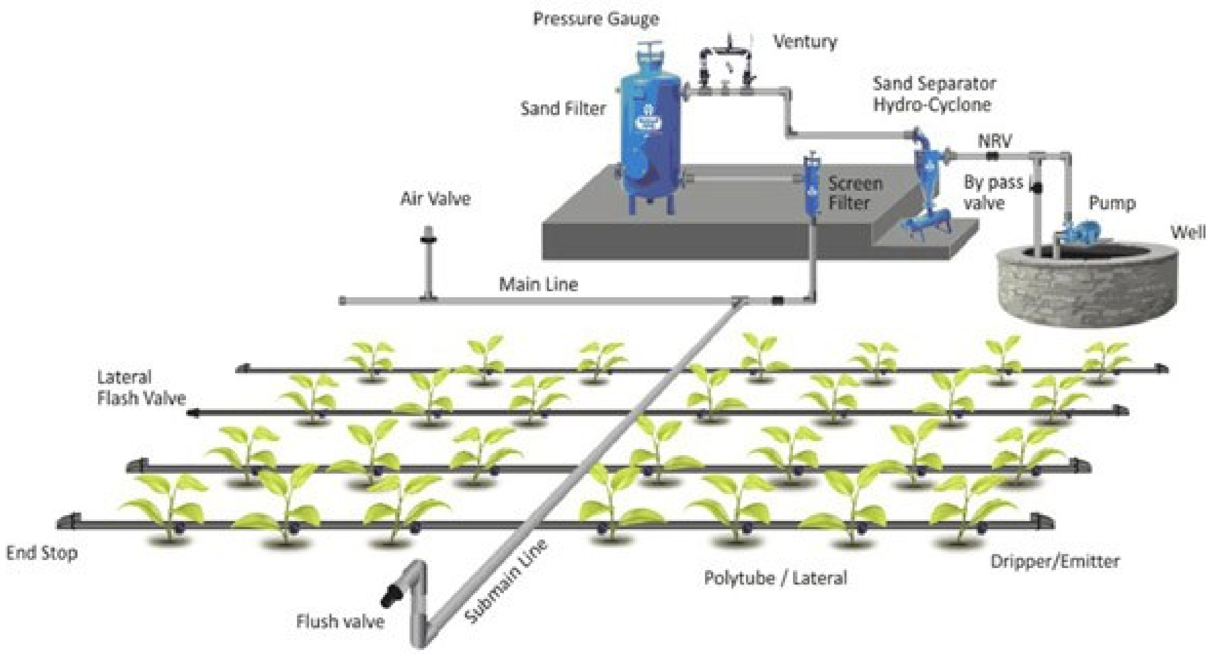


Figure 1: Components of the drip irrigation system

Head control unit

The head control unit consists of wells, bonds, and pumps. In addition, a fertilizer unit is an essential component in the advanced irrigation system. The fertigation can be done through different methods: by-pass pressure tank, venturi injector, or direct injection system.

Filters

Filters are an essential component that should be used to avoid the risk of blocking or clogging in the drip irrigation system. The filtration must be designed according to the irrigation system and the size of the holes and drippers that each system has. Filtration is essential when the water source for irrigation comes from open bonds. It is generally recommended to consider the filtration characteristics when designing the diameter of the irrigation drippers' holes. The local specific conditions and water characteristics such as salt, algae, minerals, and on top of all fish-residuals need to be considered. Also, weather conditions such as wind speed may cause problems. Therefore, the following considerations should be taken when designing the filtration system:

- Mineral’s content: iron, sulfur...
- Suspend Solids like limestone
- Algae bloom: Algae and salts are secondary clogging.
- Water currents -Winds

According to the factors mentioned above, selecting the right filter system is site-specific.

It is recommended to install a sedimentation tank before the pumping unit which could be the first level of filtration. It is recommended to use a sand filter where the organic matter content of the water is high. This type of filtration is highly required for irrigation water from open water reservoirs in which algae may develop. Meanwhile, the sand grains' dimensions should be chosen according to the size of the emitter orifice.

While the sand filter filters most impurities, fine sand particles and other minute impurities pass through it. Therefore, a disk filter should be installed, and it is instrumental in the filtration of organic material and algae, with a manual or automatic backflushing to clean the disk filters.

After the sand filter, screen filters can be added as additional protection from possible clogging.

Besides, products that keep the irrigation lines clean and avoid clogging are recommended. Generally, farmers can use acid to reduce chemical and physical clogging plus chlorine to avoid biological clogging and other available and confirmed products.

Distribution network

The distribution network constitutes essentially by mainline, submains line, and laterals with drippers:

Mainline:

The main pipeline transfers the total amount of water for the irrigation system. In addition, it connects the various sub-networks to a water source. Mainline are usually made of flexible materials such as PVC (polyvinyl chloride), plastics, or high/low-density polyethylene (HDPE/LDPE) pipes. The main pipe carries water from the filter unit to the main branch pipe. The diameter of mainline depends upon the location of water supply's source, Irrigation system flow rates & the size of pumping unit to be used. The pipe material is selected based on the local climatic condition, installation type & area of application. High density polyethylene pipe is highly recommended if pipes are going to be installed on surface because PVC pipe started deteriorating when it comes in contact with sun light & UV rays.

Usually 2-5inch diameter pipes uses as mainline for the farmer applications & 6-12inch pipe for commercial applications.

Figure 2: polyvinyl chloride (PVC), plastics, or high/low-density polyethylene (HDPE/LDPE) pipes used for the Main and Sub mainline

Sub main lines:

feed the laterals. It can be made with high-density or low-density polyethylene (PE) or PVC of 2 to 4 inches diameter. Sub mains size should consider the rate of discharge, the number of sub-mains in the networks and the friction losses in the pipes. The main pipeline and the secondary pipeline should be installed in a hierarchy from the largest to the smallest diameter

Tertiary lines:

Usually, the farmers use laterals pipes with 13 to 19mm diameter with thickness varying from 1 to 2 mm according to the availability of water from the source, crop water requirement, and spacing. The laterals are usually made up of low-density polyethylene (LDP) or linear low-density polyethylene (LLDPE).

Figure3: Dripline installation at different fields ICBA research station and RESADE BPH

Drippers:

Emitters/Drippers discharges water from the tertiary/drip pipe to the soil. Pressure compensating (PC) drippers are always preferring to use. There are two main type of PC drippers. Online PC drippers (online PC drippers installed manually on drip tube) & inline PC drippers (integrated in the drip tube) to ensure uniform flow rate on long rows distances and uneven slopes.

Figure 4: Example of Inline Dripper Online Dripper (a: pressures compensating online emitters (24 liters/hour) and (b) Virojet system (140 liters/hour)).

Pressure gauge:

it is a critical part of the irrigation system. It helps control the pressure in the system to ensure that the pressure is within the operational range of different parts of the system, mainly the emitters. Therefore, we can ensure efficient water usage with the water pressure gauges

Controls Valves:

we needed to control water flow. They made up of plastic and iron material

Example of valves used in the irrigation system

DIFFERENT TYPE OF IRRIGATION FITTINGS & THEIR INSTALLATION

gate valve

solenoid valve

PE PP valve compression fittings

PVC Ball Valve

Example of PP compression fittings for the irrigation system using PP pipes

Tee

Reducing Tee

Female Tee

Male Tee

Coupler

Elbow

Male Elbow

Male Adopter

Reducer

Female Elbow

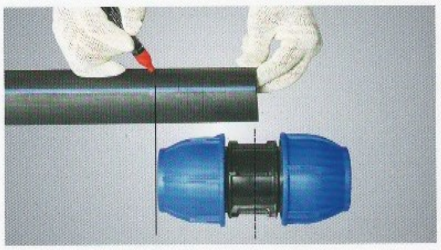
Female Adopter

End Cap

Example of PP compression fittings assembly

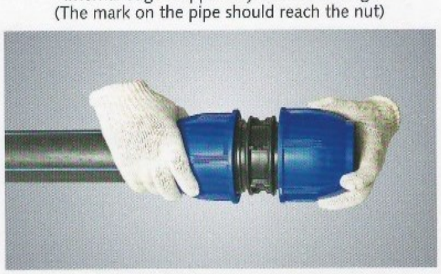
20 mm to 63 mm

Release the coupling nut almost to the thread. Do not remove it completely.



Make the insertion deep on the pipe

Push the pipe into the fitting until it reaches the internal edge stopper beyond the 'D' ring. (The mark on the pipe should reach the nut)



Tighten the nut manually

75 mm to 110 mm

Unscrew the fitting. Insert the grip ring, thrust ring and the O-ring on pipe

Tightened the nut

Unscrew the nut & insert grip ring

Tighten the nut manually

Finally Tighten nut with spanner.

Source: captain

Example of PVC fittings for the irrigation system using PVC pipes

PVC ELBOW

PVC TEE

PVC COUPLER

PVC REDUCING BUSH

PVC MALE ADAPTOR

PVC FEMALE ADAPTOR

PVC UNION

PVC REDUCER

PVC CEMENT GLUE

INSTALLATION OF PVC FITTINGS

Example of compression fittings for the irrigation system using LDPE pipes

PE COUPLER

PE ELBOW

PE ENDSTOP

PE CLIP

LDPE PIPE

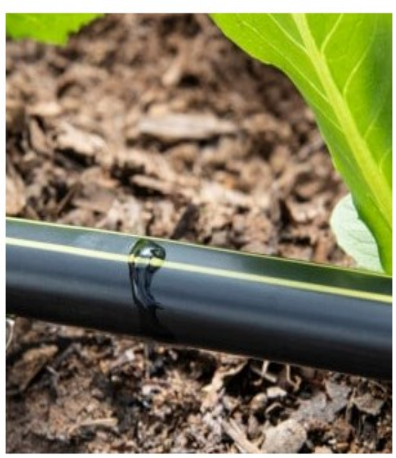
Example of Grommet fittings & installation

GROMMET FITTINGS & INSTALLATION

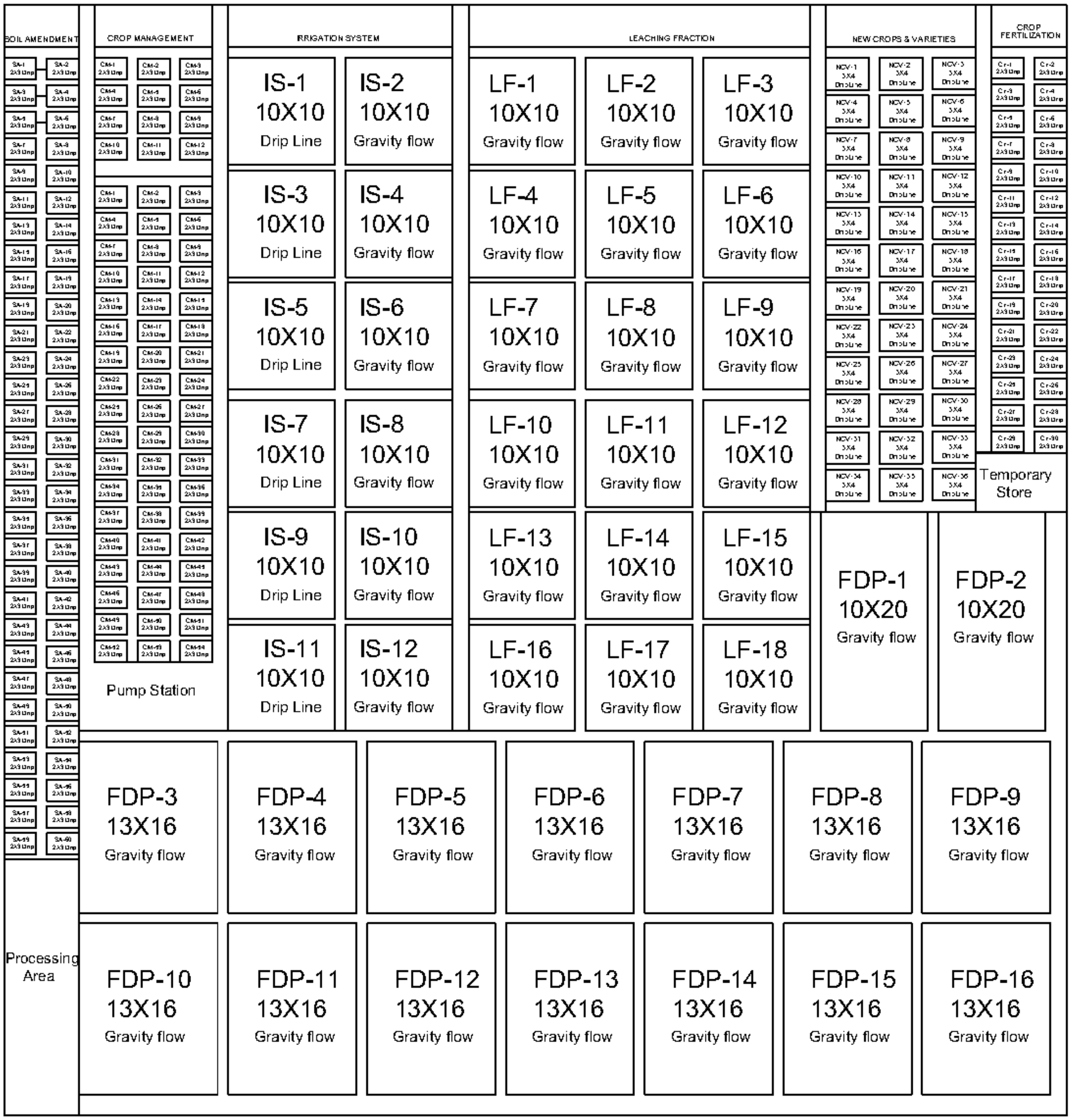
Different types of drippers

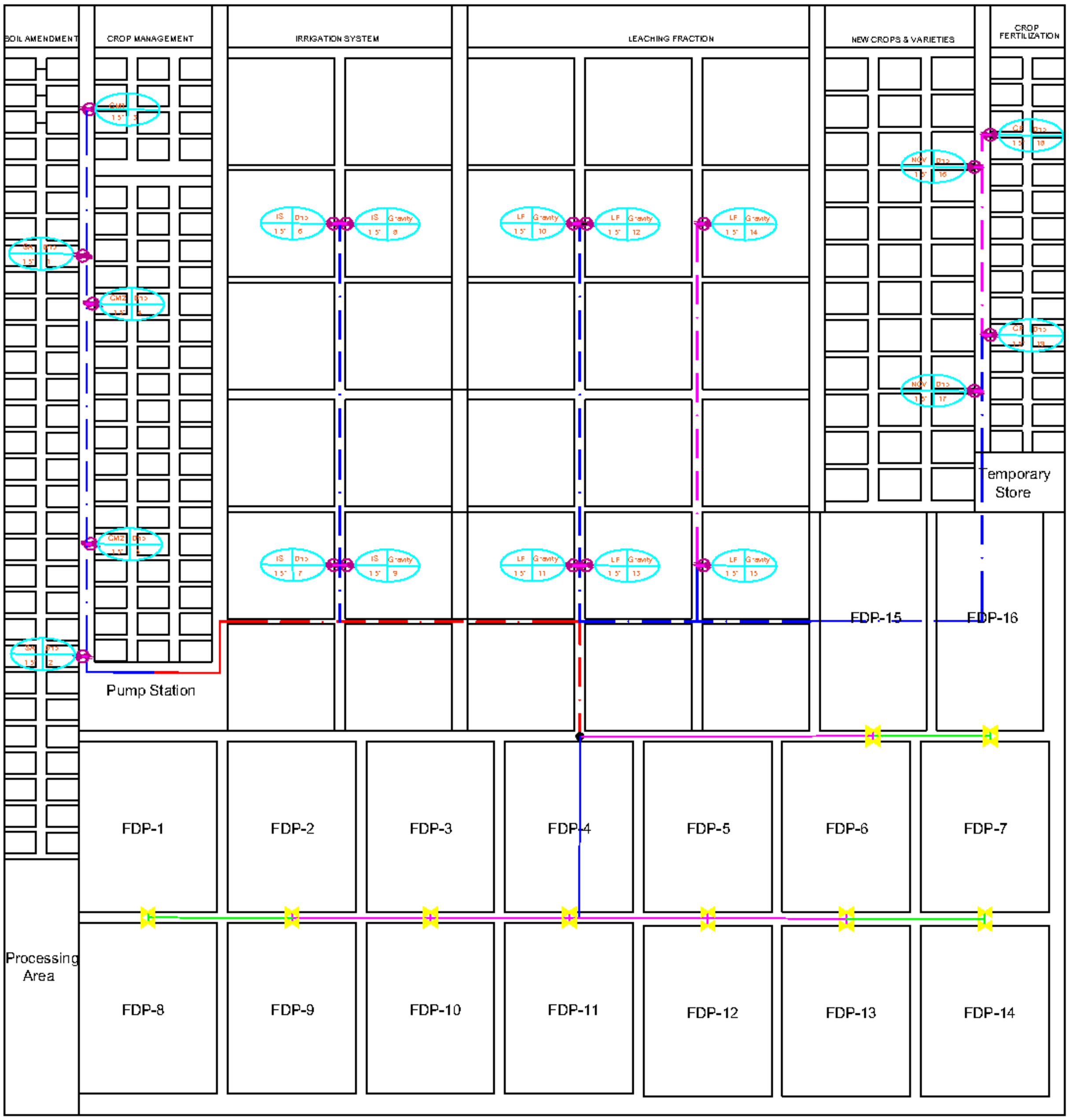




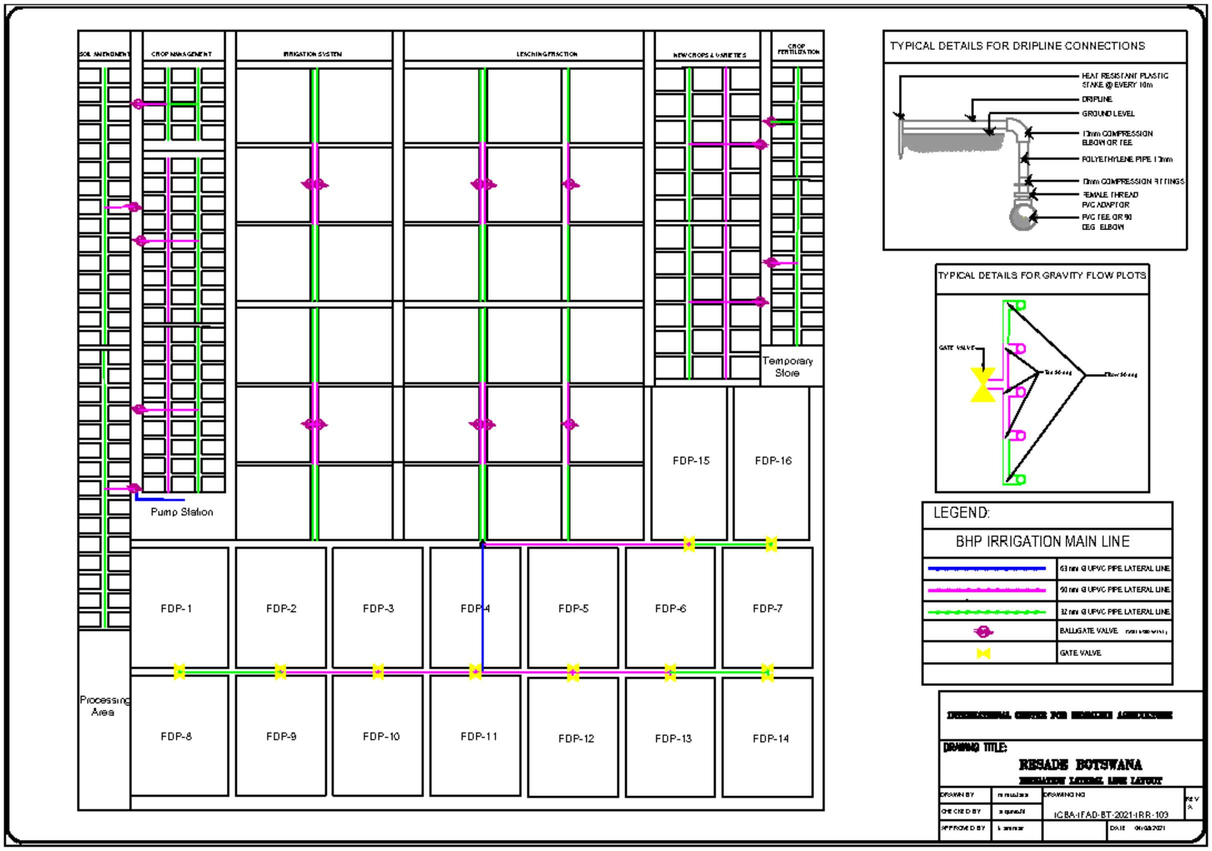




3- Best practices Hub (BHP) Irrigation design/ small scale irrigation system





SOIL AMENDMENT
CROP MANAGEMENT
IRRIGATION SYSTEM
LEACHING FRACTION
NEW CROPS & VARIETIES
CROP FERTILIZATION
Temporary Store
FDP-15
FDP-16
Pump Station
FDP-1
FDP-2
FDP-3
FDP-4
FDP-5
FDP-6
FDP-7
Processing Area
FDP-8
FDP-9
FDP-10
FDP-11
FDP-12
FDP-13
FDP-14



4- Design of Drip Irrigation System

Drip irrigation is one of the best irrigation system that allows applying water near plants' root zone with minimum water and energy loss. Application efficiency of well-designed installed & maintained drip irrigation system can be reached up to 90%. However, a water audit should be carried out regularly to achieve this objective.

Main steps to design/redesign drip irrigation system including Irrigation requirements

The design of a drip irrigation system is crucial for supplying the right amount of water at the right time for the plants. Daily irrigation needs to depend on the water the plant takes from the soil and the amount of water that evaporates from the soil near the root zone per day. Usually, Crop Water Requirement (CWR) is dependent on the canopy cover, particularly the leaf area, stage of growth, weather, soil conditions, etc.

Applying the required volume of water uniformly to all the trees in the field requires designing the system to maintain desired hydraulic pressure in the pipe network. The drip irrigation system's design includes a decision concerning the choice of emitters, laterals, manifolds, sub-main, main pipeline, and required pumping unit as well as an adequate assembly.

Usually, based on the results of the audit, a redesign of the drip irrigation network will be conducted which include but is not limited to:

Network layout

Crop water requirement

Hydraulic design of the system

Pump horsepower specification

The main steps for designing/redesigning a drip-irrigation system are:

Step 1: the maximum water requirement per day per unit area

It is crucial to know before starting to design or redesign the irrigation network, the maximum net depth of water application and the maximum water requirement per day per unit area.

Evapotranspiration of the crop (ET) = ET_0 x Crop coefficient

The volume of water to be applied= Area covered by each tree x Wetting fraction x ET

For more precise estimation, Irrigation requirements (IR)

$$IR = \frac{NWR}{Ea}$$

NWR: net water requirement, with:

$$NWR = A * Y * (FC - Wp) * D * \frac{P}{100}$$

Where: A= irrigated area; Y: Depleted moisture; FC: Field capacity; Wp: Wilting point; D: Effective root zone depth and P: Wetting fraction.

Ea: efficiency of the irrigation,

With Ea= Ks* EU

Where:

Ks is the volume of irrigation water stored in the root zone by volume of irrigation water delivered to the farm or field; it can be 1 for sand soil, 0.9 for loam soil, and 0.95 for clay soil.

EU: homogeneity of the dripper flow rate

Irrigation requirements under saline conditions.

$$Irrigation = \frac{(ET - effective\ \ precip)(1 + leaching\ req.)}{Application\ efficiency}$$

Leaching requirement for surface irrigation

$$LR = \frac{EC_w}{5\,ECe - EC_w}$$

Leaching requirement for drip system

$$LR = \frac{ECw}{2(\max ECe)}$$

Where:

ECw: salinity of the applied irrigation water in dS/m

ECe: average soil salinity tolerated by the crop as measured on a soil saturation extract to obtain the acceptable yield (for example, only 10% of yield reduction)

RESADE planned to provide Training on crop irrigation requirements, to determine the maximum crop water requirements is used, including the impact of the irrigation efficiency.

Also, a crop guide was developed by RESADE, and it contend crop water requirements for the introduced crops.

Step 2: Emitter design

The emitter flow will be chosen according to the actual crop water requirements for each plant/tree. Therefore, it is crucial to take into account the appropriate humidity area for each crop.

Depending on the soil hydraulic characteristics, the required soil moisture at the effective root zone. A low flow emitter can help keep water and fertilizer in the roots zone and avoid profound percolation loss.

Soil hydraulic characteristic:

Field capacity

Wilting point

Bulk density

Effective root zone depth

Wetting Percentage

Soil water properties from the Soil Water Characteristics software

In the absence of data on water content characteristics of the soil, namely θsat, θcc and θpfp, it is possible to estimate these values from the results of the soil particle size analysis based on the Pedotransfer Functions. One of the most used functions developed by Saxton et al. (1986 and 2005). The SPAW software developed by the USDA is based on these pedotransfer functions.

SPAW Hydrology software

SPAW Hydrology software can be downloaded from the following address:

https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/water/manage/drainage/?cid=stelprdb1045331

Otherwise, the installable **SPAW Hydrology Setup (6.02.70).exe** is provided during the workshop.

For the following exercise, we used the data of the laboratory soil analysis done at ICBA for soil samples collected from the PBH site in Togo and Liberia.

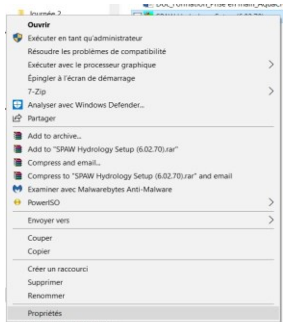
Table 1 : soil physical properties for BPH-Atti-Apedok-Togo, laboratory results

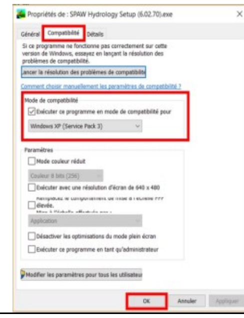
sample	depth	pH 1:1	EC 1:1 ms/cm	Clay %	Silt %	Sand %	% OM	%C
Togo1	0-20	5.14	0.243	8.352	22.6	69.048	2.02	1.17
Togo1	20-40	5.54	0.325	10.072	25.32	64.608	1.67	0.97
Togo1	40-60	5.63	0.494	15.992	21.12	62.888	2.46	1.43
Togo1	60-80	5.54	0.7	17.992	16.8	65.208	2.63	1.53
Togo1	80-100	5.18	1.016	24.672	16.48	58.848	3.50	2.03
Togo2	0-20	5.2	0.192	9.032	13.76	77.208	2.76	1.60
Togo2	20-40	5.5	0.088	8.192	11.6	80.208	1.62	0.94
Togo2	40-60	5.92	0.059	4.552	11.28	84.168	0.79	0.46
Togo2	60-80	5.96	0.094	17.232	9.52	73.248	2.60	1.51
Togo2	80-100	5.83	0.18	28.032	8.72	63.248	3.92	2.27

Tale : Soil physical properties for BPH-Liberia, laboratoty results

sample	depth	pH 1:1	EC 1:1 ms/cm	Clay %	Silt %	Sand %	% OM	%C
Liberia	0-20	4.05	0.041	1.35	6.64	92.008	2.51	1.46
Liberia	20-40	4.01	0.037	1.91	5.6	92.488	2.53	1.47
Liberia	40-60	4.19	0.03	4.19	7.44	88.368	3.15	1.83
Liberia	60-80	4.00	0.022	12.11	6.72	81.168	2.92	1.69
Liberia	80-100	3.96	0.021	13.07	5.48	81.448	2.57	1.49

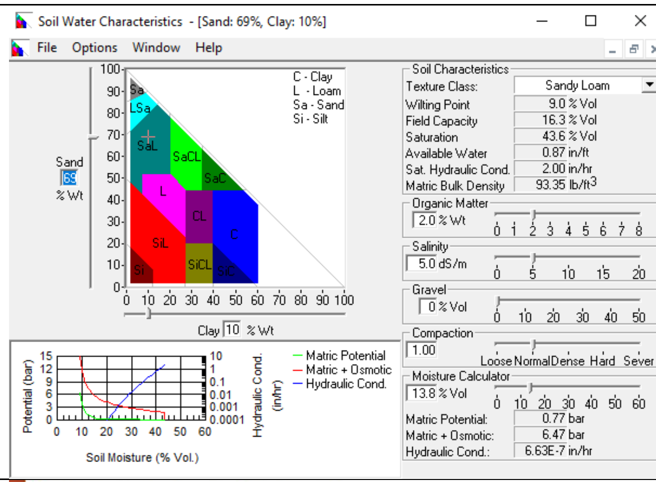
In case of installation proble: Right-click on the **installable SPAW Hydrology Setup (6.02.70).exe.**
Go to **properties**
On the **Compatibility** tab, check the compatibility mode to run this program in **compatibility mode for Windows XP (Service pack 3)** Click OK
Start the installation.



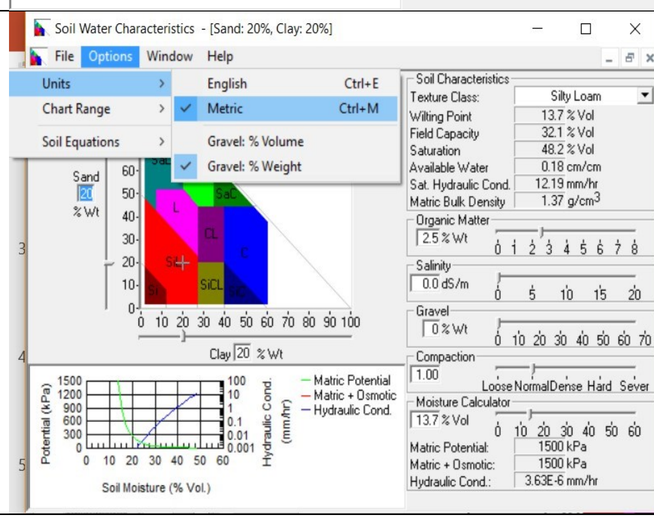


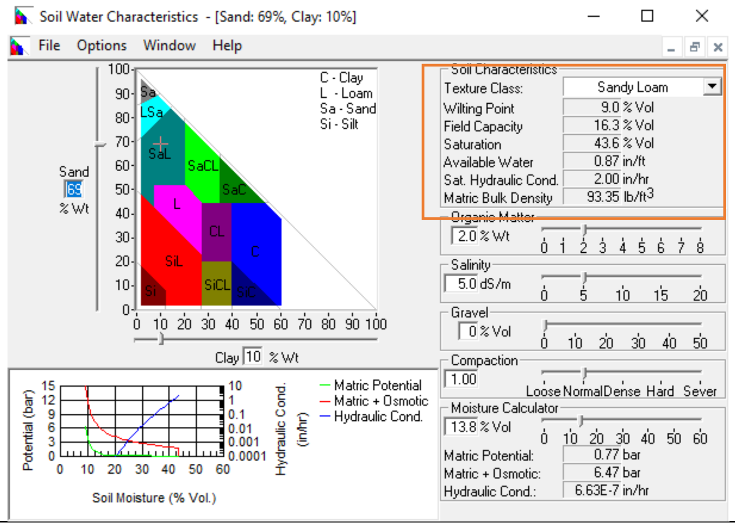
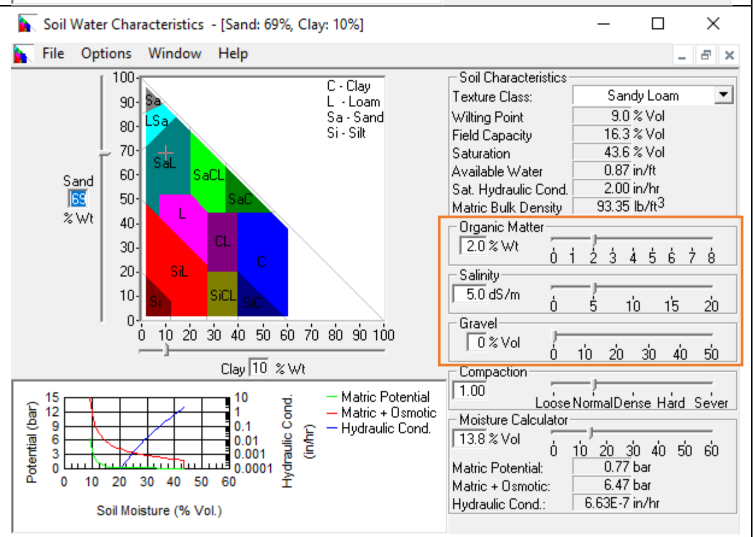
Once installed,
Launch the program
Soil Water Characteristics

Under the **SPAW Hydrology tab.**



First of all, you have to change the system of units.
Go to **options, Units** and select Metric**,** then **Gravel %Weight**



<table>
<tr>
<td>To determine the characteristic water content of the soil θsat, θccand θpfp, it is sufficient to introduce the % of clay and sand at the level of the textural triangle. The textural class of the sample as well as the values of θpfp, θcc, θsat, Useful Reserve, hydraulic conductivity at saturation and bulk density will be automatically displayed at the top right.</td>
<td>
</td>
</tr>
<tr>
<td>Also the program Soil Water Charactersitics allows you to examine the influence of:
the richness of the soil in organic matter,
soil salinity
the % of stone - and compaction on these characteristic parameters.</td>
<td>
</td>
</tr>
</table>

Step 3: Determine flow per lateral, submain, and mainlines

The crop water requirements and the total water to be supplied will be estimated for each plot or zone. If the zone has a homogeneous type of crops and similar growth rates, it will be easier to estimate the total needed water to be supplied, which takes into account the physical losses.

Step 4: Determine the total system capacity to meet the maximum irrigation crop requirement

The correct irrigation network design should meet the peak water demand in the peak season. Therefore, the size of the main pipelines and laterals should meet this requirement. Failing to meet the peak water demand will affect the fruit size and quality and yield. This will have monetary implications as the quality or size might not be meeting the market standards and quality.

Emitters and irrigation time should be selected according to:

Soil texture and crop root zone system.

the peak irrigation demands.

Assuming two emitters of 8 l/h, placed on each plant are sufficient to provide the crop's effective root zone moisture.

Discharge through each lateral & determination the number of sectors

Scenario 1: one area

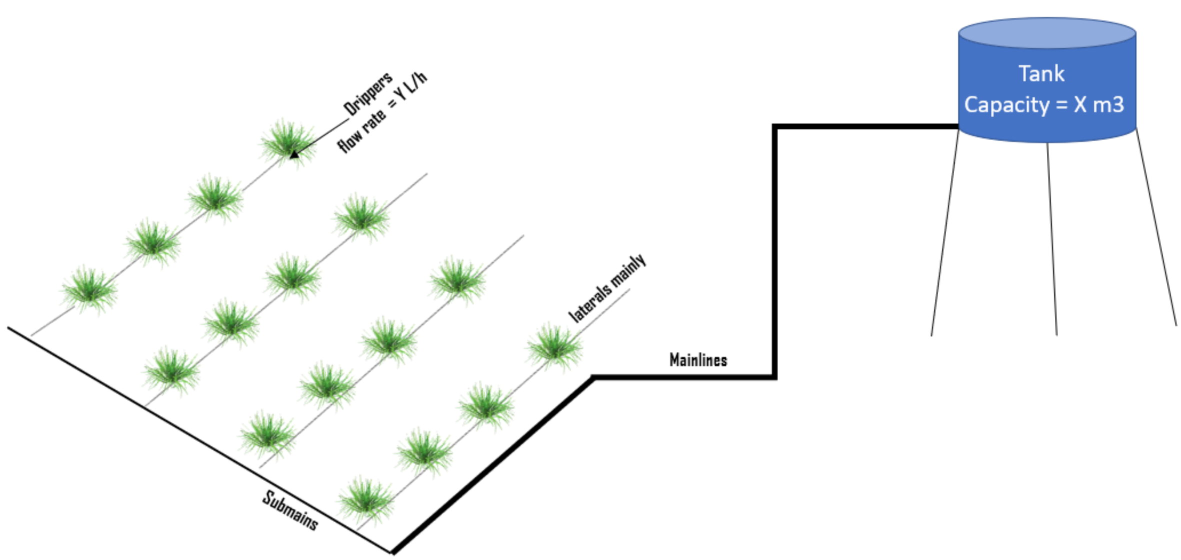
For 16 plants with one dripper/plant, the total discharge = 16*8= 0.128 m3/h (the emitter flow rate is 8 l/h). And the irrigation requirement is 8 l/day/plant

Assuming the thank capacity is 1 m3: we can used to irrigate this plot 7.8 times.

Assuming we have 15 plots to be irrigated with the same tank

So, we have 15 plots x 0.128 m3= 1,92 m3

So, we need to fill the tank two times to irrigate the 15 plots.



Step 5: Determine the size laterals, submains, and mainlines.

Once the delivered quantity of water in each plot is known, then the size of the lateral, submain and mainline can be chosen based on the Hazen-Williams equation, and it will be possible to check the feasibility of each scenario. The Hazen-Williams equation determines the relation of the water flow in a pipe with the physical properties (pipe materiel, the C value, inside diameter, pipe length) of the pipe to determine the pressure drop or friction loss in pipes. There are many available software or a simple excel sheet that can help estimate the total head loss in a pipe. For example, the calculation Excel sheets can be downloaded from the following link https://www.mepwork.com/2018/02/hazen-williams-calculator.html;

http://epanet.de/

https://www.lmnoeng.com/hazenwilliams.php

Step 6: Determine the pump characteristics needed.

5-On-Farm water audit: Field sampling to evaluate irrigation network

What is water Audit

An irrigation water audit is a process of collecting data from an on-farm irrigated area to evaluate the current performance of an irrigation system. The Goal of a water audit is to determine/quantify, and verify water losses and costs, water resources efficiency, and ensure the most efficient use of water in irrigation. In addition, the irrigation water audit provides insight into the operation of your irrigation system and helps you determine how to improve its efficiency. Efficient means the irrigation water system should be:

- uniformly applied
- with minimum losses due to evaporation, runoff, and deep drainage
- to the correct depth to meet the plot vegetation needs
- at the appropriate time

An on-Farm water audit is a tool to overcome the shortage, leakage, and losses in the irrigation system. It consists of collecting and recording information that provides the overall status of the farm. Keeping accurate and up-to-date records throughout the year will help during the auditing process. Requirements for information in the audits of the performance of an irrigating system should include:

- water use over-irrigation period
- hydraulic operating conditions (pressure and flow)
- weather information such as rainfall amounts, evapotranspiration rates, and high temperatures
- uniformity of application
- information about the irrigation system such as number of irrigated dunums, system improvements, head locations, spacing, operating pressure, drippers and pipes make, model, and nozzle sizes should also be recorded.

- a site-specific irrigation schedules

An important outcome from the audit and evaluation of an irrigation system, is the information that allows an ***optimum irrigation schedule*** to be developed. Recommendations to the farmer on improvement in the efficiency of the irrigation system and decrease water consumption should be provided at the end of the audit. In addition, highlight on the periodic maintenance and repairs should also be brought to the attention of the farmer to ensure the system is operating efficiently and minimizing water loss.

The steps involved in the preparation of optimum irrigation schedule are:

Determination of the crop water requirement

Determination of the irrigation requirements

Determination of the irrigation depth and frequency

Determination of the optimum run times and total run times

Determination of the water volumes and cost

Detailed auditing procedure for irrigation system

History of farm water use

It is necessary to have an idea about the history of the farm water usage, area of the farm or plots, the agricultural practices, date of the plantation, flowering, fruiting, previous years yield, type and brand of irrigation material used, etc. It is very important to know the current seasonal irrigation scheduling applied at the farm by asking the farmer about his agricultural practices during the different seasons and for the different crops grown in his field, how many times he is irrigating, for how long, etc. Detailed questions / required information is summarized in the water audit and agronomic measurement forms. In addition, report about the farm daily challenges and evaluate the status of the farm by describing the problems that are directly affecting the performance of the irrigation system and provide the right solutions/recommendations to the farmers.

Measurements

A basic water audit kit is required to perform the on-farm audit. It includes:

the GPS to record the plot and the audited area GPS coordinates

- a container and a graduated cylinder to collect the water and measure the volume collected
- a stopwatch to fix the time
- a pressure gauge to check the pressure at the different points of the irrigation lines
- a portable EC/pH meter to check the salinity and the alkalinity of the collected sample, an

- Once information about the farm history, farm or plots challenges, irrigation scheduling etc. are collected then proceed with the measurements at the specific plot for each crop.

The measurements should be done at least at three points: at the beginning, in the middle and at the end of the lateral line because usually the pressure is not same at the different levels within the length of the lines. The measurements can be done in two ways either fix the time (1min) or fix the volume collected (1L).

For fixed time, start water sample collection and keep time running till 1 minute.

Or the water sample is collected within 1 minute and is measured using the graduated cylinder and the information is recorded in the water audit form.

The two bellow steps are repeated at different points.

Then use the recorded information to calculate the real dripper flow as explained below:

30 ml (0.03 l) collection in 1 min

0.030 x 60 = 1.8 L/hour

It is important as well to check the salinity and the pH of the water because it helps the farmer decide the other component of water management such as leaching fraction in case of using saline water for the irrigation and adopt one of the solutions to adjust the pH.

Water Audit of main pipelines, sub-main pipelines, laterals

It is required as well to check the leakage points and any defected part of the irrigation system including the main pipelines, sub-main pipelines, and the laterals. This should be done before starting the water audit to ensure that there is no leakage that could affect the water delivered to plants and accordingly affect the pressure in the system.

Soil and root zone Sampling

The measurements are usually supplemented by soil sampling to carry out specific analysis of the soil as well as water sampling to get a clear idea about all factors that affect the performance of the irrigation. The soil samples are collected from the root zone at different points and depths in the audited area.

Calculation of uniformity

One of the main tasks of water audit is to calculate water distribution uniformity in the plot area. This is a measure of the average sample of dripper flow in one pipeline, divided by the average of all dripper flow in the plot. A higher distribution uniformity indicates a better-performing irrigation system. If all the plot samples are equal, the distribution uniformity is 100%, but a value greater than 70% is generally considered acceptable.

6- Drip Irrigation System Maintenance

1. System Inspection at the start of growing season

1. Inspection of the pump with all accessories (i.e. pressure gauges, discharges, flows etc.)
2. Inspection of the solenoid valves, gate valves all other accessories to avoid leakages.
3. Inspection of all the filters.
4. Inspection of main, sub-main, distribution pipes and flushing manifold
5. Flush the piping - main line, sub-mains and distribution pipes.
6. Flush the drip lines to purge them of settled debris, organic or mineral, and of any residues of chemicals injected into the system.
7. If necessary, inject chemicals i.e. hydrogen peroxide and/or acids as required.
8. If pressure-regulating valves are installed, check the pressure at the outlet of each valve
9. Inspection of drip lines for any damages
10. Replace or remove all malfunctioning parts/devices to ensure the smooth functioning of system during growing season.

2. Routine maintenance during the growing season

1. Check the pump's flow rate and pressure at its outlet.
2. Check all the valves in the system.
3. Check all the lines, in case of any leakage fix it immediately
4. Visually inspection of the wetting pattern on the soil. Dry areas or an uneven pattern might suggest clogging in the drip line/drippers.
5. Replace the malfunction drippers and other accessories.
6. Check that the water reaches the ends of all the drip lines.

3. Maintenance at the end of the growing season

1. Once the growing season is over, inject chemicals for the maintenance and flushing of the mainline, the sub-main lines, the distribution pipes and the drip lines.
2. Prepare the system for the inactive period between the growing seasons.
3. Remove all pipes from the field and put them in a protected place to avoid wastage.
4. It’s better to separate the dripline from the lateral line.

4. Material selection

1. Use HDPE/UPVC pipe for main, submain & lateral line.
2. If water PH is low try to use Non pc dripper
3. Use flush valve in case of subsurface dripline
4. Don’t use PVC pipe where pipes are directly in contact to sun

5. Daily Maintenance

1. After starting the pump let the pressure be stabilized in the system. If pressure is less, adjust it by throttle/ by-pass valve.
2. Ensure that water is reaching all corners of the plot/field.
3. If dry patches are found increase duration of operation.
4. If clogging is taking place, the end drippers are the first affected. Check them.
5. Monitor the mechanical damages by rodents, farm operations by labor, animal or machinery, causing leakage; correct it immediately by using proper joiners.
6. Flush all laterals. Allowing flushing for 3 minutes until clean water starts flowing.
7. Flush each sub-main at the end of irrigation till dirt free clear water starts flowing.
8. Check inlet & outlet filter pressures. Remove slurry from hydrocyclone, back flush sand filter at every 5 hours; flush screen/ disc filter at the end of days operation.