Adverse Effect on Yield Due to Water Logging in Godavari Basin-India

Dhavaleswar Rao Bhandaru, RVRK Chalam, Reshma Tabassum, S.S.Asadi

Abstract: ***The analysis of the data of Sri Rama Sagar Project in Godavari Basin reveals that there were many adverse impacts of mismanagement of surface irrigation such as water logging, soil salinity and alkalinity,. The increased water logging area of fertile land was rendered un-fit and unproductive in almost all the water logged areas of the project. The personal studies were made by visits to the sites of the six villages under this project. The data for the total production loss from the two major crops Rice, Ground Nut during the period of 5 years in both Kharif and Rabi for the affected areas of water logging, salinity/alkalinity is worked out. Many of the common field crops are affected when the Ec value is in the range of 4-8mm hos/cm, crops with high salt tolerance can grow satisfactorily, when the Ec values are between 8 and 16 mm hos/cm. The salt tolerance characteristics of some common crops are presented. Soil pH is one of the most important parameters which influence plant growth. However, there is a decreasing trend in crop yields per hectare due to water logging salinity/alkalinity. Hence, in brief, the total production loss from the two major crops in the study area during the period of 5years in both Kharif and Rabi due to mismanagement, and consequent problems of water logging, salinity/alkalinity is worked out to the order of millions of rupees. Hence, drainage is made a pre-requisite, even at the stage of planning canal irrigation projects in order to avoid huge social costs due to water logging and salinity.***

Index Term: Soil Salinity/Alkalinity, Water Logging, Reclamation. Leaching, Drainage

I. INTRODUCTION

The Sri Rama Sagar Project was constructed across river Godavari in Pochampad (V) to irrigate a total command Area of 0.67 mha. [1]Irrigation projects are specifically designed for increasing the crop production and yet the very projects may cause degradation and loss of production and land resources through soil salinization if adequate provisions for drainage and salinity control are not made. An intensification of agricultural production on a global scale is necessary in order to secure the food supply for an increasing world population [2]. It was observed that an area of 42,729 hectares under the G6-Godavari basin was identified as waterlogged and about 55,180 hectares of land was prone to water logging [1]. Un-controlled application of water in the command area of the major irrigation project generally lead to deleterious consequences like water logging salinity and alkalinity problems. Saline Water is one of the most common pollution in fresh ground water [3].On account this fact, water-logged area has been increasing in G6-Godavari Basin Excess salts, regardless of composition, generally keep the soil clays in a flocculated state, so that the soils maintain good physical properties as reflected in the all important water storage and transmission characteristics (permeability). Therefore, these soils still provide an adequate physical environment for seed germination and plant growth. Salinity's damage primarily is caused by the changes in soil chemical characteristics, namely the concentration and composition of soluble and exchangeable ions. Excess salts in the soil may also interfere with normal plant nutrition [4].

Plant growth may be completely prevented when sod city is high. In high sodic soils the organic matter gets dissolved and a dark film of dissolved or suspended organic matter appears on the soil surface. It is evident that some village commands were affected with salinity. Salinity depresses growth and yields more when nutrition is inadequate rather than compared when nutrition is normal. High salinity in soils may also adversely affect the microbial populations in soils and thus indirectly affect the transformation of essential plant nutrients and their availability to plants [5]. There are about 24 essential elements and each element becomes available in a certain range of pH. Each crop requires certain range of pH so that the growth of plants is satisfactory. In addition to the availability of various essential nutrients, soil reaction plays an important role in creating a suitable environment. Suitable ranges of soil reaction for different crops are to be presented. Every crop requires a certain quantity of water after a certain fixed interval, throughout its period of growth [6]. Good quality water has the potential to allow maximum yield under good soil water management practices. Irrigation projects are specifically designed for increasing the crop production and yet the very projects may cause degradation and loss of production and land resources through soil salinization if adequate provisions for drainage and salinity control are not made. A salinity problem due to water quality occurs if salts from applied irrigation water accumulate in crop root zone beyond certain limits and yields are affected [7]. Plants growing in saline soils may appear water stressed. This is because the high salt content of the soil hampers the ability of plants to take water from the soil. Water naturally moves from areas of low salt content to high salt content. Sometimes a white crust is visible on a saline soil surface. Plants that are sprinkler irrigated with saline water often show symptoms of leaf burn, particularly on young foliage. High concentration of salts in water may be harmful in the

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long run [8]. Salinity, primarily damages the soil chemical characteristics, namely the concentration and composition of soluble and exchangeable ions. High salinity in soils may also adversely affect the microbial populations in soils and thus indirectly affect the transformation of essential plant nutrients and their availability to plants.

The Research study is based on production loss of two major field crops Rice and Ground Nut. There is a decreasing trend in crop yields per hectare due to water logging, salinity/alkalinity.

II. SIGNIFICANCE OF THE STUDY

In India, vast areas have been brought under irrigation without provision of drainage component. Large scale irrigation has led larger scale water logging and wide spread salinity in the canal command area. During the late fifties and early sixties, large areas in various states had developed the problem of water logging [9]. The problem of water logging in India is now taking a serious turn on account of increase in the irrigated areas and shift in emphasis from protective irrigation to intensive (productive) irrigation as a means of attaining greater agricultural production.

The farmers over-irrigate the crops due to their ignorance and consequently, the land gets water logged. Till recently, little attention was given to the diseconomies associated with the canal irrigation on account of mismanagement. It is customary to state that so much percentage of irrigated command area is affected due to water logging and salinity.

Since the problems of water logging and soil salinity were diagnosed, the magnitude of the problem due to canal irrigation is yet to be quantified. The major adverse affects of mismanagement of canal irrigation are water logging and soil salinity and canal seepage. Irrigation projects are specifically designed for increasing the crop production and yet the very projects may cause degradation and loss of production and land resources through soil salinization if adequate provisions for drainage and salinity control are not made.

Water, sometimes, is less available to plants due to increased Osmotic pressure. Excess salt inhibits plant growth by disturbing osmotic relations in the root zone, causing declines in crop productivity [12]. The extent of damage to the plants depends on the nature of the crop, the salinity status of the soil and prevailing climatic conditions. Soils contain sufficient exchangeable sodium which adversely affects the growth of most common crop plants. High salinity results in marked deterioration of soil physical properties and thus soil becomes less permeable to water and to air reusing the water to stand pounded for a long time. Plant growth may be completely prevented when sod city is high. In high sodic soils the organic matter is dissolved and a dark film of dissolved or suspended organic matter appears on the soil surface.

It may thus be seen that a solution has to be found considering above facts right from design of irrigation system to construction and maintenance of the systems and the organizational and management aspects of the staff and farmers. Irrigation, drainage and reclamation are processes in the development of two of the most important natural resources-land and water [10].

Therefore, an attempt has been made in this research paper to high light the adverse affects of water logging and salinity with respect to loss in production and productivity, social costs, infestation of weed's growth and water borne diseases of Two Crops out of Eight.

III. OBJECTIVES

For achieving the objectives of the study, Sri Ram Sagar Irrigation Project was purposively selected where the problems were found passive. Water logging and soil salinity are the two major problems affecting the agricultural productivity and sometime becomes too severe to take it out from economic crop production [11]. Data regarding the extent of water logging and soil salinity was compiled from the primary and secondary sources.

The relevant data of cropping pattern yield and prices of important crops, infestation of weeds, diseases etc. under the project are collected from the official records and primary sources. The study was intended to examine the magnitude of the adverse effects of water logging and salinity due to mismanagement of surface irrigation. More specifically the study was aimed at

1) To examine the magnitude and socio-economic consequences of water logging and salinity due to canal irrigation.
2) To examine the production loss, growth of weeds, infestation of diseases etc. due to, mismanagement of surface irrigation.
3) To suggest appropriate measures for overcoming the problems of water logging and soil salinity.
4) To suggest Leeching and drainage arrangements.

IV. METHODOLOGY

It is seen that the expected yield of rice is 50qtl/ha. and the average yield is 40qtl/ha. Water logging and salinity have shown an increasing trend in many of the developing countries. Water is a scarce resource in these areas and even then loss of productivity is caused by over use, misuse and mismanagement of water. However, improper land usage has to be reduced. The case study of Sri Rama Sagar Project indicates that water logging is caused by the interaction of large number of factors such as ground water recharge, drainage, surface irrigation, cropping patterns, ground water with drawl for irrigation, soil characteristics, seepage from field channels and distributaries. In command area of Sri Rama Sagar Project observation wells indicated waterlogged and non-waterlogged areas in the same command. Site investigation and site surveys were revealed the information like topographic details, soil profile, salinity/alkalinity, EC, pH and soil Texture in villages of Sri Rama Sagar Project Command.

Soil pH is one of the most important parameters which influence plant growth. It is more related to the availability of nutrients. There are about 24 essen¬tial elements and each element becomes available in a certain range of pH. Each crop requires certain range of pH so that the growth of plants may be satisfactory. Chemical properties of the soil profile collected at a depth of 20-60 cm are furnished in Table

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Depth	pH	EC	HCO	Cl	SO4	Na	K	Ca	Mg	CaCO3	SAR
20-60 Cm	7.2	0.05	1.6	42	15.9	38.6	0.1	11.2	10.4	9.0	11.7

V. RESULTS AND DISCUSSIONS

A. Chemical Properties of the Soil

The soils were analyzed for chemical properties as per procedures out lined by Jackson, 1973.The Ec of experimental area varied from 0.05 to 4.4mmhos/cm and the pH varied from 7.6 to 8.6. The Ec value is slightly decreased in the case of alkaline soils and increased when it came to Saline Soils. The pH value has also increased from 7.60 to 8.2.

Indicating that the chlorides were dominant and expressed in line diagram for Ec and pH values in Fig. 1.

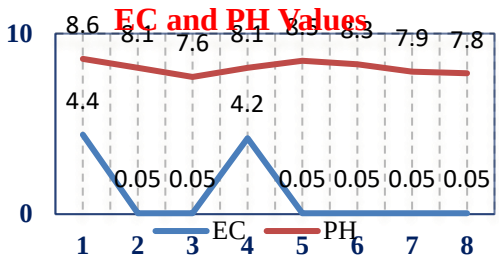

Fig. 1: Shows EC and pH

B.Fertilizer Usage

Under this project, paddy is the major crop and the command is deficient with N and P and rich in K. The consumption of Nitrogen fertilizers has increased from 69469 tons to 88320 tons between 2015 to 2016.

In addition to the availability of various essential nutrients, soil reaction plays an important role in creating a suitable environment. Suitable ranges of soil reaction for different crops are to be presented .Sometimes the doses of N applied under irrigated conditions is much higher than the recommended dose. Such situations are leading to nitrates accumulation in the soil. Consumption of Fertilizers is projected in Table. II.

Table II: Consumption of Fertilizers

Under Project year	**2015-2016**				**2017-2018**			
Fertilizers	N	P	K	Total	N	P	K	Total
Used	69469	22635	5447	97551	88520	34234	7693	130447

The introduction of canal irrigation not only brings the much needed water but also imports salts. Subsequently considerable amounts of salts are added to the soil profile as per Table III.

Salts get accumulated in the profile, year after year and ultimately crop yield is affected. The rise in water table and built up of salinity reduce crop yields by causing damage to the root zone system of crop. Yields are reduced in proportion to the increase in the salt build up as per Fig. 2.

Table III: Considerable amounts of salts are added to the soil profile

Salts added to soil through irrigation to Paddy crop			
Crop	Irrigation (mm/season)	Salts Imported(t/ha)	
		Canal water	Canal Water
	EC=0.6dsm^{-1}	EC=0.15dsm^{-1}	
Paddy	1340	5.10	1.35

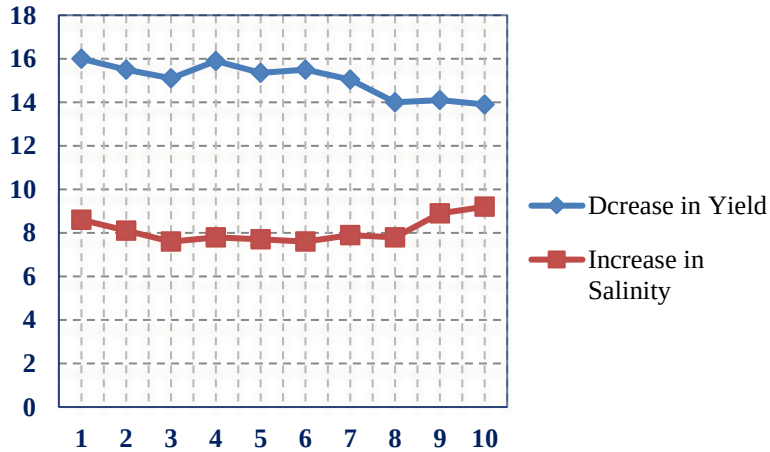

Fig. 1: shows

Excess salts in the soil may also interfere with normal plant nutrition. Salinity decreases growth and yield more when nutrition is inadequate compared to when nutrition is normal. High salinity in soils may also adversely affect the microbial populations in soils and thus indirectly affect the transformation of essential plant nutrients and their availability to plants. Trend Showing the productivity, production and area covered in Sri Ramasagar Project Command for Rice (Paddy) Crop is shown Table.IV. Trend showing the productivity, production and area covered in Sri Ramasagar Project Command for Rice (Paddy) Crop is shown in bar and line diagrams for Kharif and Rabi in Fig. 3 & Fig. 4.

Table IV: Statement Showing the trend in productivity, production and area covered in S.R.S.P command for Paddy

S.No	Year	Khariff Area Ha	Productivity Qtl/ Ha	Total Production Quintals	Rabi Area Ha	Productivity Qtl/Ha	Total Production Quintals
1	2013-14	1257	59	74163	1257	51	64107
2	2014-15	1257	58	72906	1257	50	62850
3	2015-16	1274	56	71344	2500	49	122500
4	2016-17	1291	55	71005	4380	47	205860
5	2017-18	3138	54	199452	4175	47	196225

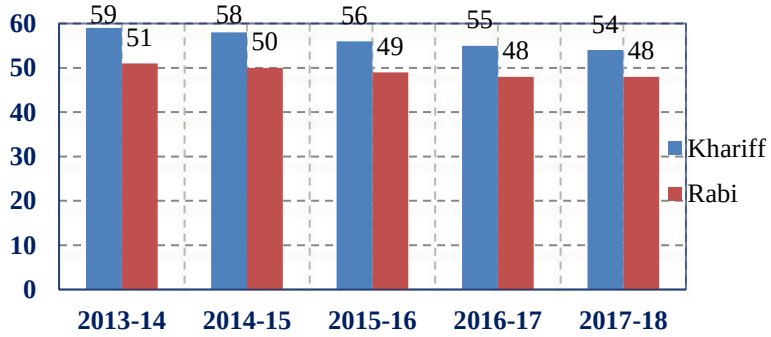

Fig. 3: Kharif Crop

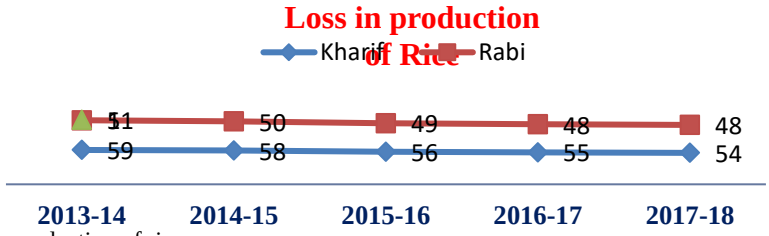

Fig. 4: Loss production of rice.

The production loss for two major crops considered in the study area is worked out for each year and the cumulative loss for 10 years is summarized here. The cumulative loss for Ground Nut Kariff (June to Oct), Rabi (Nov to Jan) is shown in Table.V.

Trend Showing the productivity, production and area covered in Sri Ramasagar Project Command for Ground Nut Crop is shown in bar and line diagrams for Kharif and Rabi in Fig. 5 & Fig. 6.

Table V: Statement Showing the Trend in productivity, production and area covered in S.R.S.P command for Ground Nut

S.No	Year	Khariff Area Ha	Productivity Qtl/ Ha	Total Production Quintals	Rabi Area Ha	Productivity Qtl/Ha	Total Production Quintals
1	2013-14	2670	15.50	41385	587	13	7631
2	2014-15	2044	15.05	30762	587	12	7044
3	2015-16	1417	14.00	19838	260	12	3120
4	2016-17	753	15.90	11973	260	13	3380
5	2017-18	800	15.35	12280	260	12	3120

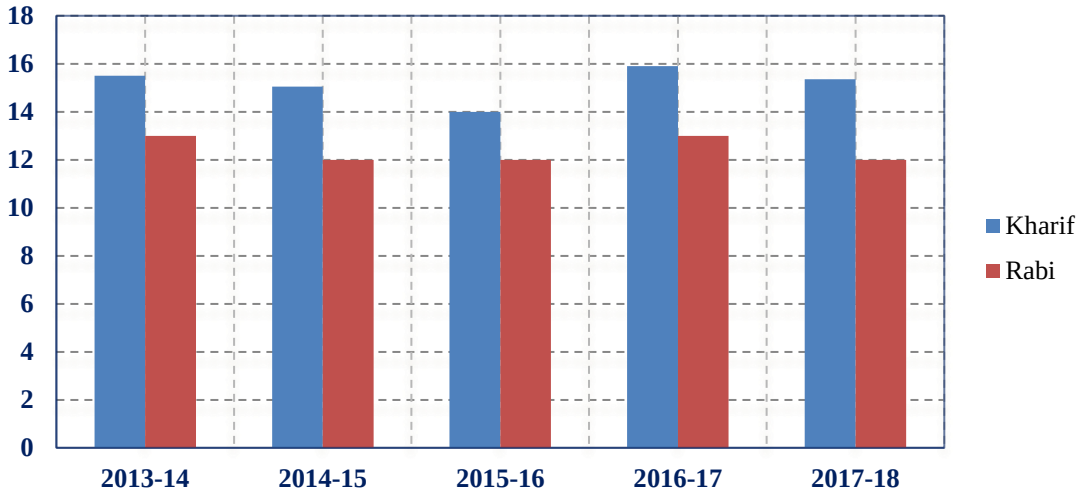

Fig. 5: Command for Ground Nut Crop in Kharif

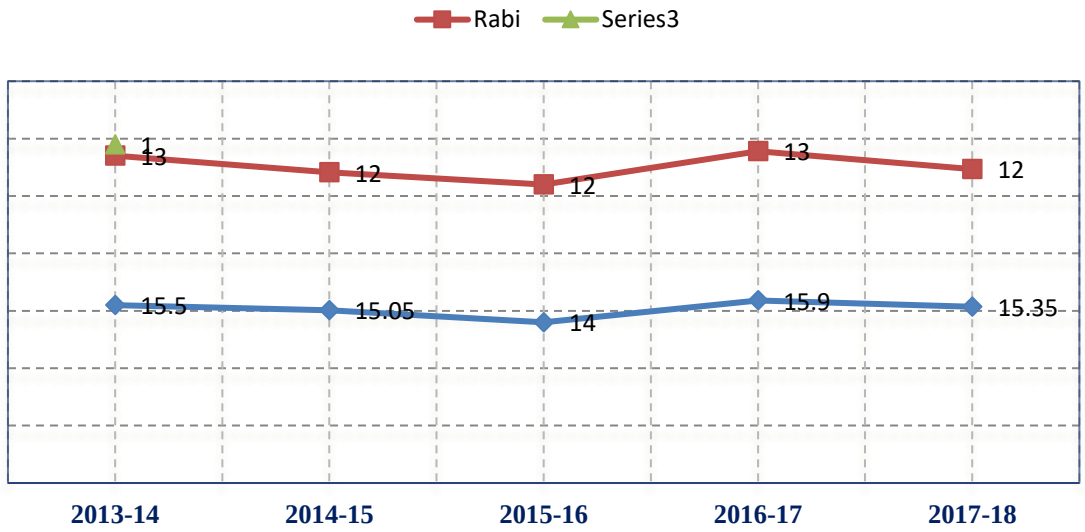

Fig. 6: Command for Ground Nut Crop in Rabi

Hence, in brief, the total production loss from the two major crops in the study area during the period of 5 years in both Kharif and Rabi due to mismanagement, and consequent problems of water logging, salinity/alkalinity is worked out to the order of Rs 10.2 million**.**

VI. MANAGEMENT ASPECT

The success of an irrigation system involves not only timely supplying agricultural input with adequate supplies of irrigation water but it also requires from the very beginning measures to control water logging and salinity. The major adverse affects of canal irrigation and its mismanagement, is water logging and soil salinity which effects farming community by resulting harmful environmental effects [14]. The salinity caused due to anthropogenic factors (secondary salinization) is related to clearing of natural deep-rooted vegetation and large-scale development of irrigated agriculture without adequate drainage[15].Careful considerations have therefore, to be given in planning of irrigation projects in order to make a thorough investigation of the topography, natural drainage, geology and hydrogeology, soils, ground water, outlet conditions presence of salts in soils and sources and quantities of excess water, which can lead to the problems of water logging and salinity of agricultural lands after introduction of irrigation. It is also necessary that existing ground water conditions must be established and areas where excess water or salts exist or areas where problems of water logging and soil salinity can arise after irrigation must be identified at the planning stage it. Good quality water has the potential to allow maximum yield under good soil water management practices [16,23].This would require special management and suitable measures that would obviate or minimize the problem which must be incorporated in the overall scheme. However, if there is excess water or salt in the root zone in any area even prior to introduction of large scale irrigation, steps need to be taken up to lower the water table in advance in such area and to flush out the excess salts if present in ground waters and then to drainage. The problem of these areas is that of

reclamation of lands to be followed by preventive measures of drainage.

The case study of Sri Rama Sagar Project indicates that water logging is caused by the interaction of large number of factors such as ground water recharge, drainage, surface irrigation, over irrigation, cropping patterns, ground water with drawl for irrigation, soil characteristics [18].

The Excess water that is applied which causes water logging [17]. The increased water logging, area of fertile land was rendered un-fit and unproductive in almost all the water logged areas of the project. It could cost to the entire society as a social cost and also caused environment. The objective should be to realize maximum net returns per unit of water. The production of other crops has decreased in the affected area of the project.

VII. MAGNITUDE OF AQUATIC WEEDS

The magnitude of aquatic weeds varied from one project to another due to technological, climatic conditions, Socio-economic factors etc. The detailed survey of crops grown in areas of Sri Rama Sagar Project revealed that the leaf spot Ceratobasidium cornigerum was the most common disease in all the districts. Be side's leaf spot, Rhizome rot caused by Pythium Fasarium, Rhizoctonia, and Macro- Phomina is the common disease and in several cases magpots of mimegralla, coeruli were found associated with damaged rhizomes, Nimithodes were see infecting roots. The infestation of aquatic weeds in the reservoir or canal surface adversely affected the efficiency of canal irrigation as well reduces production [19].

VIII. GROWTH OF WATER BORNE DISEASES

The other adverse impact caused by the mismanagement of canal irrigation was found to be infestation of water borne diseases in the villages. The important water borne diseases of very serious nature were reported to be malaria, diarrhea, cholera, etc. In fact, there could be several reasons responsible for infestation of these diseases.

Development of ground water also provides opportunities for pollution of ground water [20]. However stagnation of water is one of the important reasons which caused unhygienic conditions and growth of water borne diseases. Surface water is contaminated by chemical substances or from runoff pollution from up-stream irrigation developments increased the salts. These affect the quality of water subsequently used for drinking and other purposes.

Several field studies have also shown that water logging and soil salinity can be checked in the initial stage of the constructing the irrigation projects. The areas which are adversely affected due to mis-management of surface (i.e. canal) irrigation, could be reclaimed for cultivation purposes i.e. farming. In this context, a few control measures to check water logging and salinity have been briefly discussed.

IX. CONCLUSION AND SUGGESTIONS

This chapter aims at focusing attention on the emerging problems which need immediate solution tackling and concerted efforts by Irrigation Engineers with effective involvement of the farmers.

Leaching is essential to all saline and saline sodic soil to flush undesirable salts. If the salinity is slight to medium level and the soil is well drained, reclamation through planned irrigation is possible without drainage facilities. About 60 cm of water to a 60 cm. depth of soil can remove 80% salts in soil. Disposal of salts should be connected to a safe natural drain. If water table is within one meter, it should be constantly pumped through the dug-wells and the water pumped should be disposed off to natural drains. If soils are saline sodic and sodic in nature, there should be a provision of leaching. These soils in presence of gypsum, organic manures and the leach ate be collected by sub-surface drains. It can be generally stated that in black soils with very poor permeability conditions. Lateral spacing can be kept varying between 30m and 60 m. and the depth of drain be 1.5 m.

X. DRAINAGE

Drainage is essential for the reclamation of saline - alkali and water logged areas and it can be effective in order to overcome the problems of water logging and soil salinity, which removes excess water in water logged areas. It creates favorable conditions for crop production. Similarly, for the removal of excess water, installation of surface and sub surface drainage is an important regulatory measure [21], drainage followed by leaching with good quality water removes excess salts from the root zones, of the crop. An efficient drainage system is essential for the quick disposal of the storm water and excess irrigation water [22]. Hence, drainage should be made a pre-requisite; at the stage of planning canal irrigation projects itself in order to avoid huge social costs due to water logging and salinity.

The improved drainage through artificial means is an essential pre-requisite to reclaim waterlogged salt-affected lands. Conventional surface drainage is essential but to reclaim these lands it needs to be augmented by some kind of subsurface drainage. Horizontal subsurface drainage has been found to be quite effective and echo-friendly technology in areas with poor quality ground water.

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