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Impact of Open Sub Surface Drainage on Reclamation of Water-logged and Salt Affected Soils

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ABSTRACT

The Andhra Pradesh Water Management Project has conducted detailed study in the farmers fields of drainage pilot area located in Pathareddy Palem village under Mutluru channel command of Krishna Western Delta of Guntur district in Andhra pradesh to evaluate the performance of open subsurface drainage system (OSSD) for improving the grain yield of rice under saline and water logged conditions for three consecutive seasons starting from *kharif*, 2005. The grain yield increased from 2.2 t ha^{-1} to 4.9 t ha^{-1} over a period of four years indicating an over all increase of 123% due to installation of OSSD. The cropping intensity and non saline area were also increased to 100-158% and 6-40%, respectively.

Key words : Water logged, Salt affected, Open-Sub surface.

The yields of major food grains have stagnated or declined since 2000. One of the ways to improve the food grain production is, restoring degraded or problematic soils and improving quality of surface and ground water (Lal, 2008). The total salt-affected area in the state of Andhra Pradesh is estimated as 8.18 lakh ha. The irrigation induced water logging and salinity were estimated to be 2.72 and 1.15 lakh ha, respectively and these are the two major causes which lead to reduction in crop yields in most of the irrigated commands (Annual Reports, 2002-2006).

It is also observed that continuous irrigation over the years without proper drainage also results in raising the ground water table to the root zone, thus leading to reduction in crop yields. From the results of the reconnaissance survey, an area of 35,000 ha was identified as salt affected in the Krishna Western Delta (KWD) irrigated commands where the average grain yield of rice was as low as 1.5-2.5 t ha^{-1}.

Drainage has not been given importance as much as irrigation by the farmers as well as the Government agencies. So there is a great demand for the concerned research and development efforts to reclaim all the salt affected and water logged soils and bring them back to profitable farming with increased agricultural production as well as cropping intensity. The only means to overcome the salinity and water logging permanently is selection and adoption of suitable sub surface drainage systems. To test and demonstrate the drainage need for control of soil salinity and water logging, a collaborative project involving Acharya N.G.Ranga Agricultural University and Alterra, ILRI, The Netherlands, was approved by the Government of Andhra Pradesh, selecting Bapatla as a main center. The Bapatla center is entrusted with the responsibility of solving the water logging and salinity problems by installation of open subsurface drainage (OSSD) systems in the canal commands of Andhra Pradesh.

MATERIAL AND METHODS

A pilot area of 21.67 ha was selected at Pathareddy Palem village under Mutluru channel command of KWD in Guntur district to study the performance of open sub- surface drainage system to overcome the severe problem of salinity and water logging.

. The soil samples collected from 62 grid points of the pilot area (Fig1) fixed at spacing of 60 mts apart were analyzed for pH, ECe, water-soluble cations and anions, ESP, and available macro and micronutrients following the standard procedures described by Black (1965) and Richards (1954).Crop cutting experiments have also been conducted at each of these grid points to estimate the crop yields during 2005-08.

Fig. 1 Map showing the grid soil sample locations in open sub surface drainage system at Pathareddy Palem drainage pilot area

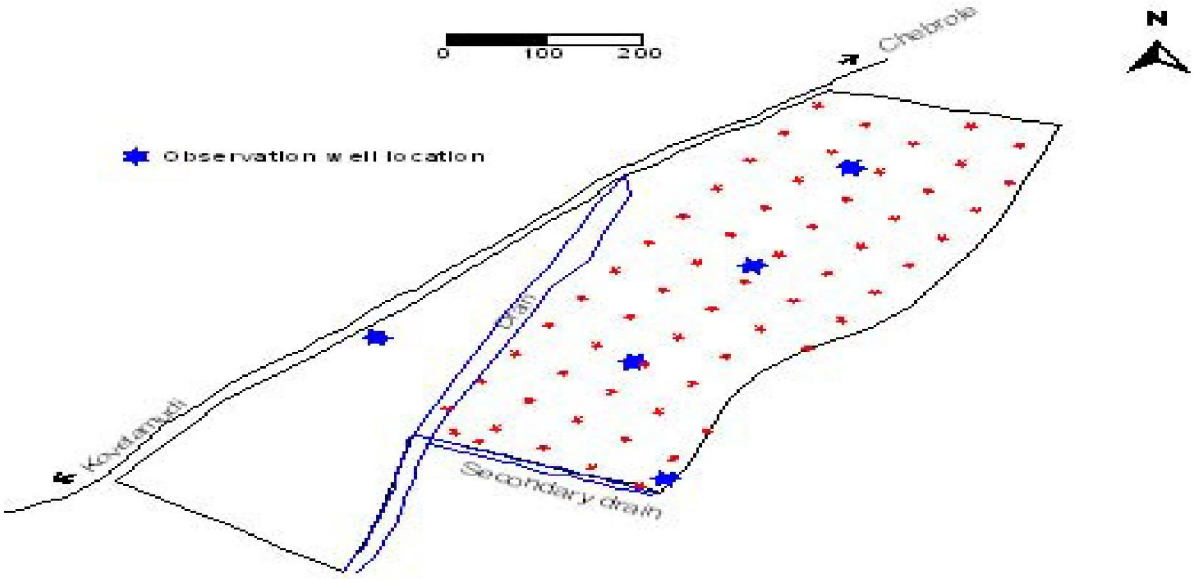


Fig. 2 Map showing open sub surface drainage system at Pathereddy Palem drainage Pilot area under Mutluru Channel Command of Krishna Western Delta

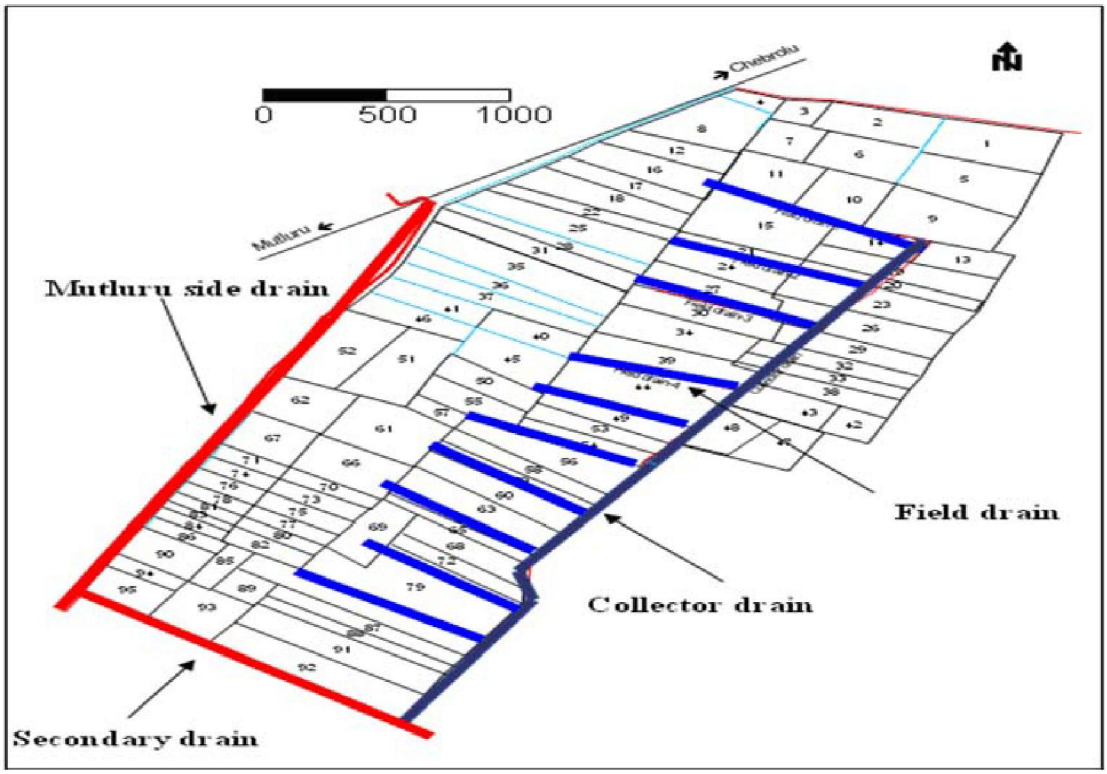
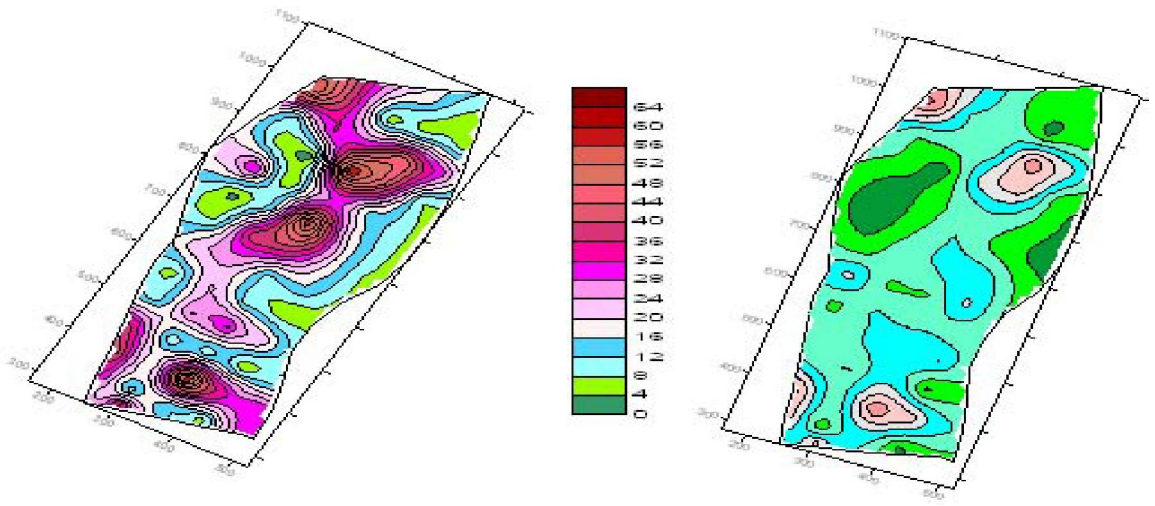


Fig.3 Impact of open sub-surface drainage system on summer soil salinity of Pathareddy Palem pilot area.

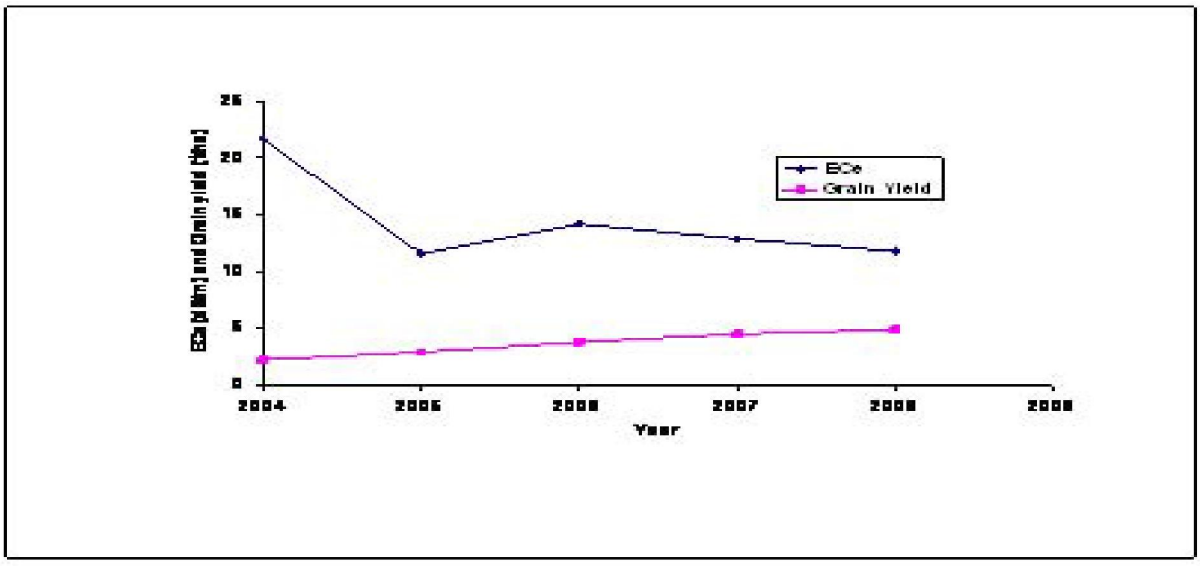


ECe in summer 2005 ECe in summer 2009

Table1. Effect of Open Sub-Surface Drainage System on soil salinity, grain yield and cropping intensity during 2005-2008

Year	ECe dS m^{-1}	Grain Yield (t ha^{-1})	Cropping intensity (%)
2004 (before installation)	21.7	2.2	100
2005	11.6	2.9	125
2006	14.2	3.8	146
2007	12.9	4.5	153
2008	11.8	4.9	158

Fig. 4 Relationship between ECe and Grain yield during 2005-2008



The soils of the pilot area are deep and clayey in texture, with ECe ranging from 1.6 to 61.3 dSm^{-1} and pH from 6.7 to 8.4.Sodium is the dominant water soluble cation followed by Mg and Ca. Chlorides are the dominant water soluble anions followed by sulphates and bicarbonates. The ESP varies from 10.12 to 14.10 indicating that the soils are saline and not sodic in nature. The available nitrogen is low to medium while the phosphorous and potassium are medium to high. The average values of ECe of ground water are highly saline and not suitable for agriculture. The soils are highly affected by water logging and salinity due to insufficient capacity of main drain to evacuate excess rainfall. The principal crop grown in the pilot area is rice during *kharif* season.

The open sub surface drainage system (Fig 2) consists of 10 laterals covering a length of 1250 m and bottom width of 0.75 m with a slope of 0.01% gradient, being properly dugged out with hydraulic excavator. The laterals were first connected to a collector drain. The collector drain was connected to a secondary drain and then to the Mutluru side drain to convey drain water offsite. The drainage coefficient was 1mm/day.

Eight observation wells were installed up to 3.4 m depth in Mutluru channel command and four out of eight falls in the experimental site to monitor water table fluctuations and for sampling ground water for water quality determinations.

RESULTS AND DISCUSSION

Monitoring of the open subsurface drainage system during *kharif* 2005-2008 clearly indicated that the system effectively controlled the ground water table in the root zone at a relatively shallow depth of 0.5-1.5 mts. The shallow water table also avoids excessive drainage while at the same time harmful salts that are brought in by the irrigation water were also reduced to a level ranging from 1.2 to 35.4 dS m^{-1}. Further the data on soil salinity at 62 grid locations showed a relative decrease in soil salinity during post drainage conditions with an average mean value of 11.6, 14.2, 12.9 and 11.8 dS m^{-1} (Table 1) during first, second, third and fourth year after installation respectively, which helped in increasing the grain yield. Similar results were reported by Prasad *et al.,* (2007).

The grain yield (Table 1, Fig. 4) from 62 grid points indicated a steady increase from 2005 to 2008. The average grain yield obtained during *kharif* 2005, 2006, 2007 and 2008 were 2.9 t ha^{-1}, 3.8 t ha^{-1}, 4.5 t ha^{-1} and 4.9 t ha^{-1}, respectively, as against 2.2 t ha^{-1} before installation of the system. Further, an overall increase of 123 per cent in grain yield was observed by the end of four years after installation of the drainage system. Similar positive results were reported by Konanki and Uppugundur drainage pilot areas of Indo-Dutch net work project (Comprehensive Report, 1995).

The cropping intensity was 100% with *kharif* rice only without any second crop before installation of the system where as the cropping intensity was also increased to 158 % by the end of four year after installation of the system allowing the farmers to raise fodder jowar, sunhemp and black gram as second crop during *rabi* season in 158% of the drainage pilot area.

The significant increase in crop yield and cropping intensity can be attributed to the direct effect of the introduction of open subsurface drainage system which in turn lowered the water table and decreased the soil salinity by leaching out the soluble salts from the root zone, there by not only creating the favorable conditions in root zone but also making the nutrients available to the plants resulting in optimum plant growth and yield.

Further, the shallow water table helped to overcome the excessive drainage and also remove the harmful salts that are brought in by the irrigation water there by creating favorable conditions in the soil root zone to establish fodder crops successfully in the second season after harvest of *kharif* rice.

The operational research conducted in the farmer's fields of drainage pilot area at Pathareddy palem indicated that, under the prevailing soil and agro-climatic conditions Open subsurface drainage system is technically feasible to reclaim water logged and saline soils and to sustain agricultural production in irrigated commands. Further, the open sub-surface drainage system needs frequent de-silting of drains during summer months for effective functioning of the system though it requires a huge amount of labour work. Thus, open subsurface drainage system is one of the best tools for permanent reclamation of water logged and saline soils in Krishna Western Delta Commands.

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