In Chapter I a literature review on saline and alkali soils has been presented. Different factors responsible for formation of various types of saline and alkali soils such as climate, topographic and hydrologic and geographic situation have been reviewed. The origin of salts and the contribution from various sources has been summarised. The literature review, starting from Hilgard work in 1922 has been presented. The work carried out in our laboratory is also been cited.

In Chapter II methods of analysis have been mentioned and the criteria for characteristic have been discussed. Preparation of bulk samples for different types of soils such as Na-soil, Ca-soil, Mg-soil and NH₄-soil have been indicated. The experimental method for hydraulic conductivity study using Witts' apparatus has been presented.

In Chapter III, a study of hydraulic conductivity has been made for distilled water for various admixtures of the soils such as La + Mg soil, La + Ca soil, La + K soil, Mg + Ca soil, Mg + K soil, NH₄ + Na soil, NH₄ + Mg soil, NH₄ + Ca soils have been cited. It has been observed that, the hydraulic conductivity of the soils for La - Mg, La - NH₄ and NH₄ + Mg are comparatively very low. From theoretical
study, behaviour of Na and Mg is likely to be similar from the point of view of bridge relationship in between these two ions in the periodic table. Analytical data also reveal that the hydraulic conductivity of Mg soil \( \text{Mg}_2 \) soil Na soil and therefore we find nearly the same pattern of low hydraulic conductivities of Na - Mg soils and Na - Mg soils. Of course, these relations could be important because in addition to the salinity supplying through Na\(^+\) and Mg\(^{++}\) ions, use of ammonium fertilizer is extremely common in our country to-day. From the practical study, it is also found that the potassium and calcium ions maintain a good soil structure, while sodium and ammonium ion responsible for decreasing the hydraulic conductivity of the soil and Mg\(^{++}\) ion has an intermediate role to play in the studies of complex, because there is not only the effect of ion on the soil colloid but also the type of the clay, which in the present case is the open chain montmorillonite will have performance study on the movement of water through the soil. Hence the water is again the polar solvent, where as our studies point about the role of magnesium in water movement which will have its ultimate effect in the position with Ca against Na in water classification.

The soils of different ESP prepared by using waters of different SE\(_K\), where the waters are prepared by using \( \text{LaCl}, \text{MgCl}_2, \text{NH}_4\text{Cl} \) and \( \text{CaCl}_2 \) have been used and their
hydraulic conductivity for distilled water have been found.
It is found that when the soils are prepared from $\text{NaCl + CaCl}_2$, its hydraulic conductivity is higher than the soil with the same Esp when $\text{NaCl + MgCl}_2$ are used. Therefore, whether the criteria of classifying water from SAR, as defined by United States Salinity laboratory, can be used to classify different soils for their hydraulic conductivity behaviour and ultimately the crop growth pattern will come out true or not. This problem has been systematically answered in the present work.

In Chapter IV hydraulic conductivity of mixed soils in relation to different fertilizer solutions has been studied. As such, use of nitrogenous fertilizer in the country attained the very high level, different nitrogenous fertilizers like $(\text{NH}_4)_2\text{SO}_4$, D.A.P and urea are in use comparing all the fertilizers at 0.5 % and 1.0 % amendment level, it is found that higher rates of infiltration are found for 1.0 % DAP in case of normal - 1a soil. The hydraulic conductivities are different for different Esp soils. This factor is important when different fertilizers are used in different seasons. Urea is used in a very large scale but, D.A.P. can be considered as better fertilizer than urea. From the study, it is interesting to note that these three nitrogenous fertilizer worked in two different ways.

(i) They provide nutrients for growth of crops.
(ii) They affect the soil structures by influencing the soil water relation, and further the availability of the moisture to the crops.
It has been possible to find out that from overall point of view of both nutrient supply as well as maintenance a good structure as judged by hydraulic conductivity. These three fertilizer can be placed in the following order.

\[ \text{DAP} > (\text{H}_4\text{H})_2\text{SO}_4 > \text{Urea} \]

In Chapter V soils saturated with different cations (Fe\(^+\), Ca\(^++\)) and the admixture of them have been taken for the study of hydraulic conductivity of solution of saturated gypsum, calcium chloride, ferric sulphate and alluminium sulphate. From the whole study, we could say calcium chloride and ferric sulphate may be considered superior chemical amendment for improvement of alkali soil, and it is possible to give the order:

\[ \text{CaCl}_2 > \text{Fe}_2(\text{SO}_4)_3 > \text{Al}_2(\text{SO}_4)_3 > \text{CaSO}_4 \cdot 2\text{H}_2\text{O} \]

According to USDA hand book no.60, thirty six inch or an larger rainfall area have been recommended the application of gypsum for improvement of saline-alkali soil.

In Chapter VI, the soil samples with TEC (total exchangeable cation) were used for various experiments. Water with different SAR (sodium adsorption ratio) and different salinity levels were used for infiltration study.
SAR values of 10, 25, 50, 75 and 100 have been selected. The salinity concentrations have been varied in each of the SAR water. From the study, the unpredictable dual behaviour of water sample with its effect on the infiltration rate can be easily traced out.

In Chapter VII, an attempt has been made to study seed germination under saline and alkali conditions (by using soils of different Esp and NaCl percentage). The general observation is that wheat is a salt tolerant crop and paddy is alkali tolerant raises a clarious question whether there can be further stratification of saline alkali conditions for different crop species. Many saline-alkali soils where paddy is grown as a monsoon crop, wheat can be grown as a winter crop, whereby the salt accumulation occurring during winter months due to capillary rise cannot have much effect on the standing wheat crop, and also that a congenial salt-free upper horizon will be created for the next paddy crop.

The seed germination study has shown that wheat (Triticum Vulgare) and Bajra (Pennisatum galacum) are saline tolerant, while sorghum (sorghum vulgare) and apdy (oriza sativa) can withstand a comparatively high Esp. Among the common pulses, Tuar (cajenus cajen) and Black gram (Phaseolus raddtus) seemed to be relatively more salinity as well as alkalinity tolerant.
Among oil seeds Mustard (Brassica nigra) tolerated 0.4 percent NaCl salinity at 15 Esp, but as Esp increased its salinity tolerance was still reduced. Sunflower, on the other hand, had a good Esp tolerance. Among vegetables Mogri (Raphanus sativus cedabas) seemed to be the most salt and alkali resistance crop followed by Reddish (Raphanus sativus) and Thantbalja (Amaranthus gangeticus).

The salt and alkali tolerance of a plant is highly dependent on movement of soil water minerals and air, which in turn is a factor to climatic changes.

Chapter VIII deals with the application of sulphuric acid (industrial waste) and a mixture of chemicals, sulphur + iron sulphate (both industrial wastes) + gypsum. Humic acid has been developed to reclaim saline alkali soils. During last ten years the chemists of Duchsager Dairy (Ahmednagar) were confronted with the problem of disposing of the waste sulphuric acid which amounted to two tonnes per day. In 1974, Dr R.K. Shah and his team of scientists from the Department of Chemistry making use of this acid waste for reclamation of saline-alkali soils. The first experiments were conducted in Sogodia (Patan taluka) and Koccharia both in North Gujarat.

The Central Soil Salinity Laboratory in India has suggested the use of sulphuric acid for alkali soils only but the present experiment revealed that in calcareous soil...
saline soils also, the results were quite encouraging. The formation of regularly spread Gypsum in soil by the action of sulphuric acid on the calcium present in the soil precipitated aggregation. This also increased soil permeability and removal of salts during the subsequent leaching. The chemistry department of Gujarat University has already reclaimed 1500 acres of land by these methods. The soils can be reclaimed within ten days after treatment. Of course, addition of water and providing drainage are essential for the success of these methods. It is also ably supported by the fact that the yield has been found to increase to 2-10 fold in different crops by these methods.

These methods are significant from the point of view that there are 20 lac acres of saline alkali land in Gujarat and about one crore acres in the whole of India. Hence reclamation by these methods are challenging processes to being economical revolution for the national development.