ROLE OF FAGMIL GYPSUM IN RECLAMATION OF SODIC SOIL

INTRODUCTION

Gypsum is a very soft mineral composed of calcium sulphate dehydrate, with the chemical formula $CaSO_4 \cdot 2H_2O$. India has huge resource of natural gypsum and 95 % of natural gypsum comes from Rajasthan. It is the second softest mineral on the Mohr's Hardness Scale. It is chemically calcium sulfate dehydrate ($CaSO_4.2H_2O$), when dissolved in water, it yields calcium ions (Ca^{2+}) and sulfate ions (SO_4^{2-}). Both of these ions are essential major nutrients for growing plants. Gypsum contains sulphur (18.6 %), which is very useful for agriculture use. In addition to this, calcium (23.25 %) also plays a vital role in establishing and maintaining good chemical balance in soil, water and plants. Gypsum is used as a chemical amendment for reclamation of sodic soil.

GYPSUM AS A CHEMICAL AMENDMENT

SALT AFFECTED SOILS:-

1. All soils contain some amount of soluble salts, which is indeed essential for the healthy growth of plants. If the quantity of this soluble salts, in soil, exceeds a certain level, the growth and/or the yield of most of the crops is adversely affected.
2. **Such soils, which contain excess soluble salts to adversely affect the plant growth, are called the salt-affected soils.**
3. THE SALT AFFECTED SOILS occur all over the country and the most affected states being Uttar Pradesh , Gujarat Rajasthan ,West Bengal ,Andhra Pradesh and Bihar.In India
4. The extent of Salt-affected soils has been estimated to be 10.1 million Ha by the National Bureau of Soil Survey & Land Use Planning, Nagpur. Most of the Sodic Soils in the country are confined to the Indo-gangetic Plains of Haryana, Punjab, Uttar Pradesh and Bihar.

   It is impossible to grow crops on such lands without addition of appropriate doses of chemical amendments.

   For economic utilization of sodic lands, it is essential to ameliorate them by replacing exchangeable sodium with calcium by the addition of soluble Ca, through external amendment. Gypsum and calcium chloride are most important amendments.

   Although calcium chloride is the most effective amendment but its cost prohibits its use due to economic limitations.
   The other kind of amendments are acidic in nature and reacts with native calcium carbonate invariably present in alkali lands. Amendments such as sulphuric acid, sulphur or Pyrite/Gypsum are grouped under this category.

CLASSFICATION OF SALT AFFECTED SOIL

The Salt Affected Soils can be classified in following two categories**:-**

A. Sodic (Alkali) Soil
B. Saline Soils

A. **Sodic (Alkali) Soil** : The Sodic Soils/Alkali soil have predominance of :

a) Sodium carbonate and bicarbonate salts
b) Excessive exchangeable sodium percentage (ESP >15)
c) High pH values (more than 8.5 but often exceeding 10)
d) Deficient amount of Ca, N and Zn
e) Low organic matter content
f) Electrical conductivity of saturation extract < 4dS /m

B. **Saline Soils :-**

Saline Soil possess:-

a) High concentration of soluble salts of chlorides and sulphates.
b) Electrical conductivity of saturation extract exceeding 4 dS /m i.e. ECe > 4dS /m
c) A variable exchangeable sodium percentage i.e. ESP < 15
d) Low range of pH values i.e. pH < 8.2

Among these amendments Gypsum is more commonly used in India because of their easy availability on reasonable cost.

BASIC PRINCIPLE OF RECLAMATION PROCESS

Saline soils are relatively easy to reclaim for crop production if adequate amount of low salt irrigation waters are available and internal and surface drainage are feasible. The main problem is to leach most of salts downward and out of contact with subsequent irrigation of water. But the reclamation of sodic soil may require technique modified from that used for reclamation of saline soils. In sodic soils, exchangeable sodium destroys the physical structure of the soil and makes it almost impervious to water. The sodium (Na^+) must first be replaced by calcium cation (Ca^{++}) and then leached downward and out of root zone. Calcium is often used to replace sodium in sodic soil, all calcium compound, calcium sulphate (gypsum, $CaSO4.\ 2H_2O$) is considered best and cheapest for this purpose. Calcium from Gypsum replaces sodium leaving soluble sodium sulphate in water which is then leached out (either by vertical leaching or drainage of the water from the field through channel)

APPLICATION AS CHEMICAL AMMENDMENT

i. **Soil Sampling and analysis:** First of all soil samples should be collected by farmers themselves after a brief training and analyzed in soil laboratories. The theoretical gypsum requirement is calculated for a layer of 15 cm of soil that depends upon the total quantity of $Na^{+\ to}$ be replaced on the clay complex. This also depends on the cation exchange capacity (CEC) of the soil and initial ESP. Though the quantity was estimated for a depth of 15 cm of soil but

ii. **Gypsum Application : Generally** 5- 12 Mt Gypsum is Required for one Hactare however the quantity of Gypsum to be required depends up on the nature of the soil like whether soil is of Class B Sodic Land [Growing One Crop per year] or Class C Sodic Land [Uncultivated throughout the year]

iii. **Period : -** This is a 3 year Project but the whole Gypsum are mixed with the soil ,during 1^{st} Year. The quantity of Gypsum recommended, depends on the nature of the soil. It is better to use the gypsum in Khariff season rather the rabi season. From 2^{nd} yr and onward the proper agronomical practices should be followed to reclaim the soil.

iv. **Gypsum mixing and leaching:** Gypsum is mixed thoroughly in the soil spreading over the fields. Gypsum is applied after initial flushing of salts with irrigation. Gypsum mixing is followed by impounding of water for 12 to 15 days thereafter once soluble sodium is flushed out through field drain /link drain.

v. APPLICATION OF AMENDMENTS

1. Gypsum :

$$\text{Soil}^{Na+} + CaSO_4 = \text{Soil}^{Ca++} + Na_2SO_4 \text{ (Leached)}$$

2. Sulphuric Acid

$$H_2SO_4 + CaCO_3 = CaSO_4 + H_2O + CO_2$$

$$\text{Soil}^{Na+} + CaSO_4 = \text{Soil}^{Ca++} + Na_2SO_4 \text{ (Leached)}$$

3.Pyrites :

$$2FeS_2 + 7O_2 + 2H_2O \rightarrow 2FeSO_4 + 2H_2SO_4$$

$$H_2SO_4 + CaCO_3 \rightarrow CaSO_4 + H_2O + CO_2$$

$$\text{Soil}^{Na+} + CaSO_4 = \text{Soil}^{Ca++} + Na_2SO_4 \text{ (Leached)}$$

SODIC LAND RECLAMATION EFFORTS IN UTTAR PRADESH BY USE OF FAGMIL GYPSUM

UPBSN has been the Implementing Agency for four Major Projects for sodic lands Reclamation in UP.

Sl.No	Name of Project	Target (Ha)	Achievement (Ha)
1.	UPSLRP-I (1993-94 to 2000-2001)	45000	68618
2.	U.P. Alkaline Land Reclamation Development Project (1993-94 to 2000-2001)	16000	26375
3.	UPSLRP-II (1999 to 2007)	1,50,000	1,89,715
4	UPSLRP-III (2010 to--------)	1,30,000	Running

OBJECTIVES OF THE ABOVE PROJECTS

1. Develop Concomitant model for environmental protection and improved agricultural production.
2. Strengthen local institutions enabling effective management of such programme with strong beneficiary participation and NGO support.
3. Contribute towards poverty alleviation of families managing sodic lands.
4. Sustainable reclamation of sodic lands and prevention of further increase in sodicity with highest concentration of sodic areas.This objective would contribute significantly to poverty alleviation in these areas.