CHAPTER-2

REVIEW AND LITERATURE
2.1 WASTE LAND RECLAMATION

Waste recycling through composting and land application is a relatively new field. It was begun in the 1960's as an alternative to land filling and as a way to amend or fertilize degraded or nutrient-depleted soils. Waste recycling techniques focused mostly on municipal solid wastes, sewage sludge and industrial solid wastes. These techniques continued to develop and gain interest throughout the following forty years largely due to stricter environmental regulations in assigning landfill permits (Rosen et al. 1993) and an abundance of studies focused largely on land application (Chaney 1990). Recycling food processing wastes and paper mill and cardboard sludges are more recent developments in the field of waste recycling and are just beginning to be explored.

In 1979, P.H. Glatfelter Co., a large paper company, began to consider landfill alternatives for the disposal of their primary and secondary paper sludges. In light of what they felt was changing technology, growing public awareness and tightened government regulations, the company began preliminary tests and a pilot scale composting facility. By 1980, they were composting 90 out of the approximately 300 tons of primary and secondary sludge produced per day. In addition, the money the company saved by composting was able to offset the cost of the pilot facility (Smyser 1982). Their success marked the beginning of numerous other studies exploring the feasibility of paper mill composting, and the effects of sludge and compost land application (Henry 1991, Pichtel et al. 1994, Kost et al. 1997).

Landfill alternatives for food residues received only intermittent attention and were slower to gain interest. In 1962, the Food Processors Association published the results of their study done on composting food wastes from fruit and vegetable processing industries (Riggle 1989). Twenty seven years later, in 1989, their study results were "rediscovered" and published under the new title "Revival time for composting food industry wastes." Shortly afterwards other studies were published on composting and land application of numerous other food processing residuals (Cato 1989). By 1995, the number of composting projects being implemented was on the rise. Canada experienced a 17% increase in their number of projects from 1993 to 1995. This increase was partly due to cooperation between composters and
local industries. Composters found they could easily obtain reliable feedstock supplies from local industries, specifically granaries, while helping the industries dispose of large volumes of a particular type of organic residual (Gies 1995).

Today, the composting market continues to grow as more opportunities for environmental applications are being discovered (Alexander 1999). Erosion control is a fairly new and promising application for composts. Compost applications can often stabilize slopes more effectively than the conventional methods of hydro seeding and hay or straw mulching by absorbing the energy from rainfall and reducing flow velocity and improving percolation rates. Composts should be applied 3-4" deep and can be used on slopes up to 2:1. Composts can also be used for soil reclamation and re-vegetation of sites with marginal or degraded soils, such as landfills, factories, roadsides, and mines. Composts supply the soil with microbes and essential plant nutrients such as carbon, nitrogen, and phosphorus, which increase soil quality and enhance plant establishment. Composts can also immobilize toxic metals and filter out pesticides (Alexander 1999).

Common Reclamation of Alkaline Soils

Alkaline soil Reclamation is a process which is practice since time immemorial. The common methods involve the use of the following gypsum, pyrites. Reclamation of alkaline soil is more difficult than saline soils and involves replacement of sodium by calcium from the soil exchange complex followed by leaching the Na from the root zone. Reclamation of alkaline soils therefore, aims at reducing exchangeable Na percentage to the extent that it does not degrade the soil physical properties or interfere with the plant growth. For this purpose a number of soil amendments are used which include Gypsum, Pyrites, and Sulphur etc.

Gypsum:

The annual availability of mined and Gypsum in India is roughly 2.5 million mg, which is sufficient to meet the demand for agricultural use. Considerable research information is available on optimum dose and method of application of gypsum for amending alkaline soils (Kanwar and chawla, 1963; Singh, et al, 1969; Bhumla and Abrol, 1972; Abrol, 1973 ).
The Gypsum is considered best of all calcium compound. It is easily available and has greater efficiency. Gypsum reacts with the exchangeable sodium, which gets converted into Sodium Sulphate. The Sodium Sulphate is leached from the soil to reduce soil pH and improve the physical condition of the soil. The chemical reaction is

$$\text{Soil } \text{Na}^+ + \text{CaSO}_4 \rightarrow \text{Soil } \text{Ca} + \text{Na}_2\text{SO}_4$$

$$\text{Na}_2\text{CO}_3 + \text{CaSO}_4 \rightarrow \text{CaCO}_3 + \text{Na}_2\text{SO}_4$$

Both these reactions are reversible, so adequate leaching arrangements have to be made to leach out Na$_2$SO$_4$. The effectiveness of Gypsum in the reclamation of sodic soils depends on the fineness (2 mm mesh), quantity and depth of its application. The rate of application of Gypsum is usually 2.5 to 3.0 t/ha, but more quantities may be added, depending on the soil pH and concentration of exchangeable sodium present in the soil complex. It should be applied on the soil surface and mixed by harrowing two to four weeks before sowing a crop.

**PYRITES:**

Waste material of the steel industry and can be therefore be available to farmer at a fairly low price. This materials has been widely used in India. Recently, Pyrites are used as amendment in the chemical amelioration ad reclamation of alkali soils. (Singh et al., 1978; Verma and Abrol, 1976)

Chemically, it is a iron sulphide (FeS$_2$). Pyrite contains Sulphur which decrease pH of the soil by forming sulphuric acid.

$$\text{FeS}_2 \rightarrow \text{FeS} + \text{S}$$

$$4\text{FeS} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 + 4\text{S}$$

$$2\text{S} + 3\text{O}_2 \rightarrow 2\text{SO}_3$$

$$2\text{SO}_3 + 2\text{H}_2\text{O} \rightarrow 2\text{H}_2\text{SO}_4$$

The biological oxidation of pyrites is carried out by Sulphuric oxidizing bacteria *Thiobacillus thiooxidens* and *Thiobacillus ferrooxidens* resulting in the
formation of sulphuric acid. Sulphuric acid then reacts with CaCO₃ which is generally present in such soils and form calcium Sulphate.

\[
\text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2
\]

Soil $\text{Na}^+ + \text{CaSO}_4 \rightarrow \text{Soil Ca} + \text{Na}_2\text{SO}_4$ (leached)

Sodium present in exchange complex is displaced by calcium decrease in pH.

**SULPHUR:**

Sulphur is used as amendment in the chemical amelioration ad reclamation of alkali soils (Talati, 1947; Kanwar and Bhumbla, 1957-1962).

Sulphur is oxidized to SO₃ which when dissolved in water produces sulphuric acid which convert calcium carbonate into sodium Sulphate. The chemical reaction is as follows

\[
2\text{S} + 3\text{O}_2 \rightarrow 2\text{SO}_3
\]

\[
2\text{SO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{H}_2\text{SO}_4
\]

\[
\text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{H}_2\text{O} + \text{CO}_2
\]

Soil $\text{Na}^+ + \text{CaSO}_4 \rightarrow \text{Soil Ca} + \text{Na}_2\text{SO}_4$ (leached)

Sodium Sulphate is removed by leaching. It is helpful to add organic matter when Sulphur is added to correct alkalinity. This organic matter supplies food to bacteria, which oxidize Sulphur to Sulphate form, improves soil structure and provides nitrogen to crops. The quantity of sulphur required would depend upon the soil and climatic conditions. Ordinarily ground sulphur may be incorporated into the soil by a harrow or country plough several weeks before planting of the crop.

**IRON SULPHATE:**

It is sometimes used as chemical amendment for improving alkali soil. Iron Sulphate forms sulphuric acid which is converted into calcium Sulphate with calcium carbonate. Calcium Sulphate thus formed replaces exchangeable sodium and sodium Sulphate formed is removed by leaching.
FeSO₄ + H₂O → H₂SO₄ + FeO
H₂SO₄ + CaCO₃ → CaSO₄ + H₂O + CO₂
CaSO₄ + Clay Na → Clay Na + Na₂SO₄

LIME STONE:

When limestone is applied to the soil, it gets dissolved in the soil solution. The calcium part of the limestone reacts with the soil complex and replaces sodium. Sodium combines with carbonates cations to form sodium carbonate which is leached out of the soil by flooding.

Clay Na⁺⁺ + CaCO₃ → Clay Ca + Na₂CO₃

MOLASSES:

Molasses are also used near about sugar cane factories to reclaim alkali soils (Dhar, 1934; Dhar and Mukerjee, 1938; Talati, 1947; Kanwar and Bhumbla, 1957-1962). The molasses provide a source of energy for microorganism and on fermentation produce organic acids. These acids reduce alkalinity.

In past no body tried with more industrial wastes at a time where as some research has been done by following scientists

- Abdullah Adil Ansari, 2008, Publication in World Journal of Agricultural Sciences, reported various changes occurred in alkaline soils during reclamation trials through the application of Organic amendments (Vermiwash, Tilage, Green Manure, Mulch, Earthworms and Vermi Compost). The results were comparable to our data.

He has studied extensively soil condition with all chemical analysis based on his trails in various stages as below

1. Initial alkaline soils.
2. Stage 1: reclaimed soil (after ½ year)- reclamation using Vermiwash, Tilage, Green Manure, Mulch, Earthworms and Vermi Compost.
3. Stage 2 Reclaimed soil after 1 year after harvest of wheat and paddy.
4. Stage 3: Reclaimed soil after 1 and ½ years after harvest of wheat.
5. Stage 4: Reclaimed soil after 2 years after harvest of paddy at various soil depths (00-15cms, 15-30cms, 30-45cms, 45-60cms, 60-75 cms, 75-90cms.).

This research revealed that

- pH can be achieved by using this method from 9.4-8.2. (Depth 00-15cms).
- EC can be achieved by using this method from 1.05-0.42 dSm⁻¹ (depth 00-15cms).
- Organic Carbon % can be achieved by using this method from 0.24 to 0.82% (00-15cms).
- Available Nitrogen (kg/ha) can be achieved by using this method from 337.60 to 836.80 kg/ha (00-15cms).
- Sodicity can be achieved by using this method is from 85.59 to 12.78ESP (00-15cms).

- **T. Raychev, S. Popandova, 2001**, Publication in *Int. Agro physics*, 2001, 15, 51-54, Physiochemical reclamation of saline soils using coal powder. In this study scientists done reclamation of alkaline soils in pots methods by using coal powder and studied extensively chemical qualities of soil at various stages
  1. Original soil +NPK
  2. Original soil +NPK+FeSO₄ washing with water
  3. Original soil +NPK+FeSO₄ washing with water+ Coal powder.

Reclaimed soil analysis was done after 6 months of the vegetation experiment.

This research revealed that

- pH can be achieved by using this method from 8.0-7.7
- EC can be achieved by using this method from 4.97-1.36 dSm⁻¹.
- Sodium exchange (cmolkg⁻¹) can be achieved by using this method from 5.0 to 0.24.
- Biomass can be achieved by using this method from 0 to 19.3gm/pot.

And also explained details about yields at addition of various quantities of powder coal (@20MT/ha, @40MT/ha, @60MT/ha) and suggested for suitable reclamation is possible coal powder addition @60MT/ha.

Reclamation of saline sodic soils by Rice Husk.

In this study scientists done reclamation of alkaline soils by using Rice Husk at varies doses like 0.1%, 0.2%, 0.3% up to 15 cms depth.

Total experiment done on 12 plots of each 391 sq.mts and rice husk added based on weight of rice husk applied was calculated from the percentage of the weight of 15 cm soil depth.

1. Reclaimed soil analysis was done after 2 and ½ years of the vegetation experiment.

This research revealed that

- pH can be achieved by using this method from 8.20 - 7.7
- EC can be achieved by using this method from 7.99 to 5.61 dSm⁻¹
- ESP from 16.71 to 10.22
- Organic Matter% from 0.68 to 0.91

- Yield of Cotton kg/ha can be achieved by using this method from 460 to 920 and wheat kg/ha from 880 to 1990 kg/ha.

And also explained details about yields at addition of various quantities of powder coal (@20MT/ha, @40MT/ha,@60MT/ha) and suggested for suitable reclamation is possible coal powder addition@60MT/ha.


Reclamation of Saline – Sodic Soils with Gypsum and MSW Compost.

The effectiveness of sequential application of gypsum followed by matured mixed municipal solid waste compost was investigated for the reclamation of saline – sodic soils. Soil plots were treated with 50Mt/ha of gypsum followed by addition of matured MSW compost at the 50,100 and 150MT/ha with five replications for each treatment. A number of physical, chemical and biological properties were investigated. The results of this study shows that the sequential application of gypsum followed by matured MSW compost can effectively restore degraded soils sufferings from high soluble salts and exchangeable sodium content.
This research revealed that

- pH can be achieved by using this method from 9.75 to 8.22
- EC can be achieved by using this method from 12.35 to 2.53 dSm$^{-1}$
- ESP from 44.75 to 7.22.
- Organic Matter% from 0.61 to 1.46.
- Recommended dosage: 50Mt/ha of gypsum and MSW compost 150MT/ha.

However after recognizing the nutrient value of industrial effluents which were until then treated as waste, its application to soil, especially to waste lands for making it amenable for agricultural came in to practice. Given bellow are the case studies of different industrial effluent which were used agricultural

- In 1998 the environment protection authority (EPA) unveiled anew industrial waste strategy that is specially targeted at solid and liquid wastes generated by Victorian industries (Jay Maheswaran et...al).

- In long term field experiment at Prague-Ruzyne (since 1955), the effect of different organic fertilizers, (farmyard manure, pig slurry, straw, cattle slurry, poultry slurry, straw, compost) on the plant yields, nutrient uptake and nutrient status in soil has been investigated (J.klier,P.Ruzek,et...al).

- Gregory, Kevnylo,et..al., investigated the applicability of wastes from paper mill industry effluent for land reclamation and found it to be reliable source of nutrient supplement.

- The use of industrial waste water for use in agricultural has been dealt with by (Maria Luisa de esperza) and was concluded that industrial effluent also have some twice substances that may have adverse impact on plant and animal life (Risk associated).

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Krystyna Malinska has come out with planned strategy on use of wastes from food processing industry for land reclamation and also has given the existing system of waste utilization practiced in Poland.

K.C. Camern, et al., stated that industrial wastes have been used in agricultural in New Zealand and Australia and observed that the management of waste application on land is a challenging task and requires rigorous scientific input (application of land).

M.Kumaravelu, et al., (2000), Investigated the effects of tannery effluent on soil properties for the growth of finger-millet. Raw effluents undiluted were found to reduce the grain and straw yields whereas the diluted effluent along with composted coir pith recorded higher yield.

Industrial waste obtained from the sulphuric acid plant of south India. Viscose Rayon factory, Sirumugh, Coimbatore Dist was found to effectively replace gypsum reclaiming alkaline soils and also it was twice cheaper than zpysum (P.Singaram ; C.K.Rajagopal-1983).
Jothimani, et al., (December, 2002) investigated the impacts of dyeing factory effluents on germination and growth of maize and cowpea. Their findings revealed that lower concentrations (25% to 50%) of the effluent favored the seed germination and growth of seedlings and increased microbial activity in soil.

K. Annadurai, et al., (1999) conducted studies on the effects of distillery effluent and organic amendment on rice yield and soil fertility. The results revealed that addition of neem leaves at 6.25 ton/ha increased the rice yield without causing any detrimental effects on soil health. It was also found that the treated distillery effluent irrigations resulted in significant increase in soil pH, E.C & organic carbon.

V. Velu et al., (March 1999) studied the impact of paper mill effluent on the yield, nutrient content and their uptake in rice. Effluent irrigation resulted in an increase of Ca and Na content and a reduction of K content on rice grain and straw. A 50% clarified effluent was found superior to raw effluent irrigation.

P. Chitralekha, et al., (1997) investigated the effect of cement kiln dust depositions on the physical and chemical properties of soil and found that there was a negative on the bulk density of soil. Whereas the porosity of the soil was found to increase. Likewise Ca, K and Na were found to decrease.

Fly ash collected from thermal power station, Ekalahare Dist, Nasik, Maharashtra was analyzed as an additive to black cotton soil and it was found that the fly ash increased P, K, Ca, Mg, S, Fe, Cu, Zn and Mn in micro lands. A addition of 7.5% was found to be effective.

The use of spent wash- a distillery waste for reclamation of alkaline soils and was found that it increases the Ca and Mg content of soils and reduced the pH of soils (Rachpal Singh et al.).

2.2 Fodder Grasses

The importance of green fodders in relation to nutrient values for livestock stimulated the interest of research workers in chemical composition. Adequate
chemical analyses conducted by researchers have resulted in new prospective. Such efforts, worldwide in scope have more or less unabated to the present time. The research work on such lines may be classified into

1. The work relating the energy providing nutritive components i.e., proximate and cell wall constituents, and

2. Nutrients that have metabolic role in facilitating the digestion and assimilation of energy nutrients i.e., minerals and vitamins. The available literature on the above two aspects has been reviewed as under.

- **Garcia and Garcia (1976)** studied the effect of three different growth stages during two growing stages on ten pasture plants including *medicago sativa* and *trifolium protange*.

- **Gupta and Pradhan (1977)** determined the nutritive value of *beersdem*, cowpeas, guar, lucern, white Senji and fenugreek at prebloom, bloom and postbloom stages.

- Nutritive value of *beerssem* and cluster bean forages was estimated by **Chauvahan et al, (1980)**.

- **Deramus (1980)** examined the quality of selected forage legumes throughout the growing season in Arkans.

- **Khatta and Katochi (1984)** reported that Barley and Chloris species showed levels of CP at Palampur than at Jawalamukhi. It was further reported that of the rabi fodders, *berseeem* had the highest CP(27.60%) and lowest CF(12.79%) contents.

- **Lohan el al., (1983)** studied carbohydrate content of *beerssem* and its effects on in vitro dry matter digestibility.

- Nutritional characteristics of *Kura Clover* and other forage legumes were examined by **Allison et al. (1985)**.

- **Hafley et al (1985)** examined crude protein in different forages. CP content was highest in *V. Sativa* cultivar vanguard and *T. subterraneum* cultivar.
Fagerberg (1988) studied the change in nutritive value in red clover and lucern in relation to phonological stage cutting time and weather conditions.

Khan (1994) while conducting protein extraction studies on berseem analyzed it for proximate composition at weekly intervals from January to April.

Joshi and Upadhyaya (1976) reported the crude protein 6.9 and crude fiber 30.5% in the hay of paragrass. They showed that the hay could supply sufficient energy, protein and minerals for maintenance of sheep on voluntary intake.

Gupta and Pardhan (1977) studied the effect of stage of maturity on chemical composition of non-legnum forages.

Different improved fodder varieties were analyzed by Balasubrahmanya el al (1978). Among three varieties of maize forage, five of jowar forage (Sorghum vulgave), one of bajrâ in DM crude protein was from 6.25% in jowar to 10.10% in south African maize.

Harris el al (1982) reported nutritive components of sorghum bicolor fodder at early vegetative, mid bloom and milk stage were DM, 18, 30 and 36%. EE, 3.9, 1.8 and 1.5%, NFE 46.9, 49.7 and 50.2%, NDF 56, 66 and 70%, cellulose 30, 33 and 34% respectively.

Jakhinola and Pathak (1983) studied natural pasture dominated by sorghum halcpense or Andropogen contorious was cut at the pre-flowering stage. Nutritive values were DM 29.5 (49) and 38.5(47) and in DM, crude protein CP 5.9 (43) and 4.4(29).

Gabra et al (1989) was studied nutritional studies on some local and improved sorghum sown in reclaimed soil. DM content of ten local and improved varieties of sorghum sown in reclaimed soils in UP ranged from 17.94 to 21.03%. on DM basis the herbage contained 10.32 -11.09% crude protein.

Arora et al (1977) was studied nutritive values for 12 genotypes of Pennisetum pedicellium cut 95 days after sowing and reported DM 15.2 to 28.5 crude protein 3.5 to 6.0, neutral detergent fibre 60.3 to 64.5.
Patel et al (1977) conducted a study on yield and chemical composition of 5 varieties of Cowpeas and reported fresh matter 196 to 494, DM 29.1 to 58.4 and crude protein 6.3 to 10.3 quantals/ha.

Wanpat et al (1989) reported the nutritive value of cowpeas. 27 cultivars were harvested at pod maturity when approximately 50% leaf matter was green, leaf and stem CP contents were 23.8 and 14.3% of DM, respectively, correspondingly acid digestible lignin values were 8.0 and 7.2 % and in vitro digestible DM was 67.3 and 63.7%.

In a study on cowpeas fodder Ranjhan (1991) reported that cowpeas fodder contained DM 18.0 to 25.5%, CP 16.5 to 28.1% CF25.3 to 30.9% EE 3.0 to 2.6% ash 9.2 to 14.2% and NEE 33.1 to 39.6%.

Hunt et al (1992) analyzed the maize fodder for their chemical compositions and reported NDF 41.7 to 49.0 and 50.3 to 64.1% respectively, ADF 23.9 to 28.3 and 31.7 to 41.0% respectively and lignin 2.6 to 3.3 and 31.1 to 4.4% respectively.

Ranjhan (1991) reported berseem fodder to contain Ca, 1.44 to 2.89%, P 0.14 to 0.40, Mg 0.19 to 0.47%, Na 0.27 to 1.91%, K1.11 to 4.22, Fe 429 to 610 and zn 50.1 ppm.

Gupta et al (1981) analyzed and reported leaf to stem ratio changes from 1.5:1 to 0.08:1. DM increased from 15.2 to 22.4 and average 21.5%.

Berger et al (1985) observed changes in the mineral concentration of alfalfa with advance in maturity.

Khalid and Durrani (1989) analyzed samples of lucerne fodder and reported that it contained Ca, 16.1 % P 2.8% Na 1.2 % K 4.1% Fe 0.3 % and Ca: P ratio as 5:8.

Ranjhan (1991) reported mineral analysis of alfalfa as Ca 0.75 to 1.40%, P 0.22 to 0.39 % Mg 0.27 to 0.53%.

Erickson el al (1977) studied Kelsey and Dal varieties of oats harvested at 6 growth stages from late boot to mature.
Ranjhan (1991) reported mineral contents of oats as Ca 0.48% P 0.33% Mg, 0.22% Na 0.81% and K 4.38%.

Wheeler et al (1983) was estimated the sodium content of sorghum and reported all are in the range of <0.06 % Na.

Awad et al. (1979) estimated concentration of Ca throughout the year is estimated 0.15 to 0.28%.

Bittencourt et al (1987) analyzed the mineral composition of some species of forage grasses during their vegetative cycles and reported differences in mineral composition were found especially between P.Purpurestan and P.Maximim.

Fonseca et al (1988) for mineral content of posture grasses in southern coasta rica. Average CP, Ca, P, Mg and K contents were 7.42,0.27, 0.14, 0.16 1nd 1.7 % of DM respectively.

Khatta and Kaloch et al (1981) reported that berseem contained sufficient Cu(2.03 mg/100g) and marginal levels of Zn (4.67 mg/100g).

Khalil and Durrani et al (1989) reported the mineral composition of cowpeas as Ca 12.5%, P 4.7 % Na 0.3% K 2.5 % Fe 0.2% and Ca: P ratio 2:7.

Ranjhan (1991) reported the carotene contents of various local fodders. Average carotene contents of oats were 258 to 429 μg/g.
CHAPTER-3

MATERIALS AND METHODS