Domestication of Agroforestry Trees for Amelioration of Salt Affected Soils

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The word *domestication* has had several definitions and interpretations since its first appearance in the English language in 1639. Most commonly the word is used with reference to annual food crop plants that have undergone adaptation in agricultural systems. Archaeologists concur that annual crop domestication began with wheat 10,000 years ago in Eurasia at a time of rising human populations and over-exploitation of local resources (Simmonds 1979). Tree domestication is a far more recent phenomenon than annual-crop domestication. One of the earliest records of tree domestication is that of manipulating pollination in *Ficus* trees 2800 years ago by the prophet Amos (Dafni 1992). Domestication of other agro forestry trees has received substantial interest following a number of articles and conferences, most significantly the 1992 IUFRO Conference in Edinburgh, UK (Leakey and Newton 1994). In agro forestry, tree domestication is concerned with thousands of tree species and millions of subsistence farmer concerned with on-farm use of firewood, fodder, fruit, live fence, medicinal and fallow trees. The next large change in agro forestry worldwide, will probably on a greater focus on cultivating trees for cash and most likely for amelioration of problem soils. For these reasons, the World Agro forestry Center introduced a wider concept of tree domestication: Domestication of agro forestry trees is an *accelerated and human induced evolution to bring species into wider cultivation through a farmer-driven or market-led process*. Tree domestication is the naturalization of a species to improve its cultivation and use for humankind. Basically, any activity that improves the ability of people to grow and utilize trees – either for products or services – is domestication. (Simons 1996).

Objective and Strategies for Tree Domestication

Trees occur naturally in forests and rangelands and can be grown in commercial plantations and on farms. With current tropical deforestation rates at around 1%, principally for expansion of agricultural areas, and even with the most optimistic increases in timber-plantation estates (FAO 2003), the largest scope for future tree planting in the tropics will be on agricultural land (Simons *et al.,* 2000). In agro forestry, the objective of domestication is to enhance the performance of trees in terms of improved tree products, such as timber, fruits, and medicines, and/or improved environmental services, such as the amelioration of soil fertility

Domestication strategies for individual species vary according to their functional use, biology, management alternatives and target environments. The intensity of domestication activities warranted for a single species will be dictated by a combination of biological, scientific, policy, economic and social factors. The determinants of a sound domestication strategy for an individual species are:

Reasons for domestication (home use, market, conservation (species), agro ecosystem diversification, conservation and amelioration of soil, improved livelihood strategies)	Nursery production and multiplication
Tree uses required (products and services)	Propagule types
Collection, procurement or production of germplasm and knowledge.	Tree productivity.
Species biology (reproductive botany, ecology, invasiveness).	Pests and diseases
History, scale of cultivation, natural distribution and eco-geographic survey	Evaluation - scientific and farmer participatory.
Scale and profile of target groups (biophysical, market, cultural).	Dissemination, scaling up, adoption and diffusion.

Why Do Farmers Plant Trees?

Farmers grow trees mainly for two reasons, either for the ***products*** or for the ***services*** provided. **Products**: trees are used for building construction, fuel wood, pulp for paper, resin or latex, leaves, fruits, roots, fodder, medicine etc. **Services**: trees are used as shelter, to control soil erosion, to improve soil fertility, to ameliorate soil, to maintain or improve soil structure, conserve biodiversity, or sequester carbon to reduce atmospheric green house gas and thus reduce global warming.

Salt Affected Lands in India

Out of 329 million ha geographical land area of the country about 175 million ha suffers from different problems and is getting further degraded through natural or man-made processes. Majority of these lands is treated as wastelands as their productivity is low due to soil based constraints like water logging, salinity, alkalinity, lack of depth and sandy, stony or gravelly soils. Distribution and properties of salt affected soils in India is given table 1 & 2.

The possible sources of excess salts are one or more of the following

• High salt deposits inherited by the soil from the original parent material during soil forming processes. Certain parent materials provide exceptionally large amounts of bases that maintain a high base status in young soils.
• Salts contained in the irrigation water applied or water lost in conveyance through irrigation distribution systems.
• More salts in water inflows (seepage) from upslope.
• Salts coming through upward movement (capillary action) of water from ground close to the soil surface.
• High sub-soil water table and aridity.
• Salt bearing winds in the coastal areas and back water flow or intrusion or ingress of seawater in coastal area such soils are met in the Rann of Kutch in Gujarat.
• Poor drainage is the single most important factor contributing to the development of such soils. The salts in badly drained soils accumulate on the ground level and also nodules are formed underneath in the summer when water evaporates.
• Use of saline and brackish water for irrigation can bring about salinity.

Scope of Agroforestry:

A large acreage of lands in arid and semiarid parts of the country can no longer be cultivated due to the salt problem. Due to the adverse edaphic environment of salt affected soils, they are devoid of any vegetation and restrict the choice of arable crops to be grown. As of no additional land resources are available for horizontal expansion of agriculture, we need to find out viable technologies for utilization of existing land resources including the wastelands in order to meet future requirements of food, fodder and fuel. Therefore, it has become necessary to develop the salt affected marginal wastelands for productive land use system. Amelioration of salt affected soils with the domesticated agro forestry trees will reduce the pressure on the productive lands to fulfill the food needs of the growing population and environmental concerns.

Table1: Distribution of salt affected soils in India: (Source: Gill *et al.,* 1997)

Broad groups	States	Approximate area (m.ha.)
Coastal salt-affected soils (a) Coastal salt-affected soils of Gujarat (b) Deltaic coastal salt-affected soils in the humid regions (c) Acidic salt affected soils	 Gujarat West Bengal, Orissa, Andhra Pradesh & Tamil Nadu Kerala	 0.714 1.394 0.016
Salt-affected soils of the medium and deep-black soils	Karnataka, Madhya Pradesh, Andhra Pradesh & Maharashtra	1.420
Salt-affected soils of the arid and semi-arid regions	Gujarat, Rajasthan, Punjab, Haryana & Uttar Pradesh	1.000
Alkali soils of the Indo-Gangetic plains	Haryana, Punjab, Uttar Pradesh, Bihar, Rajasthan & Madhya Pradesh	2.500
Total area under salt affected soils		**7.044**

Table 2: Properties of saline and alkaline soils (Source: Gill *et al.,* 1997)

Properties	**Saline soils**	**Alkali soils**
ECe at 25°C,dSm^{-1}	4.0 or more	Generally less than 4.0
PH	Less than 8.2	8.2 or more
ESP	Variable	15 or more
Chemistry of soil solution	Dominated by chlorides and sulphates of sodium, calcium and magnesium	Dominated by sodium carbonate or sodium bicarbonate or both
Effect of electrolytes	Aggregation	Dispersion
Main adverse effect (toxic) on plants	High Osmotic pressure	Alkalinity of soil solution and its corrosive effect on plant roots
Geographical distribution	Associated mainly with arid and semi-arid climates	Associated mainly with semiarid and sub-humid climates

Why Agroforestry?

To expand the net area cultivated and gross area	*To change from one kind to of farming system to another.*
To improve the capture and better utilization of environmental resources.	*To increase yields and/or decrease yield variability through technology change.*
To limit losses due to pests and diseases.	*To decrease in environmental degradation.*

What is Agroforestry?

Agro forestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.,) are deliberately used on the same land - management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agro forestry systems there are both ecological and economical interactions between the different components (Lundgren and Raintree, 1982)".

Agro forestry systems, provides alternatives for restoring soil health and amelioration of salt affected soils for their productive use. The systems, which are suitable for the salt affected soils, are,

Agri-silvicultural system (crops and trees including shrubs/vines and trees): This system involves the conscious and deliberate use of land for the concurrent production of agricultural crops including tree crops.

Silvi-pastoral system (trees + pasture and/or animals): The production of woody plants combined with pasture is referred to as a silvi-pastoral system. The trees and shrubs may be used primarily to produce fodder for livestock or they may be grown for timber, fuel wood and fruit or to ameliorate the problem soil.

Multipurpose wood lots: In this system special location specific MPTS are grown mixed or separately planted for various purposes such as wood, fodder, soil protection, soil amelioration etc.

Agri-silvi-horticultural system: In this system salt tolerant tree and horticultural plants are grown along with arable crops.

Choice of Tree Species Selection

Planting site matched tree species with appropriate tree planting technique in salt affected soils exerts bioameliorative effects, in addition to providing forest cover, fuel wood, fodder, timber and preventing soil and water loss through runoff besides improving the microclimate of that area. Since saline and alkaline soils differ from each other, methods of working the soils will also be different.

The nature and amount of salt, relative proportion of sodium ions, physical conditions of the soil and moisture regime govern choice of tree species selection. The following should be kept in mind while selecting species,

Adaptiveness of the species to local environment - Species should have the capacity to tolerate variable salt concentrations, fire, frost, occasional flooding and other extreme climatic hazards.	Species should be drought resistant as the high salt contents in soil solution also cause physiological drought.
Species should have low water and nutrient requirements.	Species must be devoid of allelopathic potentialities.
Species should be perennial, cheap enough to establish and easy to manage.	Species should have the capacity to improve soil physical, chemical and biological properties through root activity, litter fall etc.,
Species should be fast growing and should have the capacity to re-sprout quickly after pruning and pollarding, so that farmer can quickly realize the returns through short rotation forestry.	Species should posses a high photosynthetic efficiency and greater biomass production efficiency.
Species should have high coppicing ability for several sustained cycles, self-pruning capacity/ability to withstand heavy artificial pruning.	Species should be capable of producing a prolific root system to facilitate drainage from waterlogged saline soils
Species should have multi-utility value (MPTS) such as firewood, liquid fuel, food, high palatable fodder with nutrient value and minimum anti-quality factors, fiber, edible or non- edible oils, medicinal product, paper pulp and ability to fix atmospheric Nitrogen etc.,	Species selected should have high demand and better value for the produce.

General Planting Technique

- Healthy, well-grown, sturdy and tall plants raised in polythene bags should be used.
- Planting should be done immediately after the break of monsoon in sodic soils.
- In saline soils it should be done after 2-3 heavy showers when the maximum leaching of salts has taken place.
- Under irrigated conditions, winter planting can also be done.
- To reduce the compaction of soil, to facilitate proper aeration and moisture conservation, hoeing and weeding are essential. Hoeing promotes the root development and growth of plants and facilitates infiltration of water.

Influence Of Trees On Salt Affected Soils

- In areas having good tree cover, most of the moisture is lost through transpiration rather than through evaporation from the soil surface. Thus, deposition of salts in the upper layers of the soil is minimized because the shade of the vegetation retards soil moisture evaporation and thus reduces the upward movement of ground water containing salt to the soil surface.
- In areas with high water table, salt accumulation on the surface is prevented due to lowering of the water table because of accelerated moisture loss of the trees.
- Revegetation using deep-rooted perennials is seen as a method of reversing the salinity problem. The deep and sturdy root systems of tree open up the soil and improve water permeability and facilitate leaching of salts. Fine roots have contributed significantly in the reclamation of soil structure, pH and water permeability.
- Exudation of organic acids by tree roots neutralizes the alkalinity of soils.
- The decrease of bicarbonate levels in soils under tree cover is due to increased litter fall, organic carbon content and root activities. Usually organic residue addition from the leaf litter and root dyeing over the years promote microbial flora and fauna in soil and thus helped in generation of high fluxes of carbon dioxide. In addition to this, complementary effects of other decomposition products like soluble organic acids, amino acids, sugars etc. and root exudates favored the dissolution and translocation of bicarbonates in soils.
- As the trees grows, a large amount of litter is shed on the ground, which during decomposition releases several weak acids (humic and fumic) to lower down soil pH and EC. The reduction in pH and ECe was due higher amount of organic matter accumulation through litter fall and leaching of salts from surface layers to lower depths.
- High bulk density in sodic soils is decreased with incorporation of humus in soil. As a consequence, water holding capacity, infiltration rate and hydraulic conductivity are increased. Further, a continuous addition of C and N status in the soil enriches the soil fertility.
- Organic matter accumulated through leaf litter is converted into humus through biochemical process. This humus as an organic colloid plays a major role in enhancing the CEC and fertility of soil. The reduction in ESP was attributed to increase in organic carbon content of the soils. The process of decrease in sodium and increase in calcium and magnesium in the exchange sites is the main cause for reduction in ESP, which indicates the improvement in soil. Since, ESP mainly depends on exchangeable sodium content, it follows more or less the same trend of sodium. Improvement was more pronounced at lower depths, due to good root distribution all along the profile depth.
- Under alkali tolerant trees, decreasing trend for exchangeable Na is attributed to the removal of Na by tolerant trees or leaching from the surface soil through the roots of trees acting as a bio-drain. The relative changes in chemical properties of sodic soils may be attributed to the

depletion of exchangeable Na in the soil, perhaps due to the biological production of carbonic acid (H_2Co_3) by tree roots causing solubilization of the native $CaCo_3$ present in such soils.

- The improvement in desodification process all along the profile depth is due to their hardy vigorous root system, which breaks the barrier of clay and loosens the subsoil, thus increases the permeability and downward translocation of sodium.

(Source:Gill and Abrol 1990, Garg and Jain 1992 and 1996, Mongia *et al.,* 1997, Mishra 2002 and Garg 2000).

Alkali Soils

Alkali soils are characterized by high pH, higher ESP, low infiltration, dispersed soil, low organic matter and poor fertility. The layer $CaCo_3$ offers severe mechanical impedance for root penetration of perennial vegetation particularly trees. Because of high sodicity, such soils do not support any kind of vegetation except the growth of some salt tolerant indicator plants. The factors inhibiting plant growth in sodic soils include high pH throughout profile causing the problems in nutrient availability; high pH reduces the availability of Calcium, Mg and K and causes soil dispersion. Alkali soil exhibit highly deteriorated soil structure; poor water transmission characteristics lead to water stagnation and reduced aeration of roots; and presence of hard $CaCo_3$ layer at about 1m depth in the profile acts as a physical barrier for vertical penetration of roots.

Physiological Basis of Alkali Tolerance of Species

The tolerance of a species to high percentage of absorbed sodium is modified by the pH of the soil and the accumulation of soluble carbonate. In black alkali soils, the sodium carbonate is insufficient to be toxic. The infertility of such soils lie in their poor permeability to water and to other nutritional disturbances. On high sodium soils, the plant growth is inhibited owing to unavailability of calcium to plants. The severity of deficiency symptoms is related to high pH and high $CaCo_3$ content of the soil. The availability and uptake pattern of micronutrients is also affected in alkali soils. Hence, tolerance to alkali soil may involve the capacity by the plant to secure an adequate supply of calcium under conditions of relatively low availability.

Table 3: Relative tolerance of tree species for soil sodicity: (pH, 1.20m soil depth)

pH	Firewood/timber species	Fruit species
>10	*Acacia nilotica*, *Casuarina equisetifolia*, *Prosopis juliflora*, *Prosopis cineraria*, *Tamrix articulata*	**Achras japota**
9.0-10.0	*Pithecellobium dulce, Salvadora persica, Salvadora oleoides, Capparis decidua, Terminalia arjuna, Cordia rothii*, *Albizzia lebbeck*, *Pongamia pinnata*, *Sesbania sesban, Eucalyptus tereticornis*, *Parkinsonia aculeata, Cassia siamea*	*Carissa carandus*, *Psidium gujava, Zizyphus jujuba, Zizyphus mauritiana*, *Aegle marmelos*, *Punica granatum*, *Phoenix dactylifera, Tamarindus indica*, *Feronia limonia*, *Syzygium cuminii.*
8.6-9.0	*Butea monosperma*, *Acacia auriculiformis, Azadirachta indica*, *Grevillia robusta*, *Populus delteoides*, *Melia azedarach*, *Dalbergia sissoo, Hardwickia binata*, *Morus alba*, *Moringa olifera, Tectona grandis.*	*Mangifera indica*, *Pyris communis*, *Prunus persica, Vitis vinifera, Emblica officinalis*

(Source: Gupta, *et al.,* 1995; Dagar and Singh, 1994)

Choice of Tree Species for Alkali Soils

Normally, firewood species are grown on alkali soils. The choice as to which species should be grown (table 3 & 4) is determined by the ability of tree species to survive and withstand adverse conditions of excess alkalinity.

Table 4: MPTS species recommended for the Alkali soils of Andhra Pradesh

Soil Alkalinity Tolerant Species	Environment	Source: Venkateswarlu (2001)
Acacia auriculiformis	Humid	
Acacia nilotica	Arid	
Casuarina equisetifolia	Humid, Sub humid	
Prosopis cineraria	Arid, Semiarid	

Alternate Land Uses for Amelioration of Alkali Soils

Silvi-Pastoral, Silvi-Agriculture systems and Multipurpose Wood lots provide alternatives to check further deterioration, restore soil health and put lands to productive use.

Silvi-Pastoral system:

Prosopis juliflora and Karnal grass silvi-pastoral system is the most promising for firewood and forage production and also for soil amelioration. It improves the soil condition to such an extent that after some time or years, less tolerant but more palatable fodder species such as berseem (*Trifolium alexandricum*) senji(*Melilotus parviflora*) and shaftal (*Trifolium resupinatum*) can be grown under trees (Singh et al.,1993;Singh1995)(table 5).

Multipurpose wood lots:

In Central Dry Zone of Karnataka *Prosopis juliflora* plantation reclaimed the sodic soils by significantly reducing the pH, ECe, saturated extract sodium, ESP and SAR content of soil, but increased the CEC, available N, P_2O_5 and K_2O status of the soil, which clearly indicated its effectiveness in amelioration of salt affected soils (Basavaraja *et al.,* 2007) .Growing MPTS ameliorate alkali soils at a much faster rate because of the build –up of organic matter and the recycling of important nutrients (table6).

In semiarid alkali soils, soil pH and ESP under *Tamarix articulata was* reduced to maximum, followed by *Prosopis juliflora* and A*cacia nilotica*. Organic carbon in the surface layer also increased under *Tamarix articulata* by 0.23 %. (Dager *et al.,* 2001).

Silvi-Agriculture System:

In this system, salt tolerant trees are grown in conjunction with agricultural crops resulted in reduction of pH and EC and improved organic matter and fertility status. *Prosopis* and *Acacia* restored the productivity of soil much above the present agricultural production levels (CSSRI, Karnal).

The soil conditions were much improved in terms of the build up of soil organic matter, N, P, and K with reduction in pH and EC when trees were associated with agricultural crops. The improvement in soil condition with different trees was in the order: *Acacia* based system > Poplar > *Eucalyptus* > agriculture (Singh *et al.,* 1997).

Table 5:Tolerant grass species for alkali soils (Source: Kumar and Abrol, 1986)

Grass species	Local name
Diplachne fusca *(more tolerant species at ESP of 60)*	Karnal grass
Chloris gayana (more tolerant species at ESP of 60)	Rhodes grass
Cynodon dactylon	Bermuda grass
Brachiaria mutica	Para grass
Panicum species	Blue panic
Pennisetum purpureum	Hybrid napier
Panicum maximum	Guinea grass

Table 6:Ameliorating effect of tree plantation on alkali soils at Karnal

Species	Orginal		After 20years		Source: Singh and Gill (1992)
	pH	Organic C (%)	pH	Organic C (%)	
Eucalyptus tereticornis	10.3	0.12	9.18	0.33	
Acacia nilotica	10.3	0.12	9.03	0.55	
Albizzia lebbeck	10.3	0.12	8.67	0.47	
Terminalia arjuna	10.3	0.12	8.15	0.58	
Prosopis juliflora	10.3	0.12	8.03	0.58	

Saline Soils

Saline soils contain excess of neutral soluble salts generally chloride and sulphates of sodium, calcium and magnesium. These soils have low ESP and pH and good physical condition. The factors inhibiting plant growth in saline soils include salinity induced high osmotic pressure of soil water; toxic effects of specific ions; nutritional disorders due to competitive uptake of ions; high water table/ water logging associated with such soils; and ground waters met in saline areas are often of poor quality while fresh water is scarce.

Judicious use of saline soils can halt their further degradation besides augmenting the supply of food, forage, feed and timber wood. Three basic approaches to fight against salinization are 1. Improving the drainage 2. Selection and breeding for salt tolerance or resistance and 3. Alternate land uses. The last approach raises the possibility of using the vast stretch of saline soils for alternative production. Proper selection of species is very important under this approach.

Physiological Basis of Salinity Tolerance Species

The salt tolerant species have the following attributes for their survival

a) The capacity to develop high osmotic pressure of the tissue fluids to compensate for increase in osmotic pressure of the soil. The osmotic pressure of the various species varies with physiological scarcity of water in the environment in which the plants grow.
b) The capacity to accumulate considerable quantities of salt in the tissue fluids and to regulate that accumulation.
c) The inherent ability of the protoplasm to resist deleterious effects of accumulation of sodium slats in the cell sap.

Choice of Tree Species for Saline Soils

Saline soils require proper selection of tree species. As the main problem of these soils are high water table, high salinity, impeded drainage and poor soil aeration, only those tree species should be raised which can tolerate these stresses. Suitable choice of appropriate of tree species is prerequisite for reducing mortality and obtaining initial establishment of the saplings. The choice of tree species (Table 7 & 8) to be planted in saline soils is dependent upon their tolerance to salinity in addition to their suitability to local agro climate and the purpose of planting.

Planting Technique for Saline Soils:

In saline soils, selection of proper planting technique is of at most importance. The technique should be such that the rainwater is utilized to the maximum possible extent and the salt concentration in the active root zone of young seedlings is kept at a minimum level such that the adverse effect of high salinity of soil is minimized. To achieve this objective, furrow method is successful in establishment of tree seedlings. In this technique, tractor is to be used for creating furrow to the size of 60cm wide and 20cm deep and saplings were to be planted at sole of the furrows. The furrow method is efficient in desalinization of the soil depth from rainfall, creating a favorable zone of low salinity below the sill of the furrow through the downward and lateral fluxes of water making salts move away from the furrow (root zone). (Tomar *et al.,* 1998)

Table 7: Relative tolerance of tree species for Saline soils (ECe, dSm^{-1})

Range of Tolerance	Trees/ Shrubs/ fruit species
Very highly saline (20-30)	**For inland saline soils** *Prosopis chilensis, Prosopis juliflora*, *Parkinsonia aculeata*, *Salvadora oleoides, Salvadora persica, Tamarix articulata, Tamarix troupii, Tamarix ericoides, Acacia farnesiana*, *Suaeda fruticosa, Suaeda maritime, Haloxylon spp., Atriplex spp.,*
	For coastal areas Mangrove species (*Avicennia, Rhizopora, Bruguiera, Ceriops, Acanthus, Aegiceras, Exoecaria, Heritiera, Nypha, Sonneratia*), *Casuarina equisetifolia, Barringtonia asiataca, Clerodendron inerme, Pandanus spp., Pongamia pinnata, Cordia subcordata, Terminalia catappa, Calophyllum inophyllum, Ficus retusa, Manilkara littoralis, Thespesia populnea.*
Highly saline (14-20)	*Prosopis cineraria, Acacia tortilis, Acacia nilotica, Acacia pennatula, Acacia tortilis*, *Casuarina glauca*, *Casuarina obesa, Eucalyptus camaldulensis*, *Feronia limonia*, *Zizyphus jujuba*, *Acacia auriculiformis.*
Saline (10-14)	*Acacia senegal, Casuarina cunninghamiana*, *Eucalyptus tereticornis*
Moderately saline (5-10)	**Albizzia procera, Dalbergia sissoo, Emblica officinalis, Guazuma ulmifolia, Punica granatum, Samanea saman**
Less saline (<5)	*Acacia auriculiformis*, *Acacia deamii*, *Acacia catechu, Syzygium cuminii, Salix babylonica*, *Tamarindus indica Leucaena leucocephala, Populus spp., Melia azedarach Azadirachta indica, Albizzia lebbeck, Dendrocalamus strictus*, *Butea monosperma, Terminalia arjuna*, *Ailanthus excelsa, Dalbergia sissoo, Balanites roxburghii.*

(Source: Tomar and Gupta. 1986; Dagar and Singh, 1994 and Gupta, *et al.,* 1995).

Table 8: MPTS species recommended for the saline soils of Andhra Pradesh

Soil Salinity Tolerant Species	Environment	Source: Venkateswarlu (2001)
Acacia nilotica	Arid, Semiarid, Sub humid	
Albizzia lebbeck	Semiarid, Sub humid	
Casuarina equisetifolia	Humid, Sub humid, Semiarid	
Parkinsonia aculeata	Arid, Semiarid, Sub humid	
Pithecellobium dulce	Arid, Semiarid	
Prosopis cineraria	Arid, Semiarid	

Alternate Land Uses for Amelioration of Saline Soils

Sequential Agro forestry system:
In this system, trees and arable crops can be grown in sequence instead of growing them simultaneously. This practice is followed to raise fertility status of the soil, which has gone down either by continuous cropping or due to soil salinization. Short duration, fast growing and N_2 fixing trees like *Sesbania, Leucaena* etc., can be grown for4-5 years and then cut for fuel wood or forage and the land can be used for arable farming (Ravender *et al.,* 2004).

Silvi-pastoral system:
Promising woody species for saline soils are *Salvadora spp., Prosopis juliflora, Acacia nilotica*, *Pithecellobium dulce* and *Parkinsonia aculeata.* Highly salt tolerant and high biomass producing grass species include *Aeleuropus lagopoides, Sporobolus helvolus, Cynodon dactylon, Brachiaria rammosa, Dactyloctenium aegyptium, Dicanthium annalatum* and *Digitaria ciliaris* (Ravender *et al.,* 2004) (table 9).

Agri-Silvi-Horticultural system:
Most of the fruit species are sensitive to salt stress but some of the species showed good performance on saline soils. *Zizyphus jujuba, Emblica officinalis*, *Punica granatum, Sygyzium cuminii* and *Tamarindus indica* were found promising in moderately saline soils (Ravender *et al.,* 2004).

Table 9:Some grass species for saline soils. (Source: Dagar and Singh, 1994)

Range of tolerance	Grass species
Highly Tolerant (EC 25-35 dSm^{-1})	*Cynodon dactylon, Aeleutropus lagopoides, Sporobolus spp.,*
Tolerant (EC 15-25 dSm^{-1})	*Dichanthium annulatum, Saccharum spontanium, Leptochloa fusca, Chloris gayana, Brachiaria mutica, Cenchrus spp.,*
Moderately Tolerant (EC 10-15 dSm^{-1})	**Lasiurus sindicus, Andropogan annulatus**

Conclusion

Agro forestry plays a vital role in biological amelioration of problem soils. Profitable agriculture is possible in the reclaimed soils if appropriate agro forestry systems are applied for different agro-climatic regions keeping in view the criteria of productivity, sustainability, economic utility and adaptability. It is important to have sustainable agro forestry systems for salt affected soils involving Multipurpose Nitrogen fixing tree species, grass forages, fruit trees and others species of economic importance. Many trees and grass species have been identified for salt affected soils, which will not only provide required food, fodder and fuel but also ameliorate the vital soil resource. There are many socio-economic and environmental benefits from the amelioration and judicious management of degraded lands. The major benefits of amelioration through agro forestry are continuous income generation, employment and food and nutrition security for small and marginal farmers.

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