

Prospective of Tree Lucerne in Hilly Areas for Fodder, Soil Health and Carbon Sequestration -A Review

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Abstract: Tree Lucerne is a perennial fodder tree provides protein rich fodder grows well in cool hilly regions. Cultivation of tree Lucerne in slopy lands helps in conserving soil and water and improves carbon sequestration level in soil. Tree Lucerne contains 23 to 28 percent crude protein that can be converted in to human protein through eggs, milk, white meat and red meat and facilitates human health. It grows well in the hilly area of Western Ghats, southern India and also can be grown in other hilly regions of India to meet the fodder needs, improve soil health by conserving soil and water and sequestering carbon.

Keywords: Tree lucerne, Hilly area, fodder Soil health, Carbon sequestration

1. INTRODUCTION

Tree Lucerne or Tagasaste is native of dry volcanic slopes of La Palma island of Canary Islands, Pacific Ocean. The potential of tree Lucerne as a fodder was identified by Dr Perez, a medical practitioner, based on La Palma island in the 1870s, and Spanish cattle farmers. He wrote to the Spanish authorities for promoting tree Lucerne as a fodder but the Spanish government was not interested. He then sent seed to Kew Gardens in England. Kew Gardens tested tree Lucerne and its potential and then sent seeds to all its colonies around the world. It is grown in residential areas as boundary as feed stack to feed chicken, goat and cattle and also for aesthetic purpose. Livestock in hilly region depends mostly on grazing lands. The grasses in these lands have less protein, vitamins and minerals. Hence livestock are not getting nutritive foods. It is estimated that poor fodder availability from limited grazing land with poor nutritive value meets only 60 percent of the fodder needs in India. Hence production of quality and nutritive fodder and its efficient use is essential in the hilly area.

2. BOTANY

Tree Lucerne is botanically known as *Cytisus proliferus* and a member of the Fabaceae family. It is an evergreen shrub grows 3 - 4 m height. It includes both vertically and horizontally growing trees. Its leaves are trifoliolate with greyish-green equal-sized leaflets. Flowers are creamy-white and scented arises as small clusters in the leaf axils. White flowers appear in huge numbers usually in spring and in some conditions in winter. Its flat pea-like pods are green about 5 cm long contains about 10 seeds and ripening to black. The seeds are ripen in summer, are a flattened oval shape, about 5 mm long by 3 mm wide by 1 mm thick. There are about 45,000 seeds per kilogram. It nodulate with a wide range of *rhizobia*



Seeds



Young seedling



Leaves



Flowers



Grown up tree

3. CULTIVATION

Tree Lucerne is considered to be a multi parental legume. Tree Lucerne is suited to sandy, well-drained soils of pH range 4.0 to 7.0. On deep, freely drained soils its roots can extend down to at least 10 metres. Any physical or chemical barrier in the soil that restricts root growth will reduce the productivity and survival of tree Lucerne. Cultivars from arid sandy areas are very susceptible to root rot fungus on poorly drained soils, specifically *Fusarium*, *Pythium* and *Rhizotona*. It will tolerate winter temperatures as low as 9 °C, but there are cultivars tolerate up to 15°C. Tree Lucerne leaves will be burnt by frost and seedlings can be killed at temperatures below 0 °C. Growth of mature trees will slow at winter temperatures below 20 °C. It is planted in lines with 2 to 3 meter spacing as sole crop and in boundaries in agricultural fields as agro-forestry system.



4. NUTRITIVE VALUE OF TREE LUCERNE FODDER

As fodder crop, tree Lucerne supplies 23 to 27 percent crude protein and 18 to 24 percent crude indigestible fibre. These levels of protein can be maintained even in poor soil with proper application of fertiliser. In partitioning, crude protein concentration was 200, 97 and 66 g kg⁻¹ in dry matter, of leaves, twigs and mature pods, respectively. Neutral and acid detergent fibre were high in twigs. The nutritive value of tree Lucerne compared with grazing alone and feeding natural pasture hay with seed cakes by Kitaw et al.,^[1] The final body weight, daily weight gain and feed conversion are comparable with natural pasture hay with seed cakes (Table 1). Final body weight of goat (kg) was significantly higher than grazing alone (8 hrs/day) and feeding natural pasture hay plus Niger seed cake. In case of daily weight gain (gram/day) also similar trend was observed as in final body weight, however the numerical value was higher with tree Lucerne fed goats. Feed conversion of tree Lucerne was found significantly higher than natural pasture hay with cotton seed cake. Low total ash and crude protein is more than wheat bran and pasture hey, higher Neutral Detergent Fibre (NDF) compared to even seed cakes are desirable fodder qualities (Table 2).

Table1. Growth of Goat by Tree Lucerne or Tagasaste compared to different hays

Treatments	Initial live weight (kg)	Final body weight (kg)	Daily weight gain (gd ⁻¹)	Feed conversion (g feed/g gain)
Natural pasture hay plus Niger seed cake	18.4	24.1 ^c	73.7 ^c	11.7 ^b
Natural pasture hay plus Linseed cake	18.5	27.8 ^b	100 ^b	10.1 ^{ab}
Natural pasture hay plus Cotton seed cake	18.5	29.1 ^a	117 ^a	9.3 ^a
Natural pasture hay plus Tagasaste leaf	18.4	25.5 ^c	82.6 ^c	10.4 ^{ab}
Grazing alone, 8h/day	18.3	24.5 ^{bc}	75.3 ^c	#
Mean	18.4	26.2	89.8	10.4
SEM	2.25	2.77	49.9	1.98
Prob.	0.999	0.018	0.0008	0.237

(Kitaw et al., 2012)

^{abc} Means in the same column without common letter are different at P<0.05; SEM= Standard Error of Mean. # The dry matter intake through grazing was not considered.

Table2. Nutritive values of tree lucerne and other feeds and concentrates

Ingredients	DM	Total Ash	CP	DOMD	NDF	ADF
Natural pasture hay	89.90	8.81	6.52	52.41	68.38	46.40
Niger seed cake	92.60	11.10	30.03	68.96	40.64	29.73
Linseed cake	92.40	6.37	28.10	72.23	37.09	28.08
Cotton seed cake	91.60	7.70	33.29	68.30	55.27	33.67
Wheat bran	89.43	5.38	15.01	79.89	50.12	12.69
Tree Lucerne	91.79	4.91	22.59	68.06	59.65	37.88

(Kitaw et al., 2012)

DM: Dry Matter; CP: Crude Protein; DOMD: Digestible Organic Matter in the DM; NDF: Neutral Detergent Fibre; ADF: Acid Detergent Fibre

Phosphorus is particularly important both for the growth of tree Lucerne and for the growth of the animals grazing on it. Higher levels of phosphorus are required for the maximum growth of the animals than for maximum plant growth. Fertiliser will reduce the level of phenolic compounds (similar to tannins). These phenolic compounds make the tree Lucerne less palatable and reduce the animals' feed intake. The phenolics suppress the utilisation of protein in the rumen. Despite the crude protein always being above 14 percent, supplementing with a high-protein feed like lupin seed stimulates animal feed intake when phenolics are high in tree Lucerne. Tree Lucerne typically has the same nutritional value as Alfalfa when planted on good soil with balanced nutrients. This indicates high scope of tree Lucerne being used as fodder for mulching animals.

The daily weight gains of 1 to 1.5 kg per steer per day are achieved during the growing season, with 6-10 rotations per year. Flowering also changes the palatability of tree Lucerne. After flowering the leaf becomes less palatable and the bark more palatable. This results in stock stripping bark off the trunk. Also the growth rate of the plant slows and leaves will be shed. The grazing management is designed to prevent flowering and keep tree Lucerne in the vegetative juvenile state. If tree Lucerne is heavily grazed or mechanically cut in the any one of the first 6 months of the year it will not flower in the second half of the year. Some time, when mechanical cutting is done, one limb on a plant can be missed. This limb will grow and flower continuously, while the rest of the plant is maintained in a vegetative state. Tree Lucerne is useful as a maintenance feed during the dry period and fed with other feeds. The leaves are high in Vitamin A and low in sodium, phosphorus and sulphur and therefore supplementary mineral licks are recommended. The leaves may be used in poultry feed to enhance egg yolk colour. There is no toxicity reported for sheep, cattle, goats, poultry and livestock.

5. SOIL FERTILITY IMPROVEMENT

The chief benefit of tree Lucerne is its ability to increase soil productivity roughly 5 times over 5 years and up to 10 times over 10 years, in deep well drained soils mainly limited in soil nitrogen. Soil erosion and crop production removes huge amount of nutrients from the soil especially nitrogen which leads to low productivity. Perpetual loss of nutrients with improper conservation measures and manuring leads to soil poverty especially in dry land areas. Tree Lucerne fixes 590 kg of nitrogen per year per hectare through biological nitrogen fixation hence it is called as fertilizer tree. The level of biological nitrogen fixation is highest in tree Lucerne among the legume family which is estimated to be 30-50 grams per meter of row. Availability of nitrogen through tree Lucerne saves fertilizer nitrogen and reduces the cost of cultivation. Tree Lucerne fits well for alley cropping system.

Apart from nitrogen fixation, the green biomasses are used as green manures. Addition of green manure improves soil organic carbon and nutrient status of the soil. Cultivation of tree Lucerne as green manure crop increases the carbon sequestration potential of soil. Increasing the level of organic carbon in soil improves its physical, chemical and biological qualities. Wood of tree Lucerne is also used for making biochar. Application of tree Lucerne biochar in practice in many African countries for improving soil quality. Conversion of biomass of tree Lucerne in to biochar results in making recalcitrant carbon from which the carbon dioxide emission is meagre.

6. SOIL AND WATER CONSERVATION

Tree Lucerne is a multipurpose woody leguminous tree and it can be used for afforestation in marginal and poor lands of mountain and high lands. Tree Lucerne cultivation improves the soil quality in many ways. The rhizosphere of the plant helps in conserving soil and water especially in the hilly region. Tree Lucerne has two types of roots. There are a few large 'sinker' roots that can extend down to at least 10 metres. In hilly regions, the slopy land with deep soil is prone for landslides.

Cultivation of tree Lucerne across the slope with regular interval may provide strong hold and avoid landslides during rainy seasons. These roots are used to extract moisture from deep layers during the dry season. Vulnerable areas of land slide can be introduced with tree Lucerne which also provides fodder for the animals. The other type of roots is 'feeder' roots that are mostly confined to the top 1.5 m depth. These roots spread horizontally at least 15 m from the trunk. They extract mineral nutrients from the soil, and also water. In summer the soil water can be taken up at depth by the sinker roots, drawn into the shallow feeder roots and then pumped into the soil. This 'hydraulic lift' allows tree Lucerne to keep extracting nutrients from the deep soil.

7. CARBON SEQUESTRATION

Recently it has been found that tree Lucerne can sequester carbon at the rate of about 6 tonnes CO₂ equivalent per hectare per year. About half the CO₂ being stored is as organic carbon in the soil and half is in the wood of the branches, trunk and roots. Tree Lucerne typically yield roughly 1 ton of edible material per 100 mm of rain per hectare per year. Tree Lucerne is a desert plant which suits well to dry regions. It is also considered as drought reserve forage crop. Hence, CO₂ assimilation is possible even during drought period. Tree Lucerne is known to enhance C sequestration in soils. Soil Organic Carbon (SOC) stock at different soil depth by tree Lucerne was studied by Wocheslander *et al.*,^[2] It was observed that even at up to 90 cm depth higher SOC stock was found with tree Lucerne compared to grazed fields (Fig.1). Higher SOC stock due to the evergreen foliage and root system contributes for higher accumulation of organic matter in soil. In another study reported by Hasson and Jweeg^[3] reported high C sequestration by tree Lucerne at a depth of 10-30 cm is compared to those of annual and perennial vegetation (Table 3). Cultivation of tree Lucerne as sole crop or in side agricultural fields as agroforestry components provides quality fodder and improves soil quality in hilly areas.

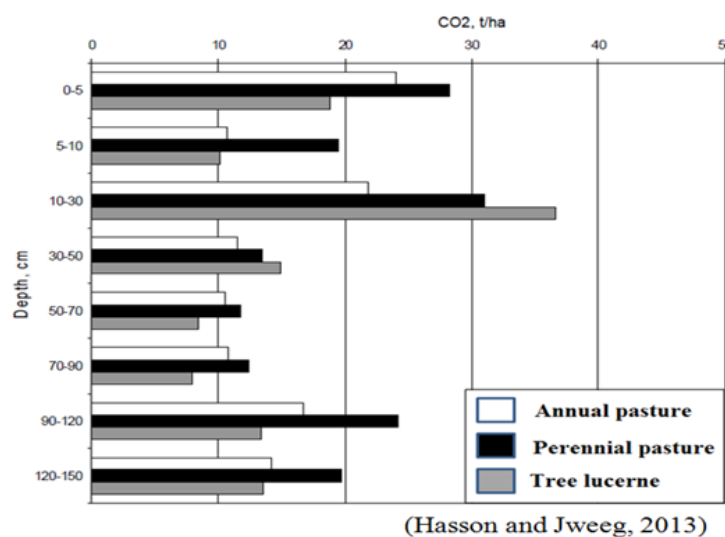


Fig1. Carbon sequestration as Carbon dioxide by tree Lucerne compared to other pasture

Table3. Soil organic carbon stock (t/ha) at different depth increment at control and tree Lucerne, alley and block planted plots

Depth (m)	Grazed land (Wheat, lupins and grass)		Tree Lucerne in Alley planting		Tree Lucerne in Block planting	
	Mean	SE	Mean	SE	Mean	SE
0-0.1	11.5	1.6	22.3	0.9	31.7	3.1
0.1-0.2	4.8	0.9	8.1	0.1	7.9	0.4
0.2-0.3	2.3	0.1	3.9	0.5	2.7	0.1
0.3-0.6	3.8	0.4	5.7	0.2	5.5	0.2
0.6-0.9	2.8	0.1	3.9	0.1	4.4	0.2
0.9-1.2	2.4	0.2	2.6	0.2	2.8	0.2
1.2-1.5	1.8	0.1	2.1	0.1	2.1	0.1
1.5-1.8	1.5	0.0	1.7	0.0	1.7	0.05
1.8-2.0	0.8	0.1	0.9	0.0	1.05	0.0
Total	31.7	0.0	51.4	0.9	59.9	3.1

(Wocheslander *et al.*, 2016)

8. OTHER BENEFITS

8.1. Bee Forage

Tree Lucerne flowers profusely during late winter and early spring and it is the first trees to flower in spring and it is an excellent nectar source.

8.2. Windbreaks

When the tree matures as a close-planted 25-50 cm hedge, it provides shelter from cold winds and summer heat. It helps in protecting cold injury during winter and heat waves. Shelter belts reduces the wind energy and reduces wind erosion.

8.3. Timber and Fuel Wood

It produces a fairly dense wood, useful for wood craft and has excellent potential as a firewood crop.



Bee forage



Windbreaker



Craft from tree lucerne wood

REFERENCES

- [1] Kitaw, G., Dejene, M., Kehaliw, A. and Assefa G. 2012. Comparative evaluation of Tree Lucerne (*Chamaecytisus palmensis*) over conventional protein supplements in supporting growth of yearling Horro lambs. *Livestock Research for Rural Development New letter*: 24 (1) (<http://www.lrrd.org/lrrd24/1/getu24008.htm>)
- [2] Wochesländer, R., Harper, R. J., Sochacki, S.R., Ward, P. R and Revell, C. 2016. Tagasaste (*Cytisus proliferus* Link.) reforestation as an option for carbon mitigation in dry land farming systems. *Ecological Engineering*. 97: 610–618
- [3] Hasson, Ahmed and Jweeg Muhsin. 2013. Soil organic carbon sequestration under pasture in arid region. *Nature environment and pollution technology*. 12: 57-62.

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