

**Evaluation of ~~To evaluate~~ the relative efficacy of Alley Species with respect to hedge- row persistence, herbage yield and fuel wood production. - District name, South/East/West/North Country name**

**Abstract**

Field experiments were conducted at malgawan Research Farm, Janta mahavidyalaya Ajitmal Auraiya during two consecutive kharif seasons of 2021- 22 and 2022-2023 'To evaluate the relative efficacy of Alley species with respect to hedge-row persistence, herbage yield and fuel wood production. Out of the two alley species tested viz. Leucaena and Sesbania under Agro-forestry system, Leucaena for herbage production is good and it gives more green fodder yield (119.59q/ha) than Sesbania yielded 105.01q/ha, that fulfils fodder requirement and becomes best alternate of fodder during shortage of fodder. Sesbania for fuel wood production are recommended and yielded 42.55 q/ha. that higher than Leucaena. Both the alley species be pruned prior to crop sowing in both the consecutive seasons and pruned material be added to the soil, increases soil fertility as well as organic carbon content in soil. Under P<sub>0</sub> (No Pruning), the establishment and persistency were better than both the pruning management and P<sub>0</sub> significantly increased the tree height 4.35meter than P<sub>1</sub> & P<sub>2</sub> 1.91 & 1.96 meter height respectively. The number of branches was significantly higher in Sesbania with no pruning (33.69) over both the pruning management P<sub>1</sub> & P<sub>2</sub> system in both seasons. The Relative growth rate kg/ha/day, fresh yield of pruning q/ha, dry matter yield of pruning q/ha, fuel wood production q/ha, leaf fodder production q/ha and N, P & K uptake q/ha were found more with Leucaena under treatment P<sub>2</sub>(pruning during crop growth and foliage used as forage) than P<sub>1</sub> (pruning during crop growth and foliage added to soil) with N<sub>2</sub> level of fertilizer than N<sub>0</sub> & N<sub>1</sub> fertilizers level respectively in both years mean basis.

Keywords: Alley species, herbage yield, and fuel wood-woodproduction, relative efficiency-

**INTRODUCTION**

~~India is an agricultural based country where ≥70% population lives in villages comprising 105 million farm families. 97 m.ha. is under soil degradation as per ICAR vision2023.~~ India is an agricultural-based country where over 70% of the population lives in villages, comprising 105 million farm families. According to ICAR's Vision 2023, 97 million hectares are under soil degradation. Nitrogen-fixingNitrogen-fixing trees (NFTs) and shrub-shrubs in agro-forestry system-systems are capable of fixing about 50–100 kg N/ha/year. Similarly, the area under forest which are the main source of timber and fuel

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wood dwindling to around 17% of the country's land area against the national requirement of around 33% under forest cover (Bahuguna 1985) and Debroy 1986 are however, of the opinion that the productive and effective forest area in the country is much less than the reported figure.

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Unfortunately forage and fuel wood are however still considered as low priority products. Moreover, due to the increasing pressure on arable lands for growing food fibre and cash crop to meet the rising needs of human populations, there is no scope for diverting cultivated land for forage or fuel wood production. Alternatively forage and fuel resources have to be developed on marginal and sub marginal lands spreads over 175 m.ha.in arid and semi arid areas. These areas are characterised with erratic monsoon behaviour & soil fertility and moisture are the most important factors limiting crop production. Under these conditions, it envisages growing of arable crops/grasses along with suitable tree species simultaneously on the same piece of land provides better land utilization and ensures stable production.

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Of the different systems of Agro-forestry "Alley Cropping" (also called as hedge row intercropping or avenue cropping) appears to be an appropriate agro-forestry system. The hedge row hedgerows are cut back at the planting of annual crops and periodically pruned during cropping to prevent shading and to reduce competition with the associated crops. The hedge row hedgerows are allowed to grow freely to cover the land when there are no crops (King-King et al 1984). Trees/shrubs used to form hedge rows should be multipurpose and nitrogen fixing which could enrich the soil besides providing the pruning for forage green manures. The other desirable characteristics are easily established, wider adaptability, fast growth rate, coppicing habit, quick regeneration after pruning tolerance to disease and pest pests and aberrant weather conditions. Subabul (*Leucaena leucocephala*) and Shevari (*Sesbania sesbane*) are important multipurpose trees with wide adaptability and potentiality for utilization as alley component in alley cropping system. The regular pruning of hedge row is crucial to reduce competition between trees and crops for sunlight, water and nutrient frequently. The biomass incorporated pruned biomass from leucaena and sesbania into the soil acting as green manure, this enhances soil organic matter and nutrient content particularly nitrogen because leucaena and sesbania are leguminous trees capable of fixing of atmospheric nitrogen, which reduces the need for synthetic nitrogen contributed by these trees.

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It is in this context that the present investigation entitled "To evaluate the relative efficacy of alley species with respect to hedge- row persistency, herbage yield and fuel wood production".

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### Method and Materials:

### Description of the Study Area

The experiment ~~was~~ conducted during rainy season of 2022 and 2023 where annual crop was grown in association with Leucaena and sesbania at Janta Mahavidyalaya Malgawan Agricultural research farm Ajitmal, Auraiya. The sub humid climate of the area features hot summer, dry winds and humid monsoon season with an average annual rainfall ranges 600-700 mm is usually received from July to Sept. with few showers during winters. The soil at the test site was sandy loam in texture, Ph 7.8, Electrical conductivity of 1.72m.mhos and soil organic carbon of 0.32% with 180kg available N, 18.94kg available P<sub>2</sub>O<sub>5</sub> and 255.43kg/ha available K respectively.

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### Experimental Design and Treatment arrangement

In this trial the treatment comprising 2 Alley species, three levels of pruning and three levels of fertility were tested in a ~~split-plot~~ design, keeping Alley species and pruning management in the main plot and fertilizer management in the subplot respectively. Treatment was comprised as-under

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T<sub>1</sub>- A<sub>1</sub>+P<sub>0</sub>+N<sub>0</sub> (No pruning and no application of nitrogen in A<sub>1</sub> Sesbania spp.)

T<sub>2</sub>-A<sub>1</sub>+P<sub>1</sub>+N<sub>1</sub> (P<sub>1</sub>- pruning during crop growth and foliage added to soil also fertilized with 45 kg/ha N in alley species Sesbania)

T<sub>3</sub>- A<sub>1</sub>+P<sub>2</sub>+N<sub>2</sub> (P<sub>2</sub>- pruning during crop growth and foliage added to soil also fertilized with 90 kg/ha N in alley species Sesbania)

T<sub>4</sub>- A<sub>2</sub>+P<sub>0</sub>+N<sub>0</sub> (No pruning and no application of nitrogen in A<sub>2</sub> alley Leucaena spp.)

T<sub>5</sub>- A<sub>2</sub>+P<sub>1</sub>+N<sub>1</sub> (P<sub>1</sub>- pruning during crop growth and foliage added to soil also fertilized with 45 kg/ha N in alley species Leucaena spp)

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T<sub>6</sub>-A<sub>2</sub>+P<sub>2</sub>+N<sub>2</sub> (P<sub>2</sub>- pruning during crop growth and foliage added to soil also fertilized with 90 kg/ha N in alley species Leucaena)

The experiments were tested in a single split plot design with a 9m×5m plot size and replicated thrice. The alley species sesbania and ~~leucaena~~ were fertilized @ 20kgN +50 kg P<sub>2</sub>O<sub>5</sub>/ha and no fertilizer was applied to the alley spp. (Table in appendix, fertilizer treatment design). in the subsequent years of the experiment. The alley species seedlings were raised in a polybag by sowing of two seed in each bag, after 60-65 days seedlings were used for transplanting. During 2<sup>nd</sup> and 3<sup>rd</sup> years of the investigation leaves of lopping of the alley spp. were used as a source of green manure for sorghum. The leaf mass was uniformly mixed into the soil at the time of final tillage operations, 15 days before the sowing of experimental crop. Sesbania and leucaena were established through planted in paired rows on either side of the plots in pits of 40×40×40 cm size maintaining an inter and intra row distance of 75 cm and 50 cm respectively. The crop and alley spp. are irrigated time to time when ever needed, and mechanical weed

management practice ~~was~~ adapted ~~as mechanical weeding~~ and applied Atrazine @ 0.75 kg ai/ha in 600 ~~liters~~ ~~liters~~ of water as preemergence.

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The Hedgerows of Alley species were pruned during July coinciding with the sowing of sorghum. Leaves are separated from the twigs and component wise weight recorded, the leaves were used for soil application or as forage as per the treatment. Sowing of fodder sorghum was done behind the plough 25cm row apart using a seed rate of 40 kg/ha respectively among the both alley species. Sorghum was fertilized at the rate of 40 kg P<sub>2</sub>O<sub>5</sub> and 30kg K<sub>2</sub>O/~~aha~~ (Table appendix). Nitrogen as per treatment was applied in the form of Urea.

The observations were recorded of Alley species are germination count, plant height, Collar diameter of the main shoot, number of branches, RGR, Fresh yield of ~~pruning'spruning~~, Dry matter yield of pruning, Fuel wood, and leaf fodder production, Seed production from Alley species and Uptake studies respectively.

#### Result and Discussion:

The result of experiments have been obtained were considered of practical importance and therefore have been discussed in detail along with the repercussions of weather parameters on growth and development, green forage yield and quality of produce, uptake and production of nutrients for the tree crops Leucaena & sesbania. Next to ~~the~~ genetic constitution environment is the foster factor, which decides the growth and development and failure and success of any crop under field conditions. As is apparent from the result, the weather conditions, on the whole, proved quite conducive at the time of seedling in ~~both the seasons~~ ~~both seasons~~ by having sufficient relative humidity, bright sunshine, mean average temperature, and evaporation during both the experimental seasons. The data indicates that the effect of seasons on alley species, ~~is~~ comparatively ~~favoured-favored~~ by entire cropping seasons in ~~the~~ first season over ~~the~~ second season. Hence it may be asserted that the variations in yield data are not due to season but are due to the treatment effects.

Alley species study depicted in ~~table~~ ~~(no)~~ reveals that the variation in establishment and persistency(95.46%), tree height(3.14meter), RGR(33.91 kg/ha/day), Fresh yield of pruning(119.59q/ha.), leaf fodder production(68.89q/ha), dry leaf fodder production(17.22q/ha), seed production(11.85q/ha) and crude protein yield were recorded with alley species Leucaena trees and it is more than the sesbania in both the seasons and also on ~~a~~ mean basis. The collar diameter of sesbania trees(26.93cm) was significantly more than the Leucaena in both ~~the~~ seasons and also on ~~a~~ mean basis.

Sesbania ~~was havinghad~~ a greater number of ~~branches~~ ~~(branches)~~ (32.85) than Leucaena in ~~both the years~~ ~~both years~~. ~~In fact~~ ~~In fact~~, the Leucaena, which is basically in ~~the~~ tree group attains more height and persistency while on the other hand, ~~the~~ Sesbania

~~basically being~~ a shrub attains less height, more number of branches, and more collar diameter. The ~~persistence~~ ~~persistence~~ is very high in Leucaena and Sesbania. The N, P & K content % ~~and~~ ~~P~~ and ~~P~~, K uptake q/ha of sesbania trees were more than the leucaena in both the years and on mean basis. The protein content therefore was also more in sesbania. The N uptake q/ha of Sesbania trees was more than the Leucaena on pooled basis. Here it may be argued that though the foliage production was more in Leucaena but the N content was so high in sesbania that Leucaena could not supersede Sesbania in N uptake q/ha.

The light interception percent of sesbania trees was more than the percent light interception of Leucaena in both the years and also on mean basis. It was all because of better canopy of Leucaena which does not allow the light to intercept on the ground. The reverse was true with Sesbania in light interception because of its poor canopy.

#### **Effect of Pruning Management:**

Under reference further reveals that the Sorghum crop with both the pruning management had significant variations with most of the characters mentioned earlier, while establishment and persistence due to pruning management were not well marked in both ~~the~~ years. Under P<sub>0</sub> (No Pruning), the establishment and persistence ~~was~~ ~~were~~ better than both the pruning management and P<sub>0</sub> significantly increased the tree height (4.35m) & ~~the~~ number of branches (33.69) over both the pruning management system in both ~~season~~ ~~season~~ ~~season~~. The variation in collar diameter due to pruning management ~~were~~ ~~was~~ not well marked in both the years, however both the pruning mgt. Showed more diameter than treatment P<sub>0</sub> in both the years and pooled basis. Here, it may be inferred that under no pruning conditions, the trees will attain ~~definitely~~ more height than the pruned trees. Further, the trees ~~who~~ ~~that~~ have been without topped will gain more diameter than the trees where topping/pruning has not been done. As per ~~established~~ fact, the seed production would also be ~~more~~ ~~higher~~ under no pruning conditions.

The Relative growth rate (32.04 kg/ha/day), fresh yield of pruning (112.98q/ha), dry matter yield of pruning (49.91q/ha), fuel wood production (37.12q/ha), leaf fodder production (51.08q/ha) and N, P & K uptake (3.05, 0.74 & 1.70 q/ha) were found more with treatment P<sub>2</sub> (pruning during crop and foliage used as forage) than P<sub>1</sub> (pruning during crop growth and foliage added to soil) in both the years and also on mean basis. The seed ~~production~~ ~~(production~~ (8.66q/ha) assessed under no pruning ~~conditions~~ ~~was~~ ~~conditions~~ ~~was~~ found more in ~~the~~ second year than first year. The N, ~~P~~ ~~P~~ & K contents were found more with P<sub>0</sub> (no pruning) ~~than~~ ~~than~~ both the pruning mgt. in both the years and also on ~~a~~ mean basis. The variations in crude protein content due to Sesbania and Leucaena alley species were not well marked in both the season and also on ~~a~~ mean basis. The Alley

species crude protein yield q/ha which was assessed under P<sub>2</sub> (Pruning during crop growth and foliage used as forage) was found more in second season than first year.

#### **Effect of N:**

A look at data presented in table reveals that the variations in germination count, establishment and persistency, tree height(3.16m), collar dia(25.01cm), number of branches, relative growth rate(32.68kg/ha/day), fresh yield of pruning's(114.10q/ha), dry matter yield of pruning's(50.25q/ha), fuel wood production(37.20q/ha), green leaf fodder production(52.02q/ha), dry leaf fodder production(13.05q/ha) and seed production(9.47q/ha) from alley species N,P and K content and its uptake qha<sup>1</sup>, light interception, LER and ATER affected due to different N levels and under N3(90kg/ha) treatment were recorded higher yield of all parameters in both the seasons. It is an established fact that N in general promotes the vegetative growth of the entire flora may be the herb, shrub and trees. This vegetative growth creates a proper sheet for photosynthetic activity of the plants which in turn, augments the entire process related to development, yield and quality. This is the reason that both the alley species viz. Leucaena and Sesbania were favoured by the N in their growth, yield and quality aspects.

#### **Conclusion**

Present study reveals that out of the two alley species tested viz. Leucaena and Sesbania under Agro-forestry system, Leucaena for herbage production is good and it gives more green fodder yield that fulfils fodder requirement and becomes best alternate of fodder during shortage of fodder and Sesbania for fuel wood production are recommended. Both the alley species be pruned prior to crop sowing and pruned material be added to the soil increases soil fertility as well as Organic carbon content in soil.

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Table 1 :Establishment and Persistency, Tree height in meter and Collar Diameter in cm						
Treatments	Establishment & Persistency %		Tree Height in meter		Collar Diameter in cm	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Alley species						
Sesbania (A <sub>1</sub> )	98.24	93.24	2.62	3.03	19.60	26.93
Leucaena (A <sub>2</sub> )	98.80	95.46	2.85	3.14	12.69	21.62
Sem±	0.469	0.843	0.060	0.110	0.629	0.551
C.D. at 5%	NS	NS	0.190	NS	1.985	1.739
<b>Pruning Management</b>						
No Pruning(P <sub>0</sub> )	98.61	94.86	4.35	5.61	14.83	24.21
Pruning (P <sub>1</sub> )	98.33	93.31	1.91	1.82	16.33	25.59
Pruning (P <sub>2</sub> )	98.61	93.89	1.96	1.83	17.28	23.03
Sem±	0.574	1.033	0.73	0.135	0.771	0.675
C.D.at 5%	NS	NS	0.233	0.428	NS	NS
<b>N level Kg/ha</b>						
0 (N <sub>0</sub> )	97.64	92.92	2.76	2.94	16.48	23.76
45 kg (N <sub>1</sub> )	98.75	95.00	2.72	3.15	15.98	24.06
90 kg (N <sub>2</sub> )	99.17	95.14	2.73	3.16	15.99	25.01
Sem±	0.663	0.919	0.053	0.083	0.447	0.388
C.D.at 5%	NS	NS	NS	NS	NS	NS

**Table 2 :Relative growth rate, Fresh yield of pruning & Dry matter yield q/ha of pruning's, Fuel wood production, Leaf fodder production, Dry leaf fodder production and seed production of Alley species q/ha as influenced by treatments**

Treatments	No. of branches/Tree	Crop growth rate(RGR) Kg/ha/Day	Fresh yield q/ha	Dry matter yield of prunning g	Fuel wood production q/ ha	Leaf fodder production q/ha	Dry leaf fodder pro.q/ha	Seed production from alley spp.
<b>Alley Species</b>								
A <sub>1</sub>	32.85	29.72	105.01	50.98	42.55	33.64	8.45	5.48
A <sub>2</sub>	22.85	33.91	119.59	47.41	30.39	68.89	17.22	11.85
Sem±	0.67	-	-	-	-	-	-	-
C.D.at 5%	2.12	-	-	-	-	-	-	-
<b>Pruning Management</b>								
P <sub>0</sub>	33.69	-	-	-	-	-	-	8.66
P <sub>1</sub>	25.28	31.68	111.62	48.70	35.82	51.45	12.88	-
P <sub>2</sub>	24.57	32.04	112.98	49.91	37.12	51.08	12.79	-
Sem±	0.82	-	-	-	-	-	-	-
C.D.at 5%	2.60	-	-	-	-	-	-	-

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N level Kg/ha								
0 (N <sub>1</sub> )	28.68	31.27	110.16	44.90	32.38	50.07	12.53	8.54
45 (N <sub>2</sub> )	27.46	32.16	112.63	49.24	36.32	51.71	12.93	7.99
90 (N <sub>3</sub> )	27.40	32.68	114.10	50.25	37.21	52.02	13.05	9.47
Sem±	0.66	-	-	-	-	-	-	-
C.D.at 5%	NS	-	-	-	-	-	-	-

**Table 3:- N, P & K Content, N, P & K Uptake and Green fodder yield q/ha of Sesbania and Leucaena as influenced by Various treatments.**

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Treatments	Obtain Content from all pruned material of Alley Species			N, P & K uptake in q/ha			Green Forage yield in q/ha		LER	ATE R q/ha/day
	N Content	P Content	K Content	N	P	K	Intercrop	Sole crop		
Sesbania (A <sub>1</sub> )	2.88	1.18	2.08	3.02	1.23	2.19	33.64	71.79	1.23	0.61
Leucaena (A <sub>2</sub> )	2.57	0.15	0.97	3.03	0.18	1.15	68.89	148.98	1.24	0.61
<b>Pruning Management</b>										
P <sub>0</sub>	2.74	0.68	1.53	-	-	-	-	-	-	-
P <sub>1</sub>	2.70	0.67	1.51	3.01	0.74	1.68	51.45	109.35	1.24	0.61
P <sub>2</sub>	2.70	0.66	1.51	3.05	0.74	1.70	51.08	109.55	1.23	0.61
<b>N level Kg/ha</b>										
0 (N <sub>1</sub> )	2.68	0.65	1.53	2.95	0.72	1.66	50.05	107.59	1.24	0.61
45 (N <sub>2</sub> )	2.71	0.66	1.53	3.05	0.74	1.72	51.71	110.62	1.23	0.61
90 (N <sub>3</sub> )	2.74	0.69	1.54	3.12	0.78	1.75	52.02	112.01	1.23	0.61

**Table 4: Available N Kg/ha (0 – 22.5 cm) of Experimental field as influenced by different treatments**

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Treatments	After experiment during 2021 - 22	After Experiment during 2022-23	In Kg /ha during 2021 - 22	In Kg/ha during 2022-23
<b>Alley species</b>				
Sesbania (A <sub>1</sub> )	0.097	0.105	194	210
Leucaena (A <sub>2</sub> )	0.093	0.106	186	212
<b>Pruning Management</b>				
P <sub>0</sub>	0.087	0.096	174	192
P <sub>1</sub>	0.095	0.102	190	204
P <sub>2</sub>	0.092	0.096	184	192
<b>N Level Kg/ha</b>				
0 (N <sub>1</sub> )	0.091	0.095	182	190

45	(N <sub>2</sub> )	0.096	0.100	192	200
90	(N <sub>3</sub> )	0.098	0.104	196	208

P<sub>0</sub> – No Pruning

P<sub>1</sub> – Pruning during Crop growth and foliage added to soil

P<sub>3</sub> – Pruning during crop growth and foliage used as forage

## References:

**AOAC.**(1970).*Official methods of analysis*. Association of Official Analytical Chemists, Washington,D.C.

**Bahuguna, S.**(1985). My life my tree message on world forest Day. Patriot, March22.

**Dubois,M.,K.A.Gilles,J.K.Hamilton,P.A.RebersandF.Smith,**(1986).Colorimetric method for determination of sugar cane related substances. *Analytical Chemistry*28:350-356.

**Tangendjaja,B.,J.B.LowryandR.H.B.Wills.**(1986).Change in sinmimosine, phenol, protein and fibre content of *Leucaenaleucocephala* leaf during growth and development.*Aust.J.Expt.Agric.*26:315-317.

**AICRPDA.**(1987), All India Coordinated research project for Dry land Agriculture, main center Rajkot, Annual Report. PP.SA-8.

**Atta- krah,A.N.**(1989). Availability and use of fodder shrubs and trees in tropical Africa Proc. Workshop on Shrubs and tree Fodder for animals IDRC-276e.140-162.

**Balasubramaniam, V. And Sekayanngel,**(1991). Effect of free legumes in hedgerows on soil fertility changes and crop performance in semi-arid highlands of Rawanda Biological Agriculture & Horticulture,8:17-32.

**Chaturvedi,O.P and Jha,A.N.** (1994). Production potential *Leucaena leucocephala* and intercrops grown under different alley management system in mid Indo- Gangetic plains, range managt. & Agroforestry. 15:93 – 103.

**FariaMarmol,J.** (1994).Evaluation of accessions of *Leucaena* in the very dry tropical forest of Zulia State, p.p. 192-201.

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- Bhatia, K.S. and Kanaujia,(2000).** Growth Responses of pearl millet and Barley to *Leucaena leucocephala* based Agroforestry system. C.S.A. University of Agriculture and Technology Kanpur. *Indian Journal of Agro Forestry*2:33-36.
- Burman,D and Gill, A.S.(2001).** Alley Cropping system for soil resource management. Indian Grassland and fodder Research Institute, Jhansi, Indian Journal of Agroforestry Vol.3 No.2: 108-119.
- Gill. A. S.(2002)** *Leucaena* leaves as a source of manureL.R.R. 5:26.
- Shukla N.P, Rekib A, Burman D. (2002)** Productivity of *Sesbania* Alley cropping system with sequently cropped Berseem and maize at different moisture regimes and fertilizers. *Tropical Agricultural Research and Extension* 5(1-2).
- Tudri,S, Y.Ishi,H. Numaguchi and S.Pransanpainch(2002).** The effect of cutting interval on the growth of *Leucaena* and three associated grasses in Thailand. *Trop.Grass*/36:90-96.
- Krishna,B.E. Allolli T.B. (2005).** Influence of cropping system and source of Nutrients in *Leucaena* based alley cropping system on yield and quality of Tomato. *Karnataka Journal Agric. Sci.*18 (2): 464-468.
- Bhatt,R.K.,T.A.Khan,P.S.PathakandA.K.Mishra,(2006).**Sustainable for age production under silvipastoral systems in semi arid conditions.
- Zaharah A. R. Chintu R, Ziana,Z. Z. Bah A.R & Rashidah Wak (2008).** Management of Agroforestry system for enhancing resource use efficiency and crop productivity. Iana Vienna, ISSN 1011-4289.
- Beedy, T.; Snapp, S.; Akinnifesi, F.; Sileshi, G. (2010)**Impact of *Gliricidia sepium* intercropping on soil organic matter fractions in a maize-based cropping system.*Agric.Ecosyst.Environ.*,138,139–146.
- N.K.Jat, Arpan Pandey, ShivaDhar. (2010).** Influence of *Sesbania* green manure with or without wheat residues and N fertilization on Maize- Wheat cropping system. *Indian Journal of Agronomy.*55(4): 253-258.

**Praveen Jakhar, Dhananjay Barman, Madhu Madiganda(2013).** Alley cropping system for natural resource conservation in shifting cultivation degraded lands of Eastern Ghats. In book Natural Resource Conservation; Emerging issues & future challenges(PP 851-855).

**Primo, D.C.; Menezes, R.S.C.; Sampaio, E.V.D.S.B.; Garrido, M.D.S.; Junior, J.C.B.D.; Souza, C.S. (2014).** Recovery of N applied as 15N-manure or 15N Gliricidia biomass by maize, cotton and cowpea. Nutrition Cycle Agroecosystem, 100, 205–214.

**Martins, J.C.R.; Freitas, A.D.S.D.; Menezes, R.S.C.; Sampaio, (2015)** Nitrogen symbiotically fixed by cowpea and Gliricidia in traditional and agroforestry systems under semiarid conditions. Pesquisa Agropecuaria Brasileira. 50, 178–184.

**Silva, A.R.D.; Collier, L.S.; Flores, R.A.; Santos, V.M.D.; Silva, L.L.D.; Oliveira, V.A.; Barbosa, J.M. (2015).** Productive Yield of Cowpea and Maize in Single Crop and Mixtures in an Agro-forestry System. Am. Eur. J. Agric. Environ. Sci. 15, 85–92.

**De Oliveira, V.R.; ESilva, P.S.L.; Pontes, F.S.T.; DePaiva, H.N.; Antonio, (2016)** R.P. Growth of Arboreal Legum in our Plants And Maize Yield In Agroforestry Systems. Revista Árvore. 40, 679–688.

**Burman D Adhikari P.P., Hombegowda H.C., Jakhan P. & Madhu M. (2017).** Soil erosion and control and carbon sequestration in shifting cultivated degraded highlands of eastern India, Performance of two contour hedge row system. Agro-forestry System 91(4): 757-771.

**Moura-Silva, A.G.; Aguiar, A.D.C.F.; Jorge, N.; Agostini-Costa, T.D.S.; Moura, E.G. (2017).** Food quantity and quality of cassava acted by legum in our residues and inorganic nitrogen application in as oil flow natural fertility of the humid tropics. Bragantia, 76, 406–415.

**Burman D Adhikari P.P., Hombegowda H.C., Jakhan P. & Madhu M (2018).** Soil and onsite nutrient conservation potential of aromatic grasses at field

scale under a shifting cultivated degraded catchment in Eastern Ghat India.  
Int. Journal of Sediment Research. 191-201

**Devi, S., Bharadwaj, K. K., Dahiya, G. and Sharma, M.K. (2020).** Assessment of yield and nutrient uptake of wheat in agri-silvi horticulture system under semi arid region of Haryana. Indian Journal of Ecology, 47(3), 866-868.

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