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Research Article

Screening and Growth Performance Evaluation of Potential Multipurpose Trees and Shrubs for the Environment of East Shewa and West Arsi Zones, Oromia, Ethiopia

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Abstract

The study aimed to evaluate the growth performance of selected multipurpose trees and shrubs in the East Shewa and West Arsi Zones of Oromia, Ethiopia, emphasizing site-matching adaptation for agroforestry systems. Four species, *Gliricidia sepium*, *Leucaena pallida*, *Millettia ferrugenia*, and *Tephrosia candida* were chosen based on their availability and suitability for local conditions across two specific agroecology, namely lowland and midland. All tree seeds underwent nursery management before planting, and uniform planting procedures were followed at the trial sites. A spacing of 2 x 2 meters was used for planting all selected tree and shrub species. Results indicated that all species survived at trial sites, with survival rates ranging from 55.6% to 90%. *Gliricidia sepium* achieved a height of 131.5 cm and a survival rate of 83.3% at the Adami Tullu site, while Leucaena pallida reached a maximum height of 403.2 cm, demonstrating potential in lowland conditions. *Millettia ferrugenia* exhibited significant growth with a diameter at breast height of 3.434 cm and a height of 441.7 cm in lowland areas. *Tephrosia candida* performed better in midland conditions, reaching a height of 295.0 cm and a survival rate of 88.89%. In conclusion, *Gliricidia sepium* and *Leucaena pallida* performed well at both Negelle and Tullu sites, while Millettia ferrugenia showed the best performance at the Tullu site. *Tephrosia candida* highly performed at the Negelle site, representing midland ecology. The findings underscore the importance of adaptive trials in enhancing site management and optimizing the use of multipurpose trees and shrubs in agroforestry practices, thereby improving soil health, biodiversity, and community livelihoods. Finally, recommend incorporating these species into various agroforestry practices while considering broader growth factors.

Keywords

Agro-ecology, Growth Performance, Multipurpose, Site Matching

1. Introduction

Ethiopia is characterized by excessive land resource degradation, low agricultural productivity, intense demands for productive natural resources, and recurring food insecurity problems. These have in turn contributed to the unsustainable use of natural resources, accelerated soil erosion, and widening of desert-like drought conditions [18].

Smallholder farmers in tropical regions including Ethiopia where climate risks and land degradation are severe can benefit from agroforestry as a “multifaceted solution” for both cli-

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mate change mitigation and adaptation. By intentionally integrating trees with crops and livestock, agroforestry can enhance soil fertility, increase carbon sequestration, and diversify livelihoods. [2].

Agroforestry systems enhance soil fertility, reduce erosion, and boost biodiversity by providing habitats for various organisms [3, 13]. They aid in climate change mitigation through carbon sequestration and improve resilience against climate extremes [11, 19]. Additionally, agroforestry increases agricultural productivity, stabilizes rural incomes, and improves food security by diversifying income through products like fuel, fruits, and fibers [16, 17].

By combining crops or livestock with trees, agroforestry offers a sustainable land management approach that helps alleviate environmental degradation while providing economic benefits. The use of Multipurpose Tree Species (MPTs) within these systems can reduce soil erosion and deforestation, conserve water, and enhance soil health [1]. MPTs also generate diverse income through non-timber forest products (NTFPs) like fruits and seeds, supporting local communities.

A wide array of solutions suggested this overall degradation as tree plantation is among it [8]. The only solution to arrest the worsening environmental deterioration and wood shortage crises in Ethiopia is to adopt stringent environmental protection schemes and embark on aggressive plantation establishment programs. Given the rather limited experiences in and resource-intensive nature of large-scale plantation management, integration of multipurpose tree and shrub species (MPTSs) in the existing land use systems holds great potential [6]. Integration of multipurpose tree and/or shrub species in the farm units can also significantly contribute to sustainable land management and livelihood [10, 15].

Promoting multipurpose tree species that align with local farming systems is crucial for improving the livelihoods of rural communities. In Ethiopia, various institutions have conducted trials to screen these species in different agro ecological zones. However, the findings often fail to reach or gain acceptance in many farming communities [7].

To effectively introduce multipurpose trees into agroforestry systems, these trees must meet specific objectives and be suited to the biological conditions. Selection should focus on both identifying suitable species and thoroughly characterizing their provenances. This requires long-term research to maximize the potential contributions of multipurpose trees (MPTs) to agroforestry.

The selection process begins with matching tree characteristics to site conditions. While over 2,000 woody species have been identified as useful MPTs, only a few are widely known and utilized, with many still awaiting exploration of their full potential [12].

Presently, farmers of the study area and surrounding depend on only a few numbers of species for tree products and services. However, according to [7], relying heavily on a few species has risks and impacts on the productivity and sustainability of farming systems. A wider range of tree and shrub species would ensure resilience and decrease sensitivity to pests and diseases.

The attempt to evaluate MPTs' performances and select those trees for both their products and services has not yet been done in the area. Therefore, this activity is designed with the following objectives.

2. Objectives

1) To select site matching promising multipurpose trees/shrubs in the study area
2) To evaluate growth performances of potential multipurpose trees/shrubs under study condition

3. Materials and Methods

3.1. Description of the Study Area

The study was conducted in the two representative altitudes in the two zones i.e., Adami Tullu representing lowland altitudes, and Negelle Arsi midland altitude.

Adami Tulu district lies between 7° 9'N lat, 38° 7'E long; elevation 1650 m above sea level. The mean annual rainfall and temperature of the area are 760.9 mm and 19.8°C respectively. The pH of the soil is 7.88. The soil is fine sandy loam in texture with sand, clay, and silt in proportions of 34, 48 and 18% respectively (ATARC, 1998). The altitude ranges from 1500-2300 m.a.s.l. Adami Tulu Jido Kombolcha Woreda has semi-arid and arid agro-climate zones. The Woreda receives an average annual rainfall of 760 mm. The mean monthly temperature varies from 18.5°C to 21.6°C with a mean yearly temperature of 20°C. Rainfall extends from February to September with a dry period from May to June, which separates the preceding short rains from the following long rains [4]. The study area has three land use systems: crop lands controlled grazing lands with closed areas, and communal open-access grazing land [9].

Negelle Arsi District is situated at a latitude of 7°09' N to 7° 41' N and 38°25' E to 38°54' E and an altitude ranges from 1500 to 2300 meters above sea level (Negele Arsi Agriculture and Rural Development Office, 2013). It is located 225 km South of Addis Ababa the capital city of Ethiopia. A continuous transformation of landscapes from natural forests to cultivated lands exists. The average rainfall ranges from 800 to 1400 mm with the average minimum and maximum temperature is 15°C and 20°C respectively. The rainfall is bimodal, the long rain occurs from June to September and the short rainfall is from March to April with the highest usually recorded in July and August, respectively. Arsi Nagele district is divided into three major climatic zones based on altitude including low, mid, and high altitudes. The mixed crop-livestock system is the mode of agriculture in the district.

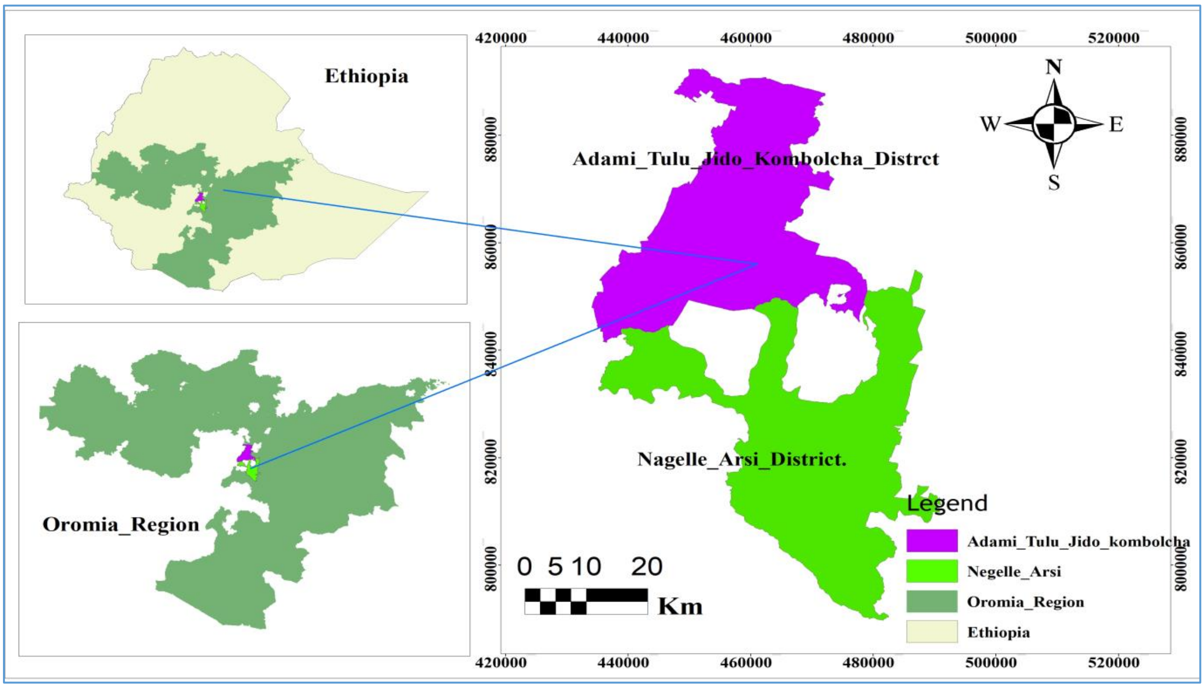

Figure 1. Map of the study area.

3.2. Multipurpose Trees and Shrub Species Selection

A total of about 4 multipurpose tree and shrub species were selected based on their planting material availability and available sites for planting. The selected multipurpose trees and shrubs have multiple roles for soil conservation and reclamation, Trees for livestock feed/fodder trees, Trees for live fences, Trees for landscape beautification and/or shade trees, Trees for honey bee flora, & etc. Their seeds were obtained from Bako Agricultural Research Center, ILRI, and locally available seed sources. The candidate Trees and shrubs include *Gliricida sepium*, *Tephrosia candida, Milletia ferrugenia, and Leuceanea pallida.*

3.3. Planting Design and Field Management

Nursery practices were done in advance of a target planting season so that seedlings were ready by the beginning of a particularly rainy season. The planting pit was prepared by digging the ground hole. Accordingly, a 2 x 2 m spacing was used for planting all selected tree and shrub species. Hence, a total of 27 plants per site for a single species were planted. Fencing and regular weeding were done to protect trees and shrubs from browsers and reduce competition, respectively.

3.4. Data Collection and Management

Planted multipurpose trees and shrubs were evaluated for early seedling survival rate, development, and growth performance of plant parts like length, root collar diameter, or diameter at breast height/DBH, and crown width.

3.5. Data Analysis

Data was analyzed using SAS V.9 ANOVA Procedure (one-way ANOVA) and least significant difference (LSD) of means at a 5% alpha level of significance.

4. Results and Discussion

Figures 2 and 3 below show the average climatic parameters of the experimental sites for the last five years, including the present time. This is important to discuss and give judgment on how the evaluated species performance is sometimes better at the lowland than the midland, and the expected average rainfall is higher than the lowland. The diagrams showed that the Tullu site rainfall is single-modal modal while the Negelle site is Bimodal. The rainfall in the summer season, starting from June almost showed a similar trend and closer records. This brings the similarity of growth performances of species between two varying altitudes because the planting season is the same for both ecologies.

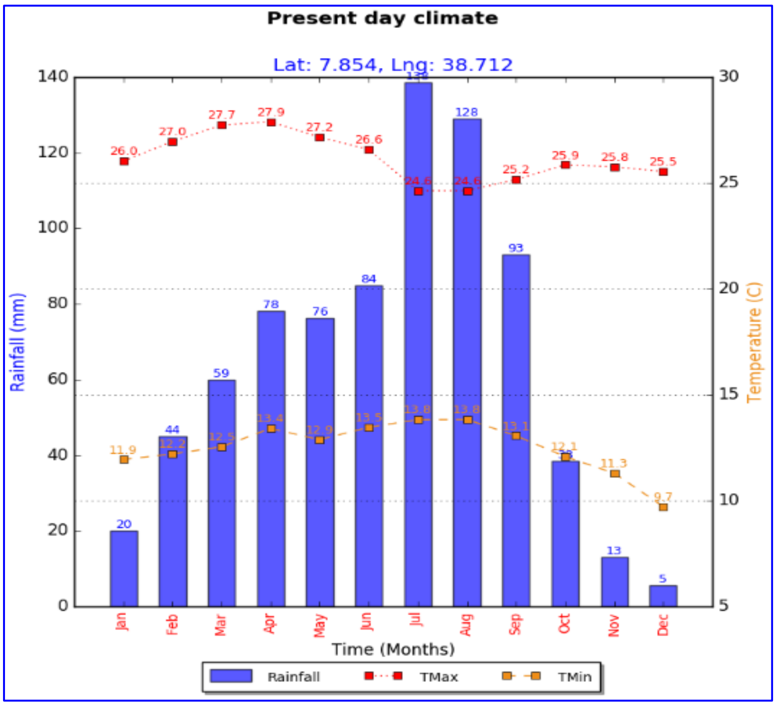

***Figure 2**. Tullu site (ATARC) Climatic diagram (Source: MarkSim, DSSAT Weather file generator).*

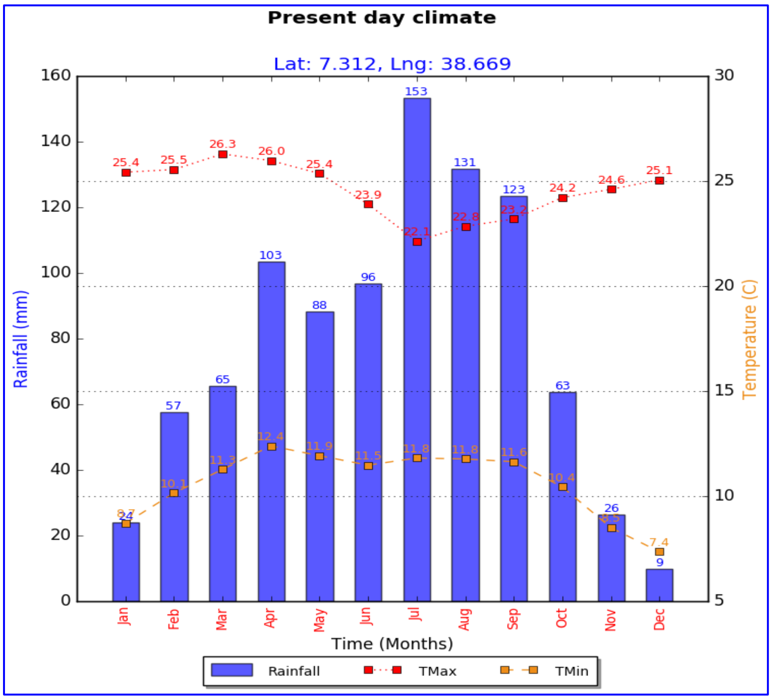

***Figure 3**. Negelle site (ATARC) Climatic diagram (Source: MarkSim, DSSAT Weather file generator).*

***Table 1**. Summary information of the species' years of evaluation.*

Species	**Plant form**	**Year evaluated**
G. sepium	Shrub	two
L. pallida	Tree	three
M. ferrugenia	Tree	three

Species	Plant form	Year evaluated
T. candida	Shrub	three

Figure 4. *Field performance of the evaluated multipurpose trees and shrubs.*

G. sepium has shown statistically no significant variation in all growth parameters evaluated for one year. However, numerically its Height, canopy growth, and survival rate at Adami Tullu have shown higher mean differences than Negelle sites. This is probably due to the short year of evaluation as it was challenging to obtain the planting material in the first year. The similar values of the evaluated shrub parameters show the potential growth performance at both ecologies. However, numerically its Height and canopy growth at Adami Tullu have higher mean differences than Negelle sites.

Table 2. *Gliricidia sepium growth performance at both sites.*

Sites	RCD_mm	Height_cm	Canopy width_cm	Survival rate%
Lowland (A/Tulu)	22.62 ±1.56	131.50 ±1.65	77.71±3.71	83.33 ±7.86
Midland (Negele)	22.66 ±1.88	111.33 ±10.02	66.50 ±7.37	77.778 ±0.00
CV	11.2	23.3	21.7	5.7
LSD (0.05)	0.04	20.17	11.21	5.6
P-value	ns	ns	ns	ns

L. pallida showed no statistically significant difference, while there was a high numerical difference in almost all growth parameters at lowland A/Tullu (Table 3). This shows the potential of the tree in lowland ecologies. Even though comparison across sites is not appropriate for such species outside of their places seeing the sites in which they were grown well is important. Mukangano (2019) reported the spp. grows well in the altitudinal range b/n 1000 up to 2000m, which is between 16 and 21 degrees Celsius almost similar to the ecology of the study. This is in line with [14] that *L. pallida* can adapt to challenging environments and mentioned soil fertility status and climatic conditions are the key growing factors. The tree/shrub height also falls in the height range by [12] mentioned its growth of 3 – 7 m.

Table 3. *Leuceanea pallid growth performance at both sites.*

Sites	DBH_cm	Height_cm	Canopy_cm	Survival rate%
Lowland (A/Tulu)	2.461±0.31	403.2±79.1	221.32±6.80	77.8±19.2
Midland (Negele)	1.9773±0.14	312.3±41.9	190.4±28.7	66.67±11.1
CV	11	17.7	10.1	21.8

Sites	DBH_cm	Height_cm	Canopy_cm	Survival rate%
LSD (0.05)	0.5523	143.53	47.3	35.6
P-value	ns	ns	ns	ns

M. ferrugenia obtained high growth performance in all growth parameters and statistically significant difference in dbh and height at A/Tullu irrespective of the Negelle midland site (Table 4). Statistical and numerical comparison for this spp. is possible because the tree is among Indigenous ones and the Negelle midland site is expected as a better-growing ecology than the lowland Tulu site. The low survival of *M. ferrugenia* at Negele is not because the tree is poorly performed at ecology. There was a highly competing grass rhizome in the site is one of the underlying factors for the low survival it. In terms of branch growth, numerical difference obtained with the highest at the lowland A/Tullu site. This shows the tree can be a potential resource in the lowland altitudes. The reason behind is that the rainfall pattern of the sites was almost showed similar resulting even better performances at lowland ecologies as their major problem is shortage of rain.

Table 4. *Milletia ferrugenia growth performance at both sites.*

Sites	DBH_cm	Height_cm	Canopy_cm	Survival rate%
Lowland (A/Tulu)	3.434±0.778 [a]	441.7±53.5 [a]	147.8±48.8	62.96±16.97
Midland (Negele)	1.404±0.259 [b]	212.5±109.6 [b]	137.3±40.7	55.6±15.7
CV	24.8	21.1	31	27.6
LSD (0.05)	2.1	234.2	17.5	7.4
P-value	*	*	ns	ns

Tephrosia candida showed a statistically significant difference in Height, and canopy growth (branch biomass), with the highest number of lateral branches recorded at the Negelle site (Table 5). It also obtained numerically the highest survival record (almost 90%) at the midland Negelle site. This shows the highest potential growth ecology for *T. candida* is midland ecology than the lowland one. The highest survival rate and biomass production are in agreement with [7] as the shrub has a high potential for biomass production and survival rate.

Since Tephrosia has shown a numerical difference and statistically significant difference in growth performance at the Negelle site, its plant tissue analysis was conducted as in Table 6. The result is still far beyond the finding of [5] obtained an average dry matter of 20-22 kg. This shows that *T. candida* has huge and varied growth potential across a wide geographical area.

Table 5. *Tephrosia candida growth performance at both sites.*

Sites	Height_cm	Canopy_cm	Main branch no.	Lateral branch no.	Survival rate%
Lowland (A/Tulu)	212.8±46.0[b]	208.0±29.3[b]	7.667±1.528	64.33±6.5[b]	62.96±16.97
Midland (Negele)	295.0±13.2[a]	283.3±36.4[a]	9.667±1.528	118.8±12.4[a]	88.89±11.11
CV	13.3	13.5	17.6	10.8	18.9
LSD (0.05)	76.7	74.9	3.5	22.437	32.559
P-value	*	*	ns	**	ns

Table 6. Tephrosia candida plant tissue analysis for Negelle Site.

Sample	DM%	ASH%	OM%	N%	CP%
200gm	86.1	10.3	89.7	2.6	16.4

5. Conclusion and Recommendations

5.1. Conclusion

To date, studies have focused on selected multipurpose trees and shrubs aimed at developing effective management techniques for cultivation. These studies have investigated the growth performance and productivity of these trees. Specific growth characteristics were observed at two different altitudes, leading to key results regarding their development.

G. sepium in one-year early growth performance showed almost the same growth performance and survival in the two sites. *L. pallida* growth is impacted not only by soil fertility status and climatic conditions but also by overall site quality in terms of competing vegetation is very important. It also obtained wider growth performance over the evaluated sites. *Tephrosia candida* obtained potential growth in midland ecology than the lowland one. *M. ferrugenia*, a fast-growing endemic leguminous tree has also shown potential growth at lowland than midland though there are other underlying sites and climatic factors. Overall changing climatic variability has an impact on all evaluated tree and shrub species.

In terms of survival, almost all species survived to their planted sites meeting the minimum survival rate of 50%. Except for *T. candida* at the lowland Tulu site, all evaluated species can be screened for future research and development considerations at the sites.

5.2. Recommendations

1) Effective management characteristics help show the climax potential of this species within respective altitudes or agro-ecologies particularly *M. ferrugenia* at both altitudes, *T. candida* at A/Tullu, and *L. pallida* at Negelle midland altitude.
2) Moving forward with this species with appropriate agroforestry practices in their potential altitude/agro-ecology is appreciable for various economic and environmental benefits.

Abbreviations

ATARC	Adami Tullu Agricultural Research Inistitute
ILRI	International Livestock Research Inistitute

Author Contributions

Bonsa Fentale Jilo: Conceptualization, Data curation, Resources, Methodology, Writing – original draft, Writing – review & editing
Desta Negayo Komicha: Methodology, Resources
Gemeda Terfassa Fida: Methodology, Resources

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Ani, F., Riniarti, M., & Duryat, D. (2020). Inventarisasi Hasil Hutan Bukan Kayu Dari Tanaman Mpts Di Hutan Desa Sukaraja Kph Rajabasa Inventarisasi of Non-timber Forest Product from Multi Purpose Tree Species in Sukaraja Forest Village KPH Rajabasa. *Gorontalo Journal of Forestry Research*, *3*(1), 1-10.

[2] Bodalkar, S., & Sharma, P. K. (2025). Agroforestry: A multifaceted solution for climate change mitigation, adaptation and environmental conservation. In D. P. S. Badwal & S. Hooda (Eds.), Abstract Book: 12th International Conference on “Agriculture & Veterinary: Transformative approach, Research & Innovations Forum” (ICAVRI-2025) (pp. 176–177).

[3] Chauhan, A. (2020). Evaluating the potential of agro-forestry for sustainable land use management: an analytical perspective. *Turk. Online J. Qual. Inq*, *11*(2), 652-657.

[4] Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J. R., Arico, S., Báldi, A. &Bartuska, A. (2015). The IPBES Conceptual Framework—connecting nature and people. Current Opinion in Environmental Sustainability, 14, pp. 1-16.

[5] Duguma, M. S., & Urga, R. T. (2023). Potential of Tephrosia candida for Restoration of Degraded Lands and Fuel Wood Production in Western Ethiopia. *Int J Multidiscip Res Growth Eval*, *4*(4), 318-23.

[6] Hailu, M., & Raj, A. J. (2014). Multipurpose trees in agroforestry. *Agroforestry: theory and practices. Scientific Publishers, India*, 91-103.

[7] Kindu, M. (2006). Tree species diversity and its role for household food security in the highlands of Ethiopia. PhD Dissertation, Albert-Ludwigs-Universität Freiburg, Germany.

[8] Kumar, R., Bhatnagar, P. R., Kakade, V., & Dobhal, S. (2020). "Tree plantation and soil water conservation enhances climate resilience and carbon sequestration of agro ecosystem in semi-arid degraded ravine lands." Agricultural and Forest Meteorology, 282, 107857.

[9] Mesku, D., Zeleke, A., Yasin, A., &Wole, K. (2008). FRG Project Completed Repass, EIAR, OARI and JAICA Cooperation, Adami Tulu Agricultural Research Center.

[10] Muthuri, C. W., Kuyah, S., Njenga, M., Kuria, A., Öborn, I., & van Noordwijk, M. (2023). Agroforestry's contribution to livelihoods and carbon sequestration in East Africa: A systematic review. Trees, Forests and People, 14, Article 100432. https://doi.org/10.1016/j.tfp.2023.100432

[11] Mosquera-Losada, M. R., Rodríguez-Rigueiro, F. J., Ferreiro-Domínguez, N., Pantera, A. and Santiago-Freijanes, J. J., 2019. Agroforestry innovations networks in Europe. *In Proceedings of the 16th international conference on environmental science and technology. Shah, Fahad.*

[12] Orwa, C. (2009). Agroforestree Database: a tree reference and selection guide, version 4.0. *http://www. worldagroforestry. org/sites/treedbs/treedatabases. asp*.

[13] Richard, Tranter. (2023). Farmers' attitudes towards, and intentions to adopt, agroforestry on farms in lowland South-East and East England. Land Use Policy, 131, 106668-106668. Available from: https://doi.org/10.1016/j.landusepol.2023.106668

[14] Revell, C., Moore, G., Real, D., & Crouch, S. (2019). Environmental adaptation of leucaena in Western Australia – challenges and opportunities. Tropical Grasslands-Forrajes Tropicales, 7(2), 112–119. https://doi.org/10.17138/tgft(7)112-119

[15] Rout, C. K., Kerketta, A., & Bahadur, V. (2023). Different varieties of cowpea (Vigna unguiculata) in Prayagraj agro-climatic conditions. International Journal of Environment and Climate Change, 13(9), 658–663. https://doi.org/10.9734/ijecc/2023/v13i92284

[16] Sarah, E., Castle., Daniel, C., Miller., Pablo, J., Ordoñez., Kathy, Baylis., Karl, Hughes. (2021). The impacts of agroforestry interventions on agricultural productivity, ecosystem services, and human well-being in low- and middle-income countries: A systematic review. Campbell Systematic Reviews, 17(2) Available from: https://doi.org/10.1002/CL2.1167

[17] Sarvade, S., Gautam, D. S., Bhalawe, S. and Bisen, P. K., 2016. An overview of potential multipurpose agroforestry tree species, Syzygium cuminii (L.) Skeels in India. Journal of Applied and Natural Science, 8(3), pp. 1714-1719.

[18] Yulia, Kusuma, Wardani., Nur, Indah, Yuli, Lestari., Rinaldo, Adi, Pratama., Razmi, Zakiah, Oktarlina., Winda, Trijayanthi, Utama., Admi, Syarif., Kiki, Sari, Ratna, Juwita. (2023). Implementasi sistem agroforestri sebagai upaya peningkatan ekonomi dan pencegahan erosi di desa teba liokh kecamatan batu brak kabupaten lampung barat. Buguh, 3(1), 105-111. Available from: https://doi.org/10.23960/buguh.v3n1.2091

[19] von Carlowitz, P. G., Wolf, G. V., & Kempermann, R. E. M. (1991). Multipurpose tree and shrub database: An information and decision support system. International Centre for Research in Agroforestry; Deutsche Gesellschaft für Technische Zusammenarbeit.