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Smallholder Eucalyptus globulus Woodlot Management Practices and Their Socioeconomic Determinants in Guna Begimeder District, South Gondar Zone, Ethiopia

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Abstract

Smallholder Eucalyptus globulus woodlots are expanding rapidly in the Ethiopian highlands because of their fast growth, coppicing ability, market demand and relatively simple tending requirements. This paper assessed common smallholder E. globulus woodlot management practices and examined determinants influencing the application of selected management practices in Guna Begimeder District, South Gondar Zone, Ethiopia. A three-stage sampling procedure was used: Guna Begimeder was purposively selected; Ata, Arega Didem and Denkuara kebeles were randomly selected; and 98 woodlot-owning households were interviewed. Descriptive statistics and a probit model reported in the original study were used, and R was additionally used to produce publication-quality visualization of the reported marginal effects. The major management practices included harvesting, beating up, weeding, pitting preparation, coppicing management and thinning. Farmers also practiced seedling raising, spacing, pruning, fencing, watering and pest/disease management. Wealth status, education and family size increased the probability of applying coppicing management, while woodlot size and extension support significantly influenced pest and disease management. The findings demonstrate that improved eucalyptus management requires both silvicultural recommendations and household-targeted extension strategies

Keywords: *Eucalyptus globulus; smallholder woodlots; management practices; coppicing; extension support; probit model; Ethiopia*

1. Introduction

Eucalyptus species have been cultivated in East Africa for more than a century, and farmers, urban consumers and public institutions have accumulated substantial experience with their uses and management. In Ethiopia, *eucalyptus* has expanded because it responds to urgent demands for fuel-wood, construction poles, farm tools, fencing material and cash income at a time when indigenous forest resources have declined and wood

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markets have expanded (FAO, 2009; Gessesse and Teklu, 2011; Zenebe et al., 2007). Several Ethiopian studies further show that *eucalyptus* is attractive to smallholders because it grows fast, coppices repeatedly, adapts to diverse ecological conditions and produces marketable wood products within short rotations (Mulugeta, 2010; Yitebitu, 2010; Abebe Birara Dessie et al., 2019).

The expansion of *eucalyptus* woodlots has also been linked to changing rural livelihoods and land-use pressures. As household landholdings become smaller and demand for wood products increases, farmers often allocate plots, boundaries and marginal lands to *eucalyptus* because it generates periodic income and can be harvested according to household cash needs (Million Bekele, 2011; Tsegaye Bekele, 2015; Tegegne Derbe et al., 2018). Similar observations from Wogera, South Ache-fer and Lay Gayint indicate that smallholder eucalyptus woodlots are not only forestry activities but also livelihood, market and risk-management strategies (Bethlehem Tsedalu, 2017; Fentahun Ayene, 2019; Estegenet Emiru, 2018).

Despite these advantages, the performance of smallholder *eucalyptus* woodlots depends strongly on management. Practices such as seedling selection, nursery management, pitting, planting time, beating up, spacing, weeding, thinning, pruning, fencing, harvesting season and coppice shoot selection influence survival, stem quality and final yield. Studies in Ethiopia and elsewhere show that poor spacing, weak tending, lack of thinning and repeated unmanaged coppicing can reduce productivity and wood quality even when the species has high biological growth potential (Oballa and Muchiri, 2010; Hamilton, 2000; Miranda et al., 2015; Latifah et al., 2014). Therefore, evaluating farmer-level management practices is essential for improving both production and sustainability.

Management decisions are also shaped by socioeconomic and institutional conditions. Education, household labour, wealth, landholding, woodlot size, distance from the homestead, market access and extension support can influence whether farmers adopt improved practices (Buyinza et al., 2008; Singunda, 2010; Abebaw and Mulatu, 2016; Mitikie Nigusie, 2017). For this reason, the present paper examines not only what practices are used by smallholders in Guna Begimeder but also which household and institutional factors influence the application of key practices such as coppicing management and pest/disease management.

1.1 Objectives

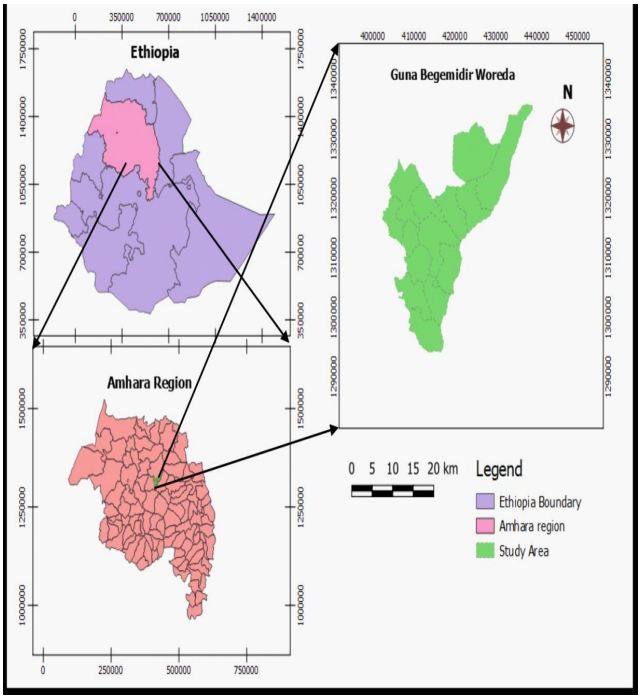
This paper is organized around two closely related objectives. The first objective is to identify and characterize the major *Eucalyptus globulus* woodlot management practices used by smallholder farmers in Guna Begimeder District. This includes establishment, seedling sourcing, pitting, planting, beating up, spacing, weeding, thinning, pruning, fencing, harvesting, coppicing and pest/disease management practices. The second objective is to examine the socioeconomic and institutional factors that determine the application of selected management practices, particularly coppicing management and pest/disease management. The two objectives are connected because management practices are not only technical silvicultural activities; they are also influenced by household

education, wealth status, family labour, woodlot size, experience, distance and extension support.

2. Materials and Methods

2.1 Study Area

The study was conducted in Guna Begimeder District, South Gondar Zone, Amhara National Regional State, Ethiopia. The district is located about 30 km from Debre Tabor and 130 km from Bahir Dar. It lies at approximately 11°54′–11°56′ N latitude and 37°55′–37°57′ E longitude, with altitude ranging from 2100 to 4200 m above sea level. Mean annual temperature ranges from about 12°C to 29°C, and annual rainfall ranges from 900 to 2100 mm. Crop production, livestock and plantation forest products are major livelihood sources.



Paper 1 Figure 1. Study area map of Guna Begimeder District, South Gondar Zone, Ethiopia.

2.2 Sampling Design and Data Collection

A three-stage sampling design was employed. First, Guna Begimeder District was purposively selected because of its high potential for *E. globulus* woodlot production. Second, three kebeles—Ata, Arega Didem and Denkuara—were randomly selected from 18 kebeles. Third, 98 households were randomly selected and interviewed about management practices, seedling sources, planting, spacing, weeding, beating up, thinning, pruning, coppicing, fencing, watering, harvesting and pest/disease management.

Table 1. Distribution of sampled households by kebele in Guna Begimeder District.

Kebele	Total households	Proportion (%)	Sample households
Ata	1446	35	34
Arega Didem	1124	28	27
Denkuara	1521	37	37
Total	4091	100	98

2.3 Data Analysis

The original household data were analysed using SPSS version 25 and a probit model. R version 4.5.0 was also used to reproduce and visualize the reported summary results. R was used to create a marginal-effect plot from the reported probit dy/dx values and to improve transparency of data interpretation.

3. Results

3.1 Household Characteristics

The majority of woodlot-owning respondents were male household heads (98%), while female-headed respondents accounted for 2%. The mean family size was 6.77 ± 0.235 persons. Regarding wealth status, 48% of households were categorized as rich,

35.7% as medium and 16.3% as poor. The average woodlot size was 0.251 ± 0.0203 ha. Most respondents (81.6%) planted eucalyptus on their own land, 16.3% on leased or purchased land and 2% on shared land. About 75.5% of respondents were educated.

Table 2. Socioeconomic and demographic characteristics of Eucalyptus globulus woodlot producers.

Variable	Category/statistic	Value
Sex of household head	Male	98%
	Female	2%
Family size	Mean ± SE	6.77 ± 0.235
	SD	2.328
Wealth status	Poor	16.3%
	Medium	35.7%
	Rich	48%
Woodlot size	Mean ± SE	0.251 ± 0.0203 ha
Land ownership	Owned	81.6%
	Leased/bought	16.3%
	Shared	2%
Education	Educated	75.5%
	Illiterate	24.5%

3.2 Common Woodlot Management Practices

The most common practices were harvesting, beating up, weeding, pitting preparation, coppicing management and thinning. Additional practices included seedling raising, spacing, pruning, fencing, watering and pest/disease management. Own nursery seedling production was common, and farmers used potted seedlings (46.9%), bare-root seedlings (29.6%) and both seedling types (23.5%). Spacing varied from less than 0.25 m to greater than 1.5 m, with 0.5–1 m being the most common spacing category.

3.3 Determinants of Coppicing and Pest/Disease Management

The reported probit model showed that wealth status, education and family size increased the probability of coppicing management. Woodlot size and extension support significantly influenced pest and disease management. These results show that farmer capacity and institutional support shape the adoption of more technical management practices.

Table 3. Probit model results for determinants of coppicing and pest/disease management practices.

Variable	Coppicing dy/dx	P-value	Pest/disease dy/dx	P-value	Interpretation
Age	0.0079	0.104	0.0004	0.804	Positive but not significant
Wealth	0.1908	0.017*	0.0020	0.919	Significant for coppicing
Education	0.2579	0.047*	0.0213	0.329	Significant for coppicing
Family size	0.0431	0.071*	0.0113	0.118	Positive influence on coppicing
Experience	0.0002	0.957	0.0006	0.639	Not significant

Land size	0.2576	0.162	0.0691	0.246	Positive but not significant
Woodlot size	0.2489	0.280	0.3159	0.013*	Significant for pest/disease management
Distance	-0.0079	0.692	-0.0028	0.545	Negative but not significant
Extension support	0.0448	0.245	0.0994	0.011*	Significant for pest/disease management

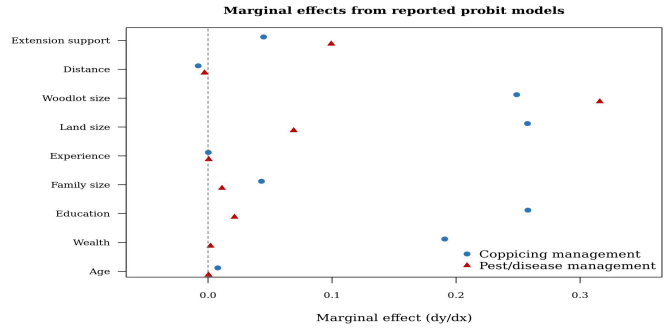


Figure 2. R-generated marginal-effect plot for reported probit models of coppicing and pest/disease management.

4. Discussion

4.1 Interpretation of Management Practices within Ethiopian Smallholder Plantation Systems

The first objective of the paper was to identify the common management practices used by smallholder *Eucalyptus globulus* growers. The findings show that farmers in Guna Begimeder do not manage *eucalyptus* woodlots as passive tree stands; rather, they apply a sequence of establishment, tending, protection, harvesting and regeneration practices. This pattern is consistent with the wider Ethiopian highland experience where eucalyptus has become a farmer-managed tree crop integrated into household livelihood strategies. FAO (2009), Gessesse and Teklu (2011), and Zenebe et al. (2007) all indicate that eucalyptus expanded in East Africa because it responds to wood scarcity, urban demand, construction needs and smallholder cash-income requirements. Therefore, the management practices observed in Guna Begimeder should be understood not only as silvicultural actions but also as livelihood decisions.

The common practices identified—seedling raising, pitting, planting, beating up, spacing, weeding, thinning, pruning, fencing, harvesting and coppicing—are similar to those reported in South Achefer, Lay Gayint, Wogera and other eucalyptus-producing districts of Ethiopia. Fentahun Ayene (2019) reported that smallholders managing *Eucalyptus camaldulensis* in South Achefer used thinning, weeding and other tending operations to reduce competition and obtain intermediate products. Estegenet Emiru (2018) also observed that small-scale *Eucalyptus globulus* growers in Lay Gayint differed in productivity partly because of differences in management intensity. These comparisons strengthen the present finding by showing that Guna Begimeder is part of a broader smallholder eucalyptus management system in the Amhara highlands.

4.2 Seedling Sources, Establishment Practices and Farmer Nursery Systems

The dominance of farmer-managed seedling sources in the study area agrees with Bethlehem Tsedalu (2017) and Fentahun et al. (2016), who reported that nursery ownership and local seedling access encouraged woodlot expansion in northern Ethiopia. Own nursery production reduces dependence on government nurseries and allows farmers to match seedling supply with rainfall and planting time. However, the advantage of local seedling access must be balanced with seedling quality. Poor seed source, weak potting media and inadequate nursery hygiene may reduce survival and productivity. Thus, farmer nurseries should be supported through technical training rather than replaced by centralized systems.

The planting period reported in the study, mainly June and July, is consistent with the rainfall-dependent establishment strategy used in many Ethiopian highland plantation systems. Similar observations have been reported by Estegenet Emiru (2018) and Fentahun Ayene (2019), where planting was synchronized with the onset of the rainy season to increase survival. The practice of beating up also reflects farmers' awareness that early seedling mortality can reduce stand stocking and future yield. In this sense, beating up is not a minor activity but an important survival-correction mechanism in smallholder eucalyptus establishment.

4.3 Spacing, Thinning, Coppicing and Harvesting Practices in Comparative Perspective

The widespread use of narrow spacing in Guna Begimeder is similar to findings from South Achefer and other Ethiopian smallholder woodlot systems, where farmers often plant closely because of land scarcity and the belief that more stems will produce more income (Fentahun Ayene, 2019). However, international eucalyptus spacing studies show that very high density can suppress diameter growth and reduce individual tree volume. Bernardo et al. (1998) demonstrated that wider spacing increased diameter growth in eucalyptus plantations in Brazil, while Soares et al. (2016) showed that stand structure and competition affect eucalyptus productivity. Therefore, the spacing choices observed in this study reflect a tension between farmers' short-term land-saving logic and silvicultural principles of competition management.

Thinning and pruning were practiced for practical reasons such as removing dead, forked, diseased or low-quality stems and obtaining intermediate products. This is consistent with the role of thinning described by Fentahun Ayene (2019) and Estegenet Emiru (2018), where farmers used thinned stems for home consumption and market sale. Oballa and Muchiri (2010) also emphasize that eucalyptus management should be linked to product objectives: fuelwood, poles, construction wood and timber require different spacing and rotation decisions. The present study therefore suggests that extension advice should not recommend a single spacing or thinning rule; rather, it should guide farmers according to product objectives and site conditions.

Coppicing is one of the main reasons smallholders prefer eucalyptus. Mulugeta (2010), Yitebitu (2010) and Zenebe et al. (2007) all note that coppicing reduces replanting costs and allows repeated

harvests. The present finding that productivity is perceived to decline after repeated rotations is supported by coppice-management literature, including Liz Hamilton (2000) and Miranda et al. (2015), which indicate that coppice vigour, stem quality and stump health can decline with age and repeated cutting. Therefore, coppice management should include shoot selection, protection from livestock, and replacement of weak or old stumps after several rotations.

4.4 Socioeconomic and Institutional Determinants of Management Adoption

The second objective was to examine determinants of management practices. The positive relationship between education and coppicing management agrees with adoption studies by Buyinza et al. (2008), Singunda (2010), Abebaw and Mulatu (2016), and Tegegne Derbe et al. (2018), which show that education improves understanding of tree values, technical recommendations and long-term benefits. Educated farmers may be more likely to recognize the importance of regulating coppice shoots rather than leaving many sprouts to compete on the same stump.

The influence of wealth status is also consistent with smallholder forestry literature. Wealthier households often have more land, labour, oxen, cash and ability to hire workers, which increases their capacity to perform labour-demanding practices such as coppice selection, thinning and protection. Million Bekele (2011) similarly emphasized that labour and management costs influence the economic returns from private woodlots. This means that technical recommendations alone may not be enough for poorer households unless accompanied by labour-saving practices, group extension approaches or staged management recommendations.

The significance of extension support for pest and disease management is especially important. Pest and disease management is knowledge-intensive and often requires diagnosis, timing and technical advice. Similar conclusions have been drawn by Million Bekele (2011) and Tegegne Derbe et al. (2018), who stressed the importance of extension contact in improving woodlot establishment and management. The present study therefore shows that extension services should not stop after planting; they should continue through the full rotation, including coppicing, protection, pest monitoring and harvesting guidance.

4.5 Broader Policy and Environmental Implications

The *eucalyptus* debate in Ethiopia often contrasts economic benefits with environmental concerns. Some studies emphasize the income, fuelwood and construction benefits of eucalyptus for rural livelihoods (Zenebe et al., 2007; Tsegaye Bekele, 2015; Abebe Birara Dessie et al., 2019), while others caution that poorly planned eucalyptus expansion may compete with cropland, water resources or native vegetation. The present paper contributes to this debate by showing that management quality matters. Well-managed woodlots can provide wood and income, while poorly managed dense stands may produce low-quality stems and inefficient land use.

For policy, the implication is not simply to promote

or discourage eucalyptus. Instead, extension and land-use planning should promote site-appropriate, product-oriented and environmentally responsible eucalyptus management. Farmers should be advised on spacing, rotation, coppice replacement, dry-season harvesting, pest monitoring and integration of eucalyptus with household land-use plans. This balanced position is consistent with FAO (2009) and Gessesse and Teklu (2011), who argued that eucalyptus should be assessed within socioeconomic and environmental contexts.

4.6 Limitations and Future Research

The paper contributes empirical evidence from a highland Ethiopian district where *eucalyptus* is economically important but management remains uneven. The inclusion of R-based visualization of marginal effects improves interpretability and makes the determinants clearer to readers.

Nevertheless, the study is based on cross-sectional household data from three kebeles. Future research should include longitudinal monitoring, gender-disaggregated decision-making data, soil and site quality variables, market-price information and direct measurement of management quality. Such data would allow stronger causal inference and more detailed modelling of management adoption and productivity outcomes.

5. Conclusion and Recommendations

Smallholder *E. globulus growers* in Guna Begimeder apply several management practices, but the intensity and quality of practices differ among households. Wealth, education and family labour influence coppicing management, while woodlot size and extension support influence pest/disease management. The objectives of the paper are therefore properly addressed.

- Strengthen extension support on spacing, thinning, coppicing and pest/disease management.
- Promote farmer training on objective-based spacing and quality seedling production.
- Support poorer farmers with labour-saving management packages and nursery guidance.
- Encourage replacement of old stumps after repeated coppice rotations.

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