



Research Paper

# Performance of an Urban Greening Intervention: Tree Seedling Survivorship and Management Challenges under the ACRoSAL Programme in Yola North, Adamawa, Northeast Nigeria

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## ABSTRACT

Urban greening has emerged as an important strategy for improving environmental sustainability and climate resilience in rapidly urbanising cities; however, the success of such interventions depends largely on the long-term survival of planted trees. This study evaluated the performance of the Greening of Greater Yola Project implemented under the Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) programme by assessing tree seedling survivorship, identifying implementation challenges and examining silvicultural practices adopted during project implementation in Yola North Local Government Area, Adamawa State, Nigeria. The study adopted a mixed-method descriptive survey design involving physical enumeration and questionnaire survey approaches. Tree seedling survivorship was determined through direct field enumeration of surviving and failed seedlings across thirteen selected planting locations, while data on challenges encountered and silvicultural practices were collected using structured five-point Likert scale questionnaires administered to sixty-three purposively selected respondents involved in project implementation and maintenance. Data were analysed using percentage survival rates, mean and standard deviation. The findings revealed that seedling survivorship ranged from 69.23% to 98.72% across the evaluated locations, indicating generally favourable establishment outcomes approximately two years after project commencement. The highest survival rate was recorded for *Ficusbenjamina* (98.72%), while lower survival was observed in selected locations dominated by *Syzygiumpaniculatum* and *Khayasenegalensis*. Major challenges identified included destruction of seedlings by stray animals, weak enforcement of environmental regulations controlling roaming livestock, damage during construction activities and limited community sensitization and engagement. Routine weeding, watering, pruning and replacement planting emerged as the most commonly adopted silvicultural practices. The study concludes that the Greening of Greater Yola Project achieved encouraging establishment success but that sustaining long-term outcomes will require strengthened post-planting management, improved institutional coordination and enhanced community participation.

**Keywords:** urban greening; seedling survivorship, urban forestry, ACRoSAL, silvicultural practices, climate resilience

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## I. Introduction

Urban greening has emerged as a critical strategy for improving environmental sustainability, climate resilience and quality of life in rapidly urbanising cities. Through the establishment of trees, green corridors, parks and other vegetated spaces within built environments, urban greening helps address environmental problems associated with urban expansion, including rising temperatures, poor air quality, flooding and biodiversity loss. However, the success of urban greening initiatives is not determined merely by the number of trees planted but by the extent to which planted seedlings survive and establish over time. Consequently,

evaluating tree survivorship has become an important measure for determining the effectiveness and long-term sustainability of urban greening programmes.

Urban vegetation provides multiple ecosystem services with direct ecological and socio-economic benefits. Urban trees contribute to reducing the urban heat island effect through shading and evapotranspiration, leading to lower ambient temperatures and improved thermal comfort (Bowler et al., 2010). Urban forests also improve air quality by removing atmospheric pollutants and capturing particulate matter while contributing to carbon sequestration and climate change mitigation (Nowak et al., 2006). Beyond environmental benefits, urban green infrastructure has been associated with increased property values, lower energy consumption and improved public health outcomes (Donovan & Butry, 2010; Elmqvist et al., 2015). These benefits have strengthened global interest in integrating green infrastructure into urban planning and environmental management.

Despite these advantages, sustaining urban greening outcomes remains challenging because tree survival after planting is influenced by numerous interacting factors. Tree survivorship refers to the ability of planted trees to remain alive and continue growth under prevailing environmental and management conditions over time. Seedling establishment and survival are shaped by both biotic and abiotic conditions, and these interactions often determine whether greening interventions achieve their intended outcomes. Biotic factors include species characteristics, pests, diseases, herbivory, competition and anthropogenic disturbances, while abiotic factors include soil properties, temperature, water availability, light intensity and wind conditions (Comita et al., 2014; Martini et al., 2019; Iverson et al., 2023). Studies on urban tree survival have further demonstrated that maintenance intensity, stewardship practices and environmental stress significantly influence post-planting success and long-term performance of urban vegetation (Hilbert et al., 2019).

Urban environments create additional pressures that often reduce seedling establishment and survivorship. Compacted soils, inadequate rooting space, browsing by stray animals, damage from vehicular activities and disturbances associated with infrastructure development can negatively affect planted trees. Environmental stress factors such as heat, drought and poor soil conditions further increase mortality risk in newly established urban plantations. Evidence from urban forestry and plantation studies indicates that the period immediately following planting records the highest rates of seedling mortality and therefore requires deliberate post-planting management interventions (Roman et al., 2015; Koeser et al., 2021). Silvicultural practices including watering, mulching, pruning, fertilization, weed control and protection against grazing and pests have consistently been identified as important measures for improving establishment success and long-term tree performance.

In response to increasing environmental challenges and climate variability, the Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) programme in Adamawa State has implemented several interventions aimed at promoting environmental restoration and sustainable natural resource management. Among these interventions is the Greening of Greater Yola Project (GGYP), initiated in September 2024 through avenue planting across strategic locations within the Greater Yola metropolitan area. The project involved the establishment of selected urban tree species including *Khayasenegalensis*, *Ficusbenjamina* and *Syzygiumpaniculatum* with the intention of improving urban aesthetics, reducing environmental stress, enhancing ecological resilience and increasing the delivery of ecosystem services to residents.

Although studies on urban tree survival and mortality are widely reported in the literature, most available evidence originates from temperate urban environments and long-term urban forestry programmes in Europe and North America. Empirical studies evaluating tree seedling survivorship under rapidly urbanising semi-arid African conditions remain limited. Existing research has largely concentrated on determinants of urban tree mortality and post-planting management without adequately examining survival outcomes and implementation challenges associated with government-led greening programmes operating under local environmental conditions (Ko et al., 2015; Roman et al., 2015; Hilbert et al., 2019). Furthermore, published empirical evidence assessing the effectiveness of urban greening interventions implemented under the ACReSAL framework in northern Nigeria remains scarce. This gap limits evidence-based planning and adaptive management required to sustain current and future greening initiatives.

This study was therefore undertaken to evaluate the survivorship of tree seedlings established under the Greening of Greater Yola Project in Adamawa State, Nigeria. Specifically, the study assessed the survival rates of planted seedlings, identified challenges affecting seedling establishment and examined the silvicultural practices adopted during project implementation. The findings provide empirical evidence for improving urban greening management and contribute baseline information for future urban forestry and climate resilience interventions in semi-arid urban environments.



and management activities were purposively selected because of their familiarity and active involvement in project execution.

### Instruments for Data Collection

Two instruments were used for data collection: Physical Enumeration Form and a Structured Questionnaire. For the physical enumeration, a field data recording sheet was designed to document the number of surviving (living) seedlings and failed (dead) seedlings observed in each planting location during physical assessment. A structured questionnaire based on a five-point Likert scale was also developed to collect information on challenges encountered and silvicultural practices adopted during project implementation. Response categories included Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (D) and Strongly Disagree (SD).

### Methods of Data Collection

For the assessment of tree seedling survivorship, data on tree survivorship were obtained through direct physical enumeration of planted seedlings at each study location. All living and failed seedlings observed during field visits were counted and recorded using the enumeration forms. For the assessment of challenges encountered and silvicultural practices, data on implementation challenges and silvicultural practices were collected through interviewer-administered questionnaires administered to the sixty-three respondents.

### Methods of Data Analysis

Tree seedling survival rates for each location were determined using:

$$\text{Percentage Survival (\%)} = (\text{Number of Living Seedlings} \div \text{Total Number of Planted Seedlings}) \times 100$$

Descriptive statistics including mean and standard deviation were used to analyse responses relating to challenges encountered and silvicultural practices adopted.

## III. Results

### Tree Seedling Survivorship Across Greening Locations in Yola North

Table 1 presents the survival performance of tree seedlings established under the Greening of Greater Yola Project across thirteen selected locations within Yola North Local Government Area. The results showed variation in survivorship across locations and tree species. Table 1 shows that seedling survival ranged from 69.23% to 98.72%, indicating generally high establishment rates during the evaluation period. The highest survivorship (98.72%) was recorded for *Ficusbenjamina* planted along AminuGaladima Way (Bank Road), where 706 out of 718 planted seedlings survived. This was followed by *Syzygiumpaniculatum* planted along Ahmadu Bello Way-Ribadu Square with a survival rate of 95.32% and *Ficusbenjamina* planted along Justice BubaArdo Road with 91.42% survival. Among locations planted predominantly with *Syzygiumpaniculatum*, relatively high survival rates were also observed along NEPA Road (92.19%), Bishop Street-Gate II Jimeta Modern Market (90.40%) and AtikuAbubakar Way (88.69%). Moderate survival performance was observed along State Low Cost-Fire Service (81.25%) and Mubi Flyover-Doubeli Junction (83.78%). Lower survivorship was recorded at locations including SPY Roundabout-Bekaji Road, where *Khayasenegalensis* recorded 73.24% survival, Weekly Scope Road (70.95%) and Shanu Roundabout-Mubi Flyover (69.23%), representing the lowest survival rate observed in the study. Across all locations, the observed survival rates suggest that the selected tree species demonstrated relatively good establishment under prevailing urban environmental conditions within the study area, although survival varied considerably among planting sites.

Table 1. Tree Seedling Survivorship across Selected Greening Locations in Yola North

**Table: 1 Seedlings Survivorship in Different Locations of Greater Yola**

S/N	Location/ Street	Tree Species	Total of Seedlings planted (A)	Number Surviving seedlings (B) (B= A-C)	Number of failed Seedlings (C) (C=A-B)	Survivorship % (% = A-C ÷ A)
1	AtikuAbubakar way	<i>Syzygiumpaniculatum</i> (Black currant)	115	102	13	88.69%
2	SPY Round About-Bekaji Road	<i>Khayasenegalensis</i> (Mahogany)	142	104	38	73.24 %
3	Shannu Round About -Mubi Fly over	<i>Syzygiumpaniculatum</i> (Black currant)	182	126	56	69.23%
4	Weekly scope road	<i>Syzygiumpaniculatum</i> (Black Currant)	592	420	172	70.95%
5	State low cost – Fire Service	<i>Syzygiumpaniculatum</i> (Black Currant)	160	130	30	81.25%

6	Mubi fly over - Doubeli Junction	<i>Syzygiumpaniculatum</i> (Black currant)	74	62	12	83.78%
7	Ahmadu Bello – Ribadusguare	<i>Syzygiumpaniculatum</i> (Black currant)	684	652	32	95.32%
8	Justice BubaArdo road	<i>Ficusbenjamina</i> (Shinning ficus)	746	682	64	91.42%
9	AminuGaladima way (Bank Road)	<i>Ficusbenjamina</i> (Shinning ficus)	718	706	12	98.72%
10	80 unit -Round about Shannu	<i>Syzygiumpaniculatum</i> (Black currant)	3340	2520	820	75.45%
11	Mubi Fly over - JimetaMordern Market	<i>Syzygiumpaniculatum</i> (Black currant)	202	180	22	89.11%
12	Bishop Street- Gate 2 Jimeta Modern market	<i>Syzygiumpaniculatum</i> (Black currant)	177	160	17	90.40%
13	NEPA Road	<i>Syzygiumpaniculatum</i> (Black currant)	193	178	15	92.19%

### Challenges Encountered During the Greening Project

Table 2 presents respondents’ perceptions of factors affecting tree seedling establishment during implementation of the Greening of Greater Yola Project. The results indicate that the most strongly perceived challenge was lack of effective enforcement of regulations controlling stray animals (M = 4.53; SD = 0.76), followed by harsh dry-season temperatures (M = 4.27; SD = 0.62), prompt destruction of seedlings by vehicles attempting to park (M = 4.08; SD = 1.46), browsing of planted seedlings by animals (M = 4.05; SD = 1.17), and planting of species considered palatable to livestock (M = 4.02; SD = 1.12). Other notable challenges identified by respondents included inadequate watering facilities and sources (M = 4.00; SD = 1.30), destruction of seedlings during construction activities (M = 3.92; SD = 1.45), concerns relating to planting pattern and spacing (M = 3.91; SD = 1.28), preference for particular tree species by residents (M = 3.81; SD = 1.38), and edaphic or soil-related constraints (M = 3.53; SD = 1.44). Conversely, respondents generally disagreed that irregular supervision (M = 1.63; SD = 0.93), irregular watering (M = 1.51; SD = 0.53), unhealthy seedlings at planting (M = 1.89; SD = 1.18), theft of protective guards (M = 1.92; SD = 0.98), or strong community rejection of planted seedlings (M = 1.73; SD = 1.20) substantially contributed to seedling loss. These findings indicate that environmental pressures, livestock interference and site-management conditions were perceived as the major constraints affecting urban greening outcomes.

**Table 2.** Challenges Encountered During the Greening Project

S/N	ITEM	SA	A	UD	SD	DA	M	SD
1	Animal browsed on seedling planted along street of this location	27	24	2	5	4	4.05	1.17
2	Seedlings are destroyed by construction work in this location	31	19	0	3	10	3.92	1.45
3	Stealing/removal of plant protective guards by residents on this street is observed	2	4	4	30	23	1.92	0.98
4	Residents along this street were inadequately sensitized on the greening project	5	4	1	32	21	2.05	1.15
5	Some residents rejected the plating and seedlings along this street	6	1	0	19	37	1.73	1.20
6	Some residents showed preference to specific seedlings species	25	23	1	6	8	3.81	1.38
7	Supervision was done irregularly	2	0	8	16	37	1.63	0.93
8	Watering/irrigation was done irregularly during dry season	0	0	1	30	32	1.51	0.53
9	Edaphic/soil related factors caused death of plants indicate number in this location ( )	23	17	1	17	6	3.53	1.44
10	Wrong plantings (under shade, close to pole, etc.) were observed	12	11	3	18	20	2.64	1.52
11	Lack of full enforcement of existing laws prohibiting stray animals affected seedlings growth	39	20	1	1	1	4.53	0.76
12	Greater Yola harsh temperatures during dry season affected many growing seedlings	21	40	0	2	0	4.27	0.62
13	Communities/NGO engagement and support is poor	18	20	0	12	13	3.29	1.55
14	Planting patterns/spacing (distance of 5m or 10m and 3m) meet global standards	20	23	1	3	6	3.91	1.28
15	Planting of palatable species promotes browsing by livestock	23	19	0	11	0	4.02	1.12
16	Print media (signposts, handbills) were distributed enough to enhance public awareness on the greening project	3	7	1	22	20	2.08	1.20

17	Planting was done during appropriate planting season/period	41	9	3	4	6	4.19	1.33
18	Watering facilities and sources of water for watering were inadequate	25	18	0	5	5	4.00	1.30
19	Poor watering by those employed was observed	14	10	1	18	20	2.68	1.58
20	Remuneration of people employed for watering was done promptly	14	45	0	2	1	4.11	0.70
21	Seedlings were destroyed by vehicles while trying to park.	41	10	1	4	9	4.08	1.46
22	Unhealthy seedlings were planted (diseased, broken etc.)	5	3	2	23	30	1.89	1.18

### Silvicultural Practices Observed During Project Implementation

Table 3 presents respondents' assessment of silvicultural practices adopted during implementation of the greening project. Routine weeding was the most strongly acknowledged management practice (M = 4.41; SD = 1.02), followed by regular pruning (M = 4.11; SD = 1.20), regular watering and irrigation (M = 4.06; SD = 1.04), pest and disease management (M = 3.98; SD = 1.18), mulching (M = 3.94; SD = 1.01), thinning prior to planting (M = 3.86; SD = 1.18), and replacement planting (beating up) of failed seedlings (M = 3.81; SD = 1.14). In contrast, respondents generally disagreed that fertilizer or manure application (M = 1.70; SD = 1.12) and provision of adequate protective guards (M = 1.71; SD = 0.93) were implemented extensively during the project. The findings suggest that maintenance efforts focused primarily on watering, pruning, weed management and replacement planting, while nutrient supplementation and physical protection received relatively lower attention.

**Table 3.** Silvicultural Practices Observed During the Greening Project

S/N	ITEM	SA	A	UD	SD	DA	M	SD
1	Thinning of multiple seedlings before planting was done	20	30	1	8	4	3.86	1.18
2	Regular/timely watering/irrigation was done	23	35	1	3	4	4.06	1.04
3	Regular pruning to enhance seedlings growth was done	30	24	0	4	5	4.11	1.20
4	Fertilizers/manures was applied to enhance seedlings growth	3	5	0	17	38	1.70	1.12
5	Routine weeding to enhance growth and control competition on nutrients	40	17	1	2	3	4.41	1.02
6	Regular beating up of failed seedlings planted was observed	15	37	0	6	5	3.81	1.14
7	Adequate protection through fencing of provision of protective guards was done	2	3	0	28	30	1.71	0.93
8	Effective control of pests {insects (termites), viral and fungal} by use of potent pesticides was done	23	30	2	2	6	3.98	1.18
9	Mulching materials were used to enhance moisture retention to the planted seedlings	15	40	1	3	4	3.94	1.01

## IV. Discussion

The present study evaluated tree seedling survivorship, identified implementation challenges and examined silvicultural practices adopted during the Greening of Greater Yola Project in Yola North Local Government Area, Adamawa State. The findings provide empirical evidence on the performance of urban greening interventions under semi-arid urban conditions in northeastern Nigeria.

The results revealed that tree seedling survivorship ranged from 69.23% to 98.72% across the thirteen planting locations, indicating generally favourable establishment of planted seedlings during the assessment period. The relatively high survival rates observed suggest that the selected species - *Ficusbenjamina*, *Syzygiumpaniculatum* and *Khayasenegalensis* - demonstrated reasonable adaptation to the climatic and edaphic conditions of the study area. Differences observed among locations nevertheless indicate that local environmental conditions and management intensity influenced establishment outcomes. Similar observations have been reported in urban forestry studies which showed that survival of newly planted urban trees is highly dependent on species selection, planting site characteristics and post-establishment management practices (Roman et al., 2015; Hilbert et al., 2019).

Among the species evaluated, *Ficusbenjamina* recorded the highest survival performance in locations where it was established. This may suggest stronger tolerance to urban environmental conditions and greater resilience under street-side planting conditions. *Syzygiumpaniculatum* also demonstrated favourable establishment in several locations despite showing reduced survival in selected areas. The lower survivorship recorded in some locations may reflect differences in exposure to environmental stressors, physical disturbance and management practices rather than species characteristics alone. Previous studies have emphasized that urban tree mortality is often driven by interactions between site conditions, maintenance regimes and external disturbances rather than genetic factors alone (Koeser et al., 2021).

Findings relating to challenges encountered during project implementation showed that livestock browsing, weak enforcement of regulations controlling stray animals, harsh dry-season temperatures and destruction of seedlings by vehicles constituted the most important constraints affecting seedling establishment. These findings align with broader evidence indicating that urban greening programmes in developing environments are frequently constrained by human activities, environmental stress and inadequate protection mechanisms (Oyinlola et al., 2026). Animal browsing remains particularly important because repeated defoliation and bark damage reduce growth performance, weaken seedling vigour and increase mortality risks in newly established plantations.

The influence of harsh temperatures observed in this study is consistent with findings from urban ecological studies demonstrating that elevated temperatures and moisture limitations reduce physiological performance, increase evapotranspiration demand and limit seedling establishment success, especially in semi-arid environments (Bowler et al., 2010). Likewise, destruction associated with vehicular movement and construction activities reflects the vulnerability of roadside greening interventions where competition for urban space frequently creates conflicts between infrastructure development and vegetation establishment.

The study also demonstrated that management interventions contributed substantially to observed survivorship outcomes. Respondents identified routine weeding, regular watering, pruning, pest control and replacement planting (beating-up) as the most commonly adopted silvicultural practices during project implementation. These interventions are recognised in forestry practice as essential post-planting management strategies that support establishment, reduce competition and improve seedling growth performance. Similar findings were reported by Lamhamedi et al. (2023), who emphasized that consistent maintenance during early establishment stages significantly improves survival rates and long-term urban tree performance.

However, the relatively low ratings recorded for fertilizer application and provision of protective guards indicate areas requiring improvement in future greening interventions. Protection against browsing, enhanced nutrient management and improved site protection may further increase survivorship outcomes and reduce replacement costs associated with urban tree mortality.

The findings in general, suggest that although the Greening of Greater Yola Project recorded encouraging survival outcomes during the study period, sustaining long-term benefits will require continued post-planting management, stronger enforcement of environmental regulations, increased community participation and adaptation of management practices to local climatic conditions. The study contributes context-specific evidence on urban tree establishment under semi-arid conditions and addresses an important knowledge gap relating to the performance of urban greening interventions implemented under the ACREsAL programme in northern Nigeria.

## **V. Conclusion**

This study evaluated the performance of the Greening of Greater Yola Project implemented under the Agro-Climatic Resilience in Semi-Arid Landscapes (ACReSAL) programme by assessing tree seedling survivorship, identifying implementation challenges and examining silvicultural practices adopted during project implementation in selected locations within Yola North Local Government Area, Adamawa State. The findings showed that the project achieved generally favourable establishment outcomes during the assessment period, with seedling survivorship ranging from 69.23% to 98.72% across the evaluated locations, indicating that a substantial proportion of planted seedlings remained established approximately two years after project commencement. These outcomes suggest that the selected tree species and management interventions adopted during implementation were reasonably effective under the prevailing climatic and edaphic conditions of the study area. However, the study also revealed important challenges that may affect long-term sustainability of the intervention, including destruction of seedlings by stray animals, inadequate enforcement of environmental regulations controlling roaming livestock, damage to planted seedlings during construction activities and limited community sensitization and participation. The findings therefore demonstrate that successful urban greening extends beyond tree planting and depends on sustained protection, coordinated management and active stakeholder engagement. To sustain the gains already recorded and strengthen future greening outcomes, there is need for ACREsAL, relevant ministries and local authorities to establish an integrated post-planting management framework that prioritizes routine maintenance, protection of seedlings and continuous monitoring of survivorship performance. Strengthening enforcement of environmental regulations, improving coordination between greening managers and infrastructure agencies, expanding community awareness and participation, and institutionalising periodic survivorship assessments are also necessary to support evidence-based planning and long-term sustainability of urban green infrastructure within Greater Yola and similar semi-arid urban environments.

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