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Adaptation and Growth Performance of Multipurpose Trees Under Haro Sebu Condition

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Abstract
This study were conducted at Haro Sabu Agricultural research center on station. The objective of this study were to evaluate adaptability and growth performance of different multipurpose tree species and to select or screen those best performed and adapted to the area. Seedlings were out planted on a plot of 12mx12m for each species, spacing between row and within row were based on recommendation of each species. In order to fit the given objectives data were collected on the following parameters:- Date of sowing, date of emergence, date of planting, growth parameters: diameter (RCD and DBH), height and survival rate were recorded and measured. Diameter(RCD and DBH),height and survival rate were collected by an interval of 3 months.As a result, Height growth response were shown significance difference ($p<0.000$) for *Grevillea robusta*, *Casuarina equisetifolia* and *M. stenopetala*. Similarly, the growth response in root collar diameter data also reviled that there were highly significant differences ($p<0.000$) among the species. High mean value of root collar diameter was recorded for *Grevillea robusta* ,*Casuarina equisetifolia* while it was low in *Cordia africana* and *Mellitia ferrugenia* respectively. The basal area of the species shows high mean value on *Grevillea robusta* followed by *Casuarina equisetifolia* while had low mean value on *Cordia africana*.The survival result also showed, *Moringa stenopetala* were higher (84.72%) followed by *Grevillea robusta* (81.81%), *Casuarina equisetifolia* (73.86%) ,and *Mellitia ferrugenia* (73.33%), while survival of *Cordia africana* were the lowest(40%). Thus, poor survival and growth response were observed on *Cordia africana* that might be explained as a response to the specific site condition of the study area. Generally, these findings may help forest managers (stakeholder)to properly allocate species into the site that grow and adapt well. Further testing of provenances of the best performing species is recommended to select the most adaptable ones for such areas for future forest plantation establishment at wider scale; on which success of forest plantations depend.

BACKGROUND AND JUSTIFICATION

Vegetation cover of the country in general and that of Oromia in particular have been decreasing from time to time at a faster rate than one can imagine. The reduction in vegetation leads most productive area of the land to severe degradation. Land degradation is the process that lowers the current and/or potential capability of land to produce goods such as crops, livestock or timber, or to provide services such as unpolluted water (Muya et al, 1997). The failurity of the land to give such goods will have a direct negative implication on ecologic, economical and soil value of the area.

The causative agents for land degradation are both biotic and a biotic, of which destruction of natural vegetation mainly forest by natural as well as man-made is the major and the number one problem in most developing countries like Ethiopia. As the land is degraded the biological composition will decrease and hence, reduction in economic growth, change in micro and macro climate, loss of valuable species, which in turn leads to the occurrence of wood and food insecurity become the periodical problem in the country.

Starting from some time ago, the reduction in land productivity due to land degradation touches the attention of many people from different fields of profession. Land degradation in the Ethiopian highlands (i.e. areas above 1500m a.s.l.) has been a concern for many years (Lakew et al, 2000). To overcome this problem, the researcher, bureau of environmental protection, responsible NGOS and over other related professionals in collaboration with the local people have been trying to develop strategies for the rehabilitation purpose. Some among the others of rehabilitation techniques practiced in many parts of the country for more than decades are area closure, reforestation, enrichment planting and the like.

All the above mentioned approach have their own limitations like, in area closure method there should be soil seed bank which can regenerate after the area is closed against any external interference. In reforestation program, the soil should have some fertility in order to support the planted tree for initial growth and likewise enrichment planting is practical in areas where the biological entities are less disturbed.

But in areas where there is no soil seed bank, lack of soil fertility for initial plant growth and highly disturbed that mean under severe degradation, the rehabilitation strategies listed might not be as such practical. So, such area needs special concern to develop land modification as an alternate method through fertilization and put in practical to rehabilitate.

The plant deficiencies of N, P and K may be directly overcome by directly applying organic and/or inorganic fertilizers or through crop rotation and agro forestry (Ramakrishnan,1994). It also has a direct contribution and strong support to the current government policy of rural development and poverty reduction strategy.

There is a large gap between demand and supply of forest, agricultural commodities and other basic necessities in the country, such an imbalance between demand and supply of is imposing more pressure on the existing forest land through encroachment, overgrazing and unplanned legal and illegal felling.

Similarly, in the particular area the forest coverage are degraded, so to cope up with such challenges developing tree species for agro forestry and forestry activities through adaptation of different tree species to the area are the best alternative option..

MATERIALS AND METHODS

Study site

The study were conducted at Haro-Sabu Agricultural Research Center which is located in Kellem Wollega Zone of Oromia Regional State. It is found at 550 km away from Finfinne, 89 and 110 km from the nearby towns, D/Dollo and Ghimbi, respectively. The elevation of the center is 1300-2000 m.a.s.l, temperature 23-34 ^{0}c, rainfall 1000-1300mm which has a beautiful scene for vision and is quite conducive for agricultural production system under rain-fed in the present climatic conditions.

Material

Materials required to undertaken this activities were:-Polythene tube, Nursery equipment, Germ-plasm, Chemicals, measuring tapes, bar meter, Caliper and Clinometers.

METHODOLOGY

Seed of the species (*Moringa stenopetala, Grevillea robusta, Casuarina equisetifolia, Cordia africana* and *Mellitia ferrugenia*) that used for the experiment were obtained from forestry research centre. Seedlings were raised directly into polythene tubes at Haro-Sabu Agricultural Research Center on-station with the recommendation of nursery activities. One to two seed were put in polythene tubes and the weak one were removed out (transplanted to other polythene tubes) sometime after emergence. Seedlings were out planted on a plot of 12mx12m for each species. Spacing between row and within row were based on recommendation of each species. In order to fit the given objectives data were collected on the following parameters:- Date of sowing, date of emergence, date of planting, growth parameter(Diameter(RCD and DBH),height and survival rate). RCD were collected only up to the tree reaches 1.3 meters in height where as height and survival were up to the end of the period of the activity. Finally, the data collected were analyzed using appropriate statistical package(SAS and Minitab).

RESULTS AND DISCUSSION

Survival data of the five species under the present investigation in average (Table 1) revealed that *M. stenopetala* were highest (84.72%) followed by *G. robusta* (81.81%), *C. equisetifolia* (73.86%) and M.ferrugenia (73.33%) , while survival of Cordia africana were the lowest(40%). (Table 1).

The poor survival and growth response were observed on *Cordia africana* (40%)(Table 1)that might be explained as a response to the specific site condition of the study area. Soil and below ground competition are also other factors that influence the growth and survival rate (Casper and Jackson, 1997).

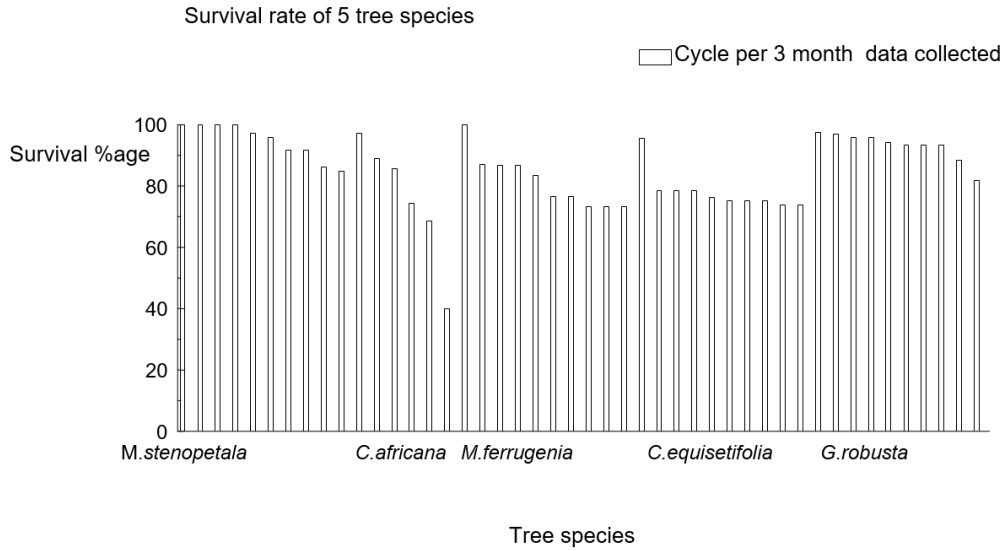
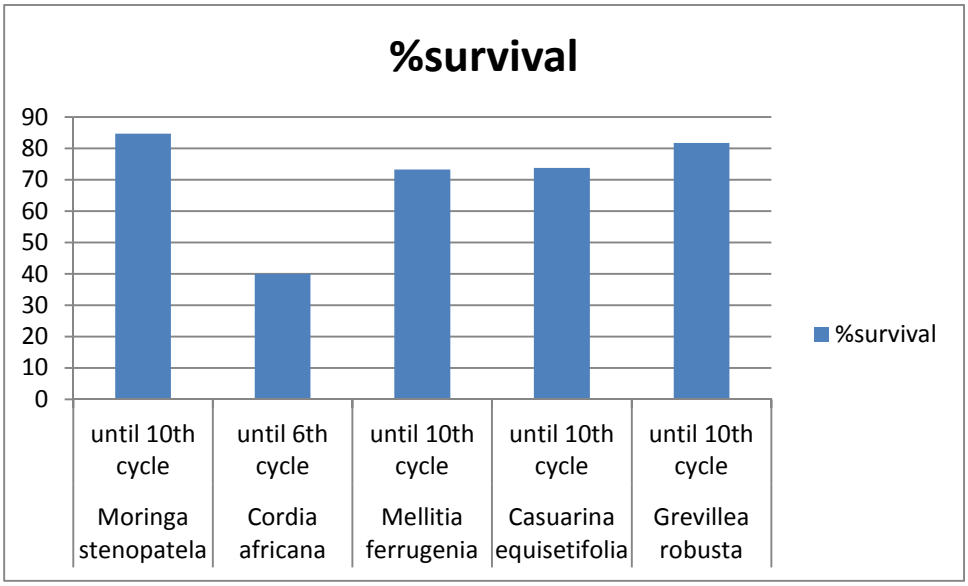


Figure 1.sequence of Survival (%) for *Moringa stenopetala*, *Cordia africana*, *Mellitia ferrugenia*, *Causuarina equisetifolia*, *Gravillea robusta* through sequential periods from March 2011 to June 2014.



Note:-On the above figure one cycle have three months/quarter of the year

Figure 2. Mean Survival (%) for *Moringa stenopetala*, *Cordia africana*, *Mellitia ferrugenia*, *Causuarina equisetifolia*, *Gravillea robusta* through sequential periods from March 2011 to June 2014 in average form.

Table 1.survival rate of *Moringa stenopetala*, *Cordia africana, Mellitia ferrugenia*, *Causuarina equisetifolia*, *Gravillea robusta* in average.

Tree Species	Survival %
Casuarina equisetifolia	73.86
Cordia africana	40
Grevillea robusta	81.81
Mellitia ferrugenia	73.33
Moringa stenopetala	84.72

Height and diameter growth

The analysis of variance of the height data recorded by the end of the experiment revealed that there were highly significant differences among the species ($p<0.000$). *Grevillea robusta*, *Casuarina equisetifolia* and *M. stenopetala* were the species attained the highest mean values, while *Cordia africana* and *Mellitia ferrugenia* species had the lowest value (Table 2.).

Similarly, the root collar diameter data also reviled that there were highly significant ($p<0.000$) differences among the species and the basal area of the species shows high mean value on *Grevillea robusta* followed by *Casuarina equisetifolia* while had low mean value on *Cordia africana*.(Table 2).

Table 2. Mean height, mean basal area and mean diameter at breast height for *Moringa stenopetala*, *Grevillea robusta*, *Casuarina equisetifolia*, *Cordia africana* and *Mellitia ferrugenia*

Tree Species	Mean Height(m)	Mean BA(m^2)	Mean DBH(m)
Casuarina equisetifolia	3.51310 ± 0.086610^{b}	$0.000423 \pm 0.0000328^{c}$	$0.0203503 \pm 0.0008991^{b}$
Cordia africana	$1.74381 \pm 0.078796^{dc}$	0.0001 ± 0.00003^{de}	0.0109 ± 0.00113^{dc}
Grevillea robusta	4.08799 ± 0.072303^{a}	0.0012 ± 0.00005^{a}	0.0355 ± 0.00093^{a}
Mellitia ferrugenia	$1.67000 \pm 0.116017^{dc}$	$0.00016 \pm 0.00003^{cde}$	0.0127 ± 0.00132^{dc}
Moringa stenopetala	1.73575 ± 0.031617^{d}	0.00013 ± 0.000012^{d}	0.0116 ± 0.00049^{c}

Values followed by the same letters within each column are not significantly different at $p<0.05$ level. Values are expressed as mean ± standard error. DBH= Diameter at Breast Height, BA=Basal Area.

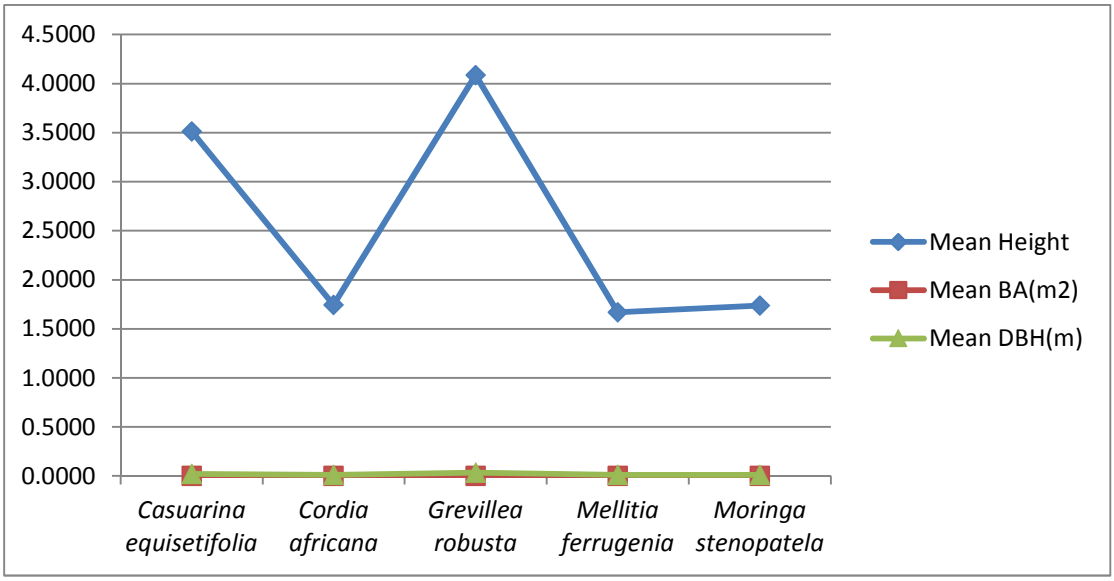


Figure 3. Growth of mean height (m),Basal Area (m2),mean DBH(m) **for** *Moringa stenopetala*, *Grevillea robusta*, *Casuarina equisetifolia*, *Cordia africana* and *Mellitia ferrugenia*

Relative growth rate

The analysis of variance of relative height, and diameter growth rates for the selected species showed highly significant differences .The comparisons between the height and diameter at breast height averages for the species showed that Grevillea robusta were the highest average height value followed by Casuarina equisetifolia and Moringa stenopetala. Similarly, the basal area of the selected species showed highly significant differences($p<0.000$) among the species. The highest mean Basal Area value were recorded by Grevillea robusta followed by Casuarina equisetifolia and moringa stenopetala. while the lowest mean Basal Area were recorded by Cordia africana and Mellitia ferrugenia (Table 3) .

Results on the growth response also showed that, Grevillea robusta, Casuarina equisetifolia, Moringa stenopetala were higher than the other species. Thus, increase their importance for soil conservation in the area, since trees with fast growth habit can shorten establishment period and protect the soil form excessive soil erosion. Similarly, Raebild et al. (2003) also stated that apart from indicating productivity, height may also be seen as a measure of the adaptability of trees to the environment as tall trees usually being better adapted to the site than short trees.(Cossalter, 1987). M. stenopetala also can play a great importance in the rehabilitation process especially during periods of drought or in areas where nutrient resources are not available. Several similar studies also showed that fast growth of seedling is an important indicator in terms of determining the situation of growth response especially in the first growing period and it is commonly assumed that the early fast growth rates of tropical trees reflect productivity status of the trees (Baris and Ertenkin, 2010).

Table 3. Mean height, diameter at breast height, Basal area and survival rate of Moringa stenopetala, Grevillea robusta, Casuarina equisetifolia, Cordia africana and Mellitia ferrugenia

Tree species	Mean Ht(m)	Mean DBH(m)	BA(m^2)	Survival Rate
C.equisetifolia	3.513^{b}	0.02035^{b}	$4.23E\text{-}04^{c}$	73.86
C.africana	1.744^{cd}	0.01099^{cd}	$1.15E\text{-}04^{de}$	40
G.robusta	4.088^{a}	0.03552^{a}	$1.20E\text{-}03^{a}$	81.81
M.ferrugenia	1.670^{cd}	0.01276^{cd}	$1.55E\text{-}04^{cde}$	73.33
M.stenopetala	1.736^{d}	0.01162^{c}	$1.27E\text{-}04^{d}$	84.72

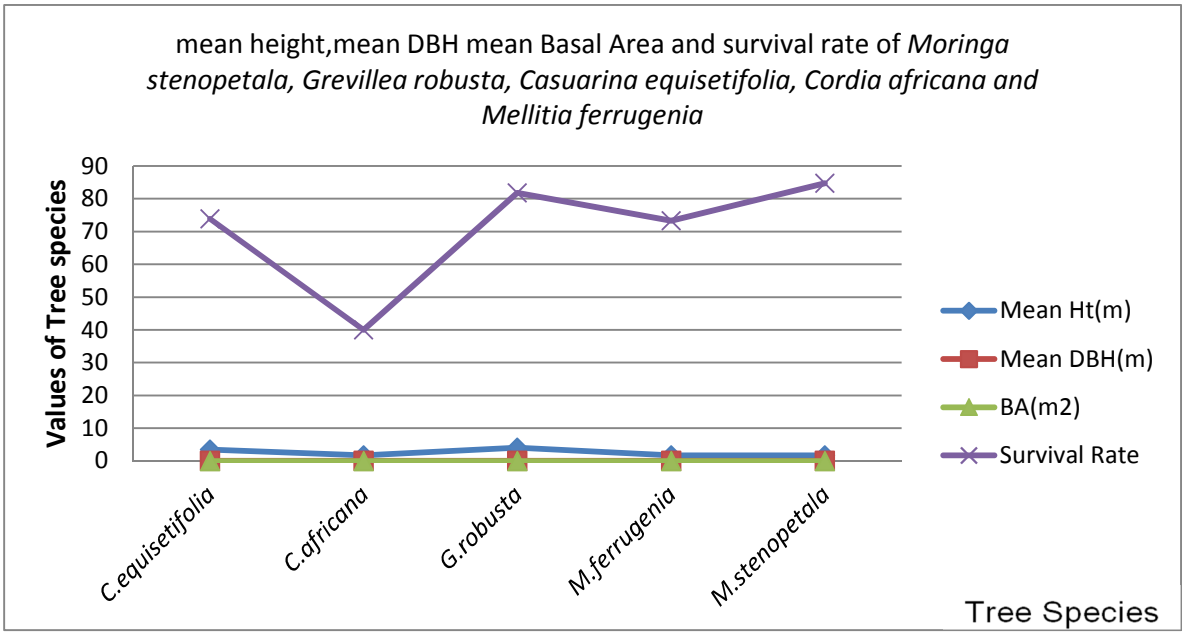


Figure 4. Mean height ,Mean DBH, Mean Basal Area and survival rate for *Moringa stenopetala, Grevillea robusta, Casuarina equisetifolia, Cordia africana and Mellitia ferrugenia*.

Table 4. Mean Height of *Moringa stenopetala, Grevillea robusta, Casuarina equisetifolia, Cordia africana and Mellitia ferrugenia*

Tree species	Mean Height(m) ± SE Mean Height(m)
Casuarina equisetifolia	$0.728750 \pm 0.0489213^{ab}$
Cordia africana	$0.800345 \pm 0.0439366^{a}$
Grevillea robusta	$0.716338 \pm 0.0406597^{ab}$
Mellitia ferrugenia	$0.427442 \pm 0.0251595^{cd}$
Moringa stenopetala	$0.806809 \pm 0.0355595^{a}$

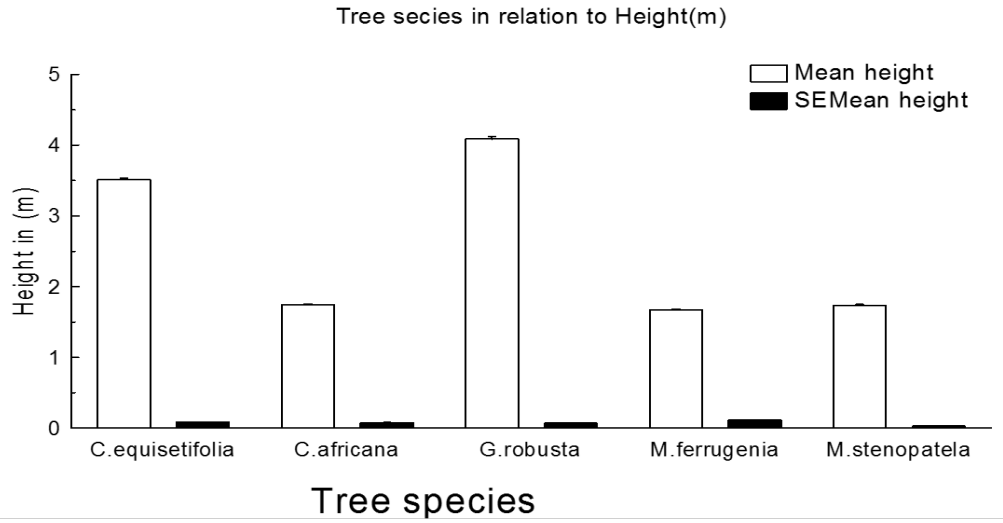


Figure 5. Growth of height for *Moringa stenopetala, Grevillea robusta, Casuarina equisetifolia, Cordia africana* and *Mellitia ferrugenia*

Conclusions and Recommendations

The result revealed that the Survival rate of Moringa stenopetala were the highest followed by Grevillea robusta and Casuarina equisetifolia . while Mellitia ferrugenia and Cordia africana were shown poor survival rate. Poor survival and growth response might be explained as a response to the site condition and termite problems of the study area. The height data recorded by the end of the experiment revealed that there were highly significant differences among the species ($p<0.000$).Grevillea robusta, Casuarina equisetifolia and M. stenopetala were the

species attained the highest mean values, while Cordia africana and Mellitia ferrugenia species had the lowest value. Similarly, the root collar diameter data also reviled that there were highly significant ($p<0.000$) differences among the species and the basal area of the species shows high mean value on Grevillea robusta followed by Casuarina equisetifolia while had low mean value on Cordia africana.

The analysis of variance of relative height and diameter growth rates for the selected species showed highly significant differences ($p<0.000$). The comparisons between the height and diameter at breast height averages for the species showed that Grevillea robusta were the highest average height value followed by Casuarina equisetifolia and Moringa stenopetala. Similarly, the basal area of the selected species showed highly significant differences($p<0.000$). The highest mean Basal Area value were recorded by Grevillea robusta followed by Casuarina equisetifolia and moringa stenopetala. while the lowest mean Basal Area were recorded by Cordia africana and Mellitia ferrugenia. Generally, results on the growth response showed that, Grevillea robusta, Casuarina equisetifolia, Moringa stenopetala were good performed than mellitia ferruginea and moringa stenopetala. Therefore planting/growing of those good performed tree species and increase their importance for soil conservation, timber production, shading purpose, and in general multifunction purposes in the area was recommended.

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