



Anwar Seid Hassen*

Afar Pastoral and Agro Pastoral Research Institute:
Dubti Pastoral and Agro pastoral Research Center.P.O.
Box 16. Samara, Ethiopia

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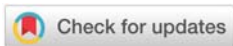
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*Corresponding author: Anwar Seid Hassen, Afar
Pastoral and Agro Pastoral Research Institute: Dubti
Pastoral and Agro pastoral Research Center. P.O.
Box 16. Samara, Ethiopia,
E-mail: anu751751751@gmail.com

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Research Article

Participatory forage production for biomass and seed production through different sowing methods in Afar Regional State, Ethiopia: In the Case of Afambo District of Afar Ethiopia

Abstract

This experiment was conducted with the objective of to evaluate effect of sowing methods on biomass, seed and planting materials production with participatory of the local community in Afambo districts. Accordingly, the biomass yield of Panicum antidotale, Cenchrus ciliaris, Lablab purpureus (147), Vigna unguiculata (9333), and sowing by drill method was significantly higher than sowing by broadcasting methods. Drilling method was having significant effect ($P \leq 0.05$) on days of seed maturity, seed yield and plant height than broadcast method. But there was no significant effect ($P \leq 0.05$) of sowing methods on days of emergence and diseases incidence on both grasses and legumes. Similarly, drilling method was having significant effect ($P \leq 0.05$) on herbage yield than broadcast method on both grasses and legumes. But there was no significant effect ($P \leq 0.05$) of sowing methods on days of flowering, days of seed setting and on both grasses and legumes. According to the trial agro pastoralist perception P. antidotale was selected first followed by Cenchrus ciliaris for their palatability, bio mass yield, drought tolerance, due to its vegetation and morphological performance.

Abbreviations

APARDB: Afar Pastoral Agriculture and Rural Development Bureau; WARC: Werer Agricultural Research Center; APARI: Afar Pastoral Agro Pastoral Research Institute; DAs: Development Agents; P. antidotale: Panicum antidotale; C. ciliaris: Cenchrus Ciliaris; V.aguiculata: Vigna unguiculata

Introduction

Forage crops are plants which, when grown as a crop, have been found to produce high yields of plant material, which are also high in nutrients suitable for livestock requirements for maintenance and production. Forage crops produce much yielding than natural forages and because they produce high yields, can be fed to cattle as both green forages during the rains and conserved for the long dry season [1].

Many indigenous forage species in principal areas of Afar region especially in the study area Afambo districts have low productivity or low digestibility, which reduces their usefulness for livestock nutrition. Though there are some efforts made towards using forage technologies, but they are insufficient

to meet the growing demand, because they have been grown the forage crop in small plot with traditional way. Improved grasses have greater palatability and productivity than other indigenous species and are therefore desirable additions to pastures and common grazing area [2].

Drought is the common phenomena in Afar region, during the last ten years the Afar areas were hit by two major droughts but a mini- drought was occurred in each year. Direct effect of drought is poor growth of range vegetation and consequently the death of livestock. Actually, pastoralists have a traditional drought coping mechanisms by using different alternative like migration, herd diversification, but now due to population increment and global crises (environmental changes) leading pastoral livelihood by rearing only livestock is very difficult, so improving the forage availability in the area should be necessarily to trim down the drought vulnerability of the pastoralists [3].

The grazing lands are gradually shrinking in size due to expansion of crop framing to satisfy the food needs of the increasing human population [4]. Because of the decline in the productivity of the pasture, the pastoralists in the region are

forced to move from their localities to other places within the region and to neighboring regional states. This in turn could affect the provision of basic services to the pastoralists in their permanent residence. On the other hand, major forage crop production constraints in the region are frequent drought in the rain-fed areas, limited supply of agricultural inputs including improved forage crop varieties that tolerate biotic and abiotic stresses, weak extension system, and limited forage crop production experience in irrigated areas [1].

Three sowing methods are conveniently used for forage establishment. These are broadcasting, dibbling and drilling depending on the forage materials, size of the land area and funding from the farmer. Broadcasting is employed when the seed drills are unavailable or when the ground is too soft to allow the use of machinery [5]. A range of sowing methods and machinery are used for sowing forages, in many cases, the sowing method is a compromise between agronomic desirability, practicality and the desire to minimize establishment cost [6]. The most important process in the establishment of forage cereals is the amount of seeds which germinate and emerges and the number of seedlings which survive and develop into mature plants [7]. Broadcasting small grains on freshly tilled soil and lightly covering the seed with soil cause random seeding depth and typically does not firm the soil around the seeds. The result normally is less seed emergence success (60–70% plant seeds) than with drilled [8].

There are some promising and well adapted improved forage species have been identified for low and mid altitude of irrigated areas of Awash valley, where the altitude were 340m –710 m above sea level. It was observed that some forage species have a potential to provide high biomass yield. Thus, information on their agronomical management such as the stage of harvesting and optimum level of seeding rate for maximum biomass production to improve yield and quality of forage is generally identified. Currently, there is widespread feed and water shortage in the region. The amount of rainfall is low and erratic and the plant species in the rangeland are in disappearing. Popularizing and widely promoting proven and market oriented forage technologies with appropriate sowing methods is very important to improve feed availability and household income [9].

Objectives

The general objective of the research is to evaluate effect of sowing methods on biomass and seed production with local community in Afambo District districts.

- ❖ The specific objectives are:-
- ❖ To introduce high biomass yielder grass and legume species.
- ❖ To evaluate the biomass and seed yield potential of different forage crops using different sowing methods.

To acquaint agro-pastoralists the recommended seed production techniques up to seed storage for quality seed production.

Materials and Methods

Description of the study area

The study was undertaken in Afambo district, (Figure 1) of the Afar National Regional State. The district was located 76 km far from the capital city of Afar regional States town of Samara. The research was conducted in the field of Farmer Training Center (FTC) which was located in the vicinity of trial agro-pastoralists residence. The site is located between latitude 12° 26' North; longitude 42° 21' East and an altitude of 342 meter above sea level. On which the site were selected in consultation with the respected districts administration and/or Pastoral agriculture development offices.

Climate

Afambo is climatically characterized as arid agro-ecological area, where livestock production is the main occupation of the community. The average temperature of the area is about 38°C and the rainfall is bimodal with erratic distribution, with the long rainy season (*Kerma*) between Mid-June to Mid-September and short rainy season (*Sugum*) occurs between March and April, and the average annual rainfall is between 110 and 200 mm [10].

The altitude range of the area is between 342m [10]. The dominate soil types in these areas are black, sandy, vertisols and deposits of silt and fine sand particles occur in the plain flat areas where cultivation is practiced [10].

Farming system

Afambo consisted of 7 kebeles (Administrative units) of which 3 kebeles (Administrative units) were entirely

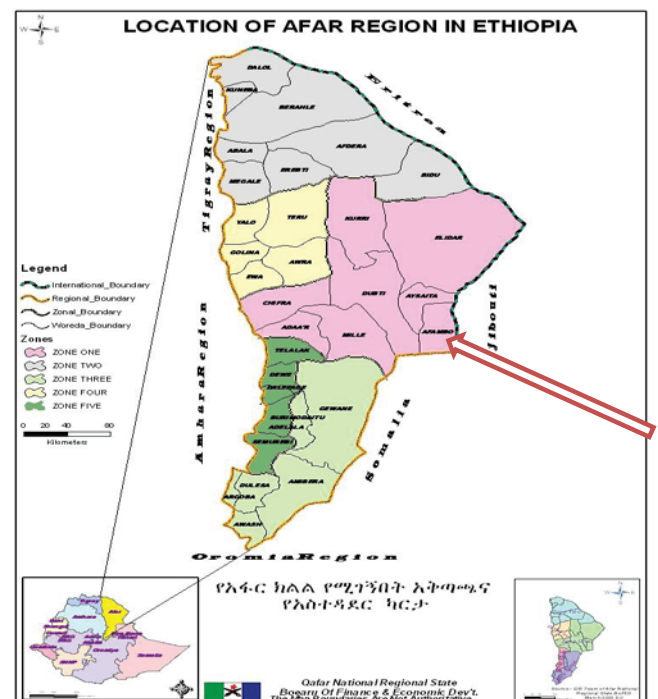


Figure 1: Location of the study area.

dependent on livestock production and the remaining 4 kebeles (Administrative units) were agro-pastoralists practicing both farming and extensive livestock rearing. The major crops grown in the districts were maize, and also vegetables, fruits, oil crops and date palm are also cultivated in a limited range as source of food and income [3].

Experimental design and treatments

The land was prepared using tractor and manually hand hoeing. A 0.5 hectare of land was demarcated and ploughed, harrowed and well-prepared with manual and tractor. 10m x 10m plot was marked out for each type of improved forage species and all were allotted for treatment of drill and broadcasting methods. The treatment consists of two sowing methods (broadcasting, and drilling). The treatments were laid out in a Randomized Complete Block Design (RCBD). Each forage species were replicated two times for each types of sowing methods. Hence, a total of 16 plots were used where eight plots for broadcasting methods, while eight plots for drilling methods.

Planting materials

The treatment of forage seed varieties, were (*Panicum antidotale*, *Cenchrus ciliaris*, *Vigna unguiculata* (9333), and *Lablab purpureus* (147). The seed was collected from Sirinka and Melkassa research center. Trial Agro pastoralists having 20 members were participated in all process of farm practices (land preparation, layout, sowing, watering, harvesting). Grasses seeds were sown by direct seeding (manually). Drill method were planted 40cm between rows and random spacing between plants. While the depth were 1cm-1.2 cm and seeding rate were 6kg/ha and 10kg/ha used for *Panicum antidotale* and *Cenchrus ciliaris* respectively. Broadcast method was random spacing between rows and plants were used.

Similarly, *Vigna unguiculata* were planted using drill method at 30 cm between rows and 10cm between plants at a depth of 4 cm and at 20kg/ha seeding rate. *Lablab purpureus* were also planted using in same methods at 80cm rows, with 50 cm between plants at depth of 4 cm and at 18kg/ha seeding rate. While for broadcast method random spacing between rows and plants were used.

Field management

Both grasses and legumes seed were weeded after emergency when it getting grow up. Weeds were controlled manually using hand hoe after every two weeks and subsequently throughout the duration of the experiment. Watering frequency (furrow irrigation) at 10 days interval was used. For this trial no fertilization was used

Harvesting

Forage grasses and legumes were harvested as a livestock feed before on set of seed, when it reaches at vegetative/heading stage. Seed was collected at maturity stage. Harvesting of seeds was continued every 60 days till one year. While harvesting of fodder was done manually, using a sharp sickle every 4 weeks

after the first round off harvesting. Fodder and seed were selected from separate plot of each forage plots.

Data collection and analysis

Data were collected on sowing date, days of seed maturity, days of flowering, disease and pest incidence, days of seed setting, seed yield (kg), plant height and herbage yield. 1m x 1m quadrant was randomly used for each plot sampled and tagged for measurement of all the growth parameters during the experimental period. While Agro pastoralist preferences on forage yield, easy of management, drought tolerant, seed production, and palatability were compared with pair wise ranking matrix.

The data collected were subjected to analysis of variance (ANOVA) using SAS [11]. Least significance difference (LSD) was adopted for mean separation where significance difference was observed at $P \leq 0.05$

Selection of pastoralists/Agro-pastoralists

Trial agro pastoralist was selected purposively based on their interests and experienced in livestock farming with forage/crop production and having potential role to share findings to other agro-pastoralists. Therefore, twenty trial agro pastoralists (male and female) were involved in this trial.

Material used

Forage seed varieties, were (*Panicum antidotale*, *Cenchrus ciliaris*, *Vigna unguiculata* (9333), and *Lablab purpureus* (147).

The task was contained on twenty trial agro pastoralist members and one developmental agent (DAs) and one researcher to conduct the trial. DAs were intensely involved on guiding and organizing the routine task while researcher was conducting layout and facilitating training (Figure 2).

Result and Discussion

In relation the effect of sowing methods on sowing date, days of emergency, days of seed maturity, seed yield, plant height and diseases incidence on both grasses and legumes were presented in table 1. The result revealed that, seed maturity, seed yield and plant height influenced by the sowing methods. Drilling method was having significant effect ($P \leq 0.05$) on days of seed maturity, seed yield and plant height than broadcast method. But there was no significant effect ($P \leq 0.05$) of sowing methods on days of emergency and diseases incidence on both grasses and legumes. This result in line with Casler *et al.*, [5], who stated that, drilling sowing methods have positive effect on plant height and seed maturity than broadcast methods. The significant difference recorded could be due to variation of the planting depth and minimal competition between plants in drill method, which enhanced proper nutrient utilization. This is in agreement with the work of Korres and Froud-Williams, who reported that planting depth and spacing favors general performance. Similarly another author in Nigeria Abdulaziz B, 2017 who revealed that the response of leaf width to sowing methods were significantly affected ($P < 0.05$) throughout the

period of trial from tenth weeks after sowing (WAS). Dibbling method was found to be the highest with mean of 0.75 cm, while drilling method was having 0.48 cm. Broadcasting method was found to be least with 0.42 cm. Generally speaking, the result revealed that the response of all types of forages morphological performances to sowing methods were significantly different at ($P \leq 0.05$) in all aspects of production performance across the treatments.

Similarly, the effect of sowing methods on days of flowering, days of seed setting and herbage yield on both grasses and legumes were presented in table 2. The result indicated that, herbage yield influenced by the sowing methods. Drilling method was having significant effect ($P \leq 0.05$) on herbage yield than broadcast method on both grasses and legumes. But there was no significant effect ($P \leq 0.05$) of sowing methods on days of flowering, days of seed setting and on both grasses

and legumes. But in terms of standard establishment counts of all types of forages were positively influenced by drill sowing methods where all plots of drill methods found to have the highest standard establishment, while broadcasting method was found to be the lowest yield establishment.

The response of all types of forage yield to sowing methods was significantly different at ($P < 0.05$). Drill method was found to be the highest with yield of 475kg, 980kg, 472, 392kg /ha. for *Cenchrus. ciliaris*, *Panicum. antidotal*, *lablab purpureus* and *Vigna.aguculata* respectively. While broadcasting method was having 354kg, 790kg, 321kg, 281.kg for *Cenchrus. ciliaris*, *Panicum. antidotal*, *lablab purpureus* and *Vigna.aguculata* respectively, hence Broadcasting method was found to be leastwith as presented in table 2. The significance response recorded in herbage yield was obtained from sowing methods drill whereas the lowest yield was recorded in broadcasting. This contradicts the work of Evans, who reported that herbage yield in lablab was higher by the influence of broadcasting method of sowing than the drilling methods (Figure 3).

Community intuition towards the experimental forages

Forage species preference of trial agro pastoralists for individual selection criteria and sowing methods was participated in selecting better performed forage species. Hence, accordingly the amount of forage production and best performed of both grasses and legumes produced in both drill and broadcast methods were ranked as first and second by trial agro pastoralists. In terms of herbage yield, early maturity and



Figure 2:

Table 1: Effect of sowing methods on morphological yield.

Forage Species	Sowing methods									
	Drill Methods					Broadcast methods				
	Date of emergence	Days of seed maturity	Seed yield in kg	Plant height In meter	Diseases incidence	Date of emergence	Days of seed maturity	Seed yield In kg	Plant height In meter	Diseases incidence
<i>C. ciliaris</i> 200.00 ^c	4 days AS	58 ^a	0.95 ^a	1.98 ^a	NI	4 days AS	74 ^b	0.6 ^b	1.53 ^b	NI
<i>P. antidotal</i> 345.00 ^a	4 days AS	51 ^a	3.1 ^a	198 ^b	NI	4 days AS	67 ^b	2.2 ^b	131 ^b	NI
<i>Lablab purpureus</i>	5 days AS	77 ^a	3.3 ^a	1.6 ^a	NI	4 days AS	94 ^b	2.4 ^b	1 ^b	NI
<i>V. unguiculata</i>	5 days AS	71 ^a	2.9 ^a	0.59 ^a	NI	4 days AS	92 ^b	1.9 ^b	0.45 ^b	NI

Mean comparison among results of the four forage species on, days of emergence, days of seed maturity, seed yield, plant height and diseases incidence, Means of the same letter in a row are not significantly different NI=No incidence.

Table 2: Effect of sowing methods on days of flowering, days of seed setting and bio mass yield.

Forage Species	Sowing Methods					
	Drill methods			Broadcast methods		
	Date of flowering	Days of seed setting	Biomass yield in kg	Date of flowering	Days of seed setting	Biomass yield in kg
<i>C. ciliaris</i> 200.00 ^c	36 ^b	45 ^b	475 ^b	48 ^b	50 ^b	354 ^a
<i>P. antidotal</i> 345.00 ^a	38 ^b	49 ^a	980 ^b	46 ^b	56 ^a	790 ^a
<i>lablab purpureus</i>	59 ^b	68 ^b	472 ^b	72 ^b	73 ^b	321 ^a
<i>V. aguculata</i>	57 ^a	69 ^a	392 ^b	66 ^a	74 ^a	281 ^a

Mean comparison among results of the four forage species, days of flowering, days of seed setting, and bio mass yield, Means of the same letter in a row are not significantly different.

palatability, *Panicum antidotale* was ranked first using drill methods while *C. ciliaris* ranked second followed by lablab and *V.aguculata* 3rd and 4th respectively. This result also in line with Amakirin *et al.*, [12], who stated that, high value fodder crops like panicum grass vastly preferable by the Nigerian farmers for dry season supplementary feeding as silage.

All the trial agro pastoralists also set ranks for all grass and legumes species based on the yield and agronomical performances of the two sowing methods. Hence, *Panicum antidotale* ranked first since it stayed green and vigorously for a longer period without water stress followed by *C. ciliaris* in both sowing methods. regeneration and vegetative capacity was also used to rank both grass and legumes species to evaluate the potential to regrow after harvesting and long dry period; hence, *P. antidotale* take the first rank to restore its growth in which it reached second harvest within 35 days followed by *C. ciliaris* it reached second harvest within 37 days. The trial agro pastoralist was ranked lablab and *V.aguculata* 3rd and 4th for the reason legumes was failed to regenerate after long dry season with its short lived perennial nature, on which it showed fast growth at the first and second harvest in progressive watering frequency. This finding in line with Abdullah *et al.*, 2013, who stated that, Growing and developing perennial forage crops such as *Panicum antidotale* grass type provide the farmer with available grazing resources for meeting the nutritional requirement of the animal. In the same way, seed production, disease and pest resistance, easy of management and easy of seed collection were also another selection criteria for both grasses and legumes. Therefore, all trial agro pastoralists commonly preferred drill methods than broadcast methods and they also gave priority to palatability, high herbage yield and drought tolerance traits as feed for

livestock. Accordingly, lablab and *V.aguculata* ranked 3rd and 4th for its low tolerance, regeneration capacity and short life cycle; even though lablab was scored good biomasses yield. Hence, the trial agro pastoralist preferences presented in (Table 3) [13-15].

Generally, based on the stranded on the criteria, all the team of trial agro pastoralist participated in the selection process preferred *P. antidotale* as a number one grass species followed by *C. ciliaris* due to its collective performance on palatability, early maturity, regeneration capacity, easy of management, seed production and biomass yield in both sowing methods.

On top of that, Pair-wise ranking matrix was used for ranking of the seated criteria by the perception of trail agro pastoralist's and to identify the most important and preferred morphological trait for the merit of future forage production. The trial agro pastoralists were voluntary to compare the morphological traits and rank them in order of importance based on their perception. Therefore, Pair-wise comparison result was shown presented in (Table 4). The selection criteria were compared according to the order of importance and the result indicated that, palatability ranked first followed by biomass yield and drought tolerance second and third respectively. While the other morphological traits selected 4th -8th in their order of importance.

As the result indicated in table 5, panicum antidotale grass ranked first compare to the other grass and legumes species in both sowing methods, followed by *C. ciliaris* grass. While legumes of lablab and *V.aguculata* were ranked third and fourth respectively.

Summary of the Findings

In this adaptive research trail we applied two sowing methods of treatments, drill and broadcast methods. Grasses and legumes species of seed were used, namely *P. antidotale*, and *C. ciliaris* are grasses while lablab and *V.aguculata* were legumes. Base on the experimental result, drilling method was better performance on days of seed maturity, plant height, seed yield, and biomass yield broadcast method. But there was no differences between drill and broadcast methods on days of emergency, days of flowering, days of seed setting and diseases and pest incidence on both grasses and legumes. Based on forage species preference of trial agro pastoralists *P. antidotale*, and *C. ciliaris* grasses type was ranked first and second respectively while legumes of lablab and *V.aguculata* was selected 3rd and 4th respectively. The selection criteria of the trial pastoralists was based on the choice for their livestock due to its palatability, biomass yield, drought tolerance, regeneration capacity, easy of management and diseases and pest tolerance.

Constraints & limitation

However, this adaptive research trial was accomplished properly, since the absence of participatory on-farm evaluation of different forage species in the study area, which reflected on low participation of the trial agro pastoralist on weeding, watering, cultivating and monitoring the trial. On the other



Measurement on herbage yield in the study area



Measurement of forage production of the performance

Figure 3:

Table 3: Trial agro pastoralists' preferences.

Species	Pastoralists' preference																				Average	Rate
	AP1	AP2	AP3	AP4	AP5	AP6	AP7	AP8	AP9	AP10	AP11	AP12	AP13	AP14	AP15	AP16	AP17	AP18	AP19	AP20		
C. ciliaris	1	3	2	2	4	4	2	3	2	2	1	3	2	2	1	3	3	1	2	3	2.3	2
P. antidotale	2	1	2	1	2	1	1	2	2	2	1	1	3	1	2	2	2	1	1	1	1.6	1
Lablab	3	3	3	4	4	3	3	3	2	2	3	2	1	2	3	2	3	3	1	1	2.6	3
V.aguculata	3	4	3	3	3	4	2	3	4	4	3	2	2	4	4	3	2	3	3	2	3.1	4

Note: AP1= Agro pastoralist 1, AP2= 3AP10= pastoralist 20.

Table 4: Pair-wise ranking matrix of Agro pastoralists' selection criteria for different grasses and legumes species.

Species	DT	EM	BY	RC	Pal	Ma	DPT	SY	Points	Rank
DT		DT	BY	DT	Pal	DT	DT	SY	4	3
EM			BY	RC	Pal	EM	EM	SY	2	5
BY				BY	Pal	BY	BY	BY	6	2
RC					Pal	Ma	RC	RC	3	4
Pal						Pal	Pal	Pal	7	1
Ma							Ma	Ma	3	4
DPT								SY	0	6
SY									3	4

Note, DT=Drought tolerance, EM=Easy of management, BY=Biomass yield, RC=Regeneration, Pal=Palatability, ESC=Easy of seed collection, Ma=Maturity, DPR=Disease and Pest Tolerance, SP=Seed production.

Table 5: Pair-wise ranking of grass and legumes species by trial agro pastoralists for different morphological traits.

Species	C. ciliaris	P. antidotale	lablab	V.aguculata	Points	Rank
Cenchrus ciliaris		P. antidotale	C. ciliaris	C. ciliaris	2	2
Panicum antidotale			P. antidotale	P. antidotale	3	1
lablab				lablab	1	3
V.aguculata					0	4

hand, the poor irrigation schemes and interruption of irrigation water was also among the constraints during the trial.

Important lesson drawn

Presently, the trial agro pastoral was able to identified best sowing methods, forage type, agronomical practices, and prepared required materials/inputs for forage production. But to address the demand of large group of the communities' linkage among research institutes, agricultural offices/extension systems has to establish. And participatory/adaptive research works should be promoted.

Conclusion and Recommendation

Based on the experimental result, drill sowing methods was better than broadcast sowing methods. The trail agro pastoralists were preferred panicum antidotale and C. ciliaris grasses as the first and second choice for their livestock feed due to its palatability, biomass yield and drought tolerance. While lablab and V.aguculata was selected third and fourth respectively due to low regeneration capacity and short lived nature of their life cycle. Hence accordingly panicum antidotale and C. ciliaris grasses should be scale up as to top priority followed by lablab and V.aguculata. It is suggested that, the

selection of these grasses should continue with collaborative research with stakeholders on multi-locations in various utilization systems using Agro pastoral participatory methods to ensure long-term and widespread adoption of forage technologies.

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