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Evaluation of the Effect of Grazing Lands Top Dressing with Inorganic Fertilizer on Biomass Yields for Sustainable Animal Feed Production, Ethiopia: The Case of Participatory Approach

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Abstract
Sub-Saharan livestock production and productivity are very low due to poor quality and inadequate quantity of available feed. Henceforth, livestock production can be improved through good management of natural grasslands and introduction of improved fodder species with the supply of fertilizer and water to maintain high productivity. Pre-extension demonstration of grazing land improvement technologies were conducted in 2017/18 in six Agricultural growth program (AGP II) districts, namely, Boneya Boshe, Wayu Tuka, Guto Gida and Diga from East Wollega and Horro and Guduru districts from Horro Guduru Wallega zone to evaluate, select and popularize farmers' preferred technologies based on their selection criteria and to create awareness on the importance of the approved technologies. One representative potential peasant association (PA) was selected purposively from each district based on grazing land and livestock population potential and accessibility for field monitoring and visit. Farmers' selection was done based on interests of farmers in trial management, willingness and ownership of sufficient grazing land to accommodate the trials and gender equality. In each PA, one farmer's extension research group (FREG) comprising 16 farmers were established to evaluate and select the technologies. Training was given to farmers, DAs and experts. Three treatments/technologies, namely, T1 = Control (farmer practice), T2 = 150 kg/ha urea and T3 = 110 kg/ha urea and 100 kg /ha NPS were evaluated and demonstrated on 4 farmers' fields on plot size of 400 m^2 in each study districts. The collected data were analyzed using descriptive statistics (mean and standard deviation) and qualitative narrations. The agronomic result showed that T3 performed better in average herbage dry matter yield (12.44 t/ha) followed by T2 (8.71 t/ha) and T1 which gave lower yield (5.5 t/ha). The two treatments/technologies (T3 and T2) had a yield advantage of 55.76 % and 36.83 %, respectively, over the control across the study districts. The overall technology preference score of all districts showed that T 3 (110 kg/ha urea and 100 kg /ha NPS) and T 2 (150 kg/ha urea) were the most preferred technologies and ranked as first and second, respectively, by participants because of high biomass, fast growth habit, early maturing for harvesting, plant height, leafiness and species diversity at all districts. Therefore, the combination of Urea and NPS fertilizer at a rate of 110 kg and 100 kg/ha, respectively, was recommended to be promoted in large scale in the study areas and other places with similar agro-ecologies.
Keywords: Demonstration, Evaluation, Grazing land, Herbage dry matter, Technologies
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1. Introduction

Sub-Saharan livestock production and productivity are very low; one of the major constraints is the poor quality and inadequate quantity of feed available (Kindomihou *et al*, 2014). Given decreasing grazing land and increasing production of cash crops , agro industrial by-products could become important inputs in feed rations for different classes of livestock but it is highly costly and not easily available everywhere. Hence, livestock production can be improved through good management of natural grasslands and introduction of improved fodder species with the supply of fertilizer and water to maintain high productivity (Anneessens, 1989).

Lack of nutrients, inadequate management of pastures, and inappropriate cultural practices are responsible for pasture degradation (Werner 1994). Low nitrogen availability has been identified as a major cause of degradation of tropical pastures (Werner 1994), and the constant removal of forage without proper supply of nutrients extracted by plants emphasizes the problems of grazing land degradation. The application of nitrogen has proved to be effective in maximizing the leaf area and the production of dry matter and nutritional status of grasses (Bonfim-Silva and Monteiro, 2006; Batista and Monteiro, 2008). Habtemichael (2010) and Habteslassie (2009) reported that nitrogen deficiency in the grazing areas could be the leading constraint for limited plant growth and reduced biomass yield. Hence, application of nitrogen seems imperative to enhance plant growth and increase herbage biomass production. This study was, therefore, conducted to evaluate, demonstrate and promote grazing land improvement technology through top dressing with nitrogen and phosphorous fertilizer.

2. Materials and Methods

Site and Farmers Selection

The study was conducted in Boneya Boshe, Wayu Tuka, Guto Gida and Diga districts of East Wollega, zone;

Horro and Guduru districts of Horro Guduru Wollega zone of Oromia Region during 2017/2018 cropping season. To apply the technologies, grazing areas under cut and carry grazing system was purposively selected in each district. Selection of the districts was based on accessibility for field monitoring and visit and potentiality for grazing land, livestock population and compatibility with the AGP II criteria. One potential peasant association (PA) was selected from each district. In each PA, one farmer research extension group (FREG) comprising 16 farmers were established.

In each FREG four hosting farmers were selected with the rest being participant farmers. Development Agents and district experts collaborated in site and farmer selection. The FREG member farmers were selected based on willingness; accessibility for supervision of activities; good history and experience in working in group and willingness to share innovations to other farmers. Besides; the experimenting farmers were selected based on availability of sufficient grazing land to accommodate the trials; vicinity to roads so as to facilitate the chance of being visited by other farmers; good history of handling experiments in the past; genuineness and transparency to explain the technology to others.

Stakeholders' training

After the establishment of the FREGs a theoretical training was given to farmers, Development agent (DAs) and district experts. The training was given by researchers on management and utilization of grazing land.

Field design and management

Three treatments (T1 = Control, T2 = 150kg/ha urea and T3 = 110kg/ha urea and 100kg /ha NPS) were applied side by side on adjacent plots with a plot size of 20 m x 20 m with 3 m distance between plots at each experimental sites. The amount of nitrogen in T2 and T3 is the same. Then, the difference between T2 and T3 is expected to be due to P. Nitrogen was applied in the form of urea as a split dressing (one-third at seven days of the first rain and two-thirds after about a month of the first rain and P was applied at seven days of the first rain together with the nitrogen applied at seven days after the first rain.

Participatory evaluation of the technologies

Experience sharing programs (field days) were arranged to supplement the theoretical training. The technologies were then evaluated based on the farmers' selection criteria for grazing land. At the end of the evaluation process, results of the evaluation were displayed to the evaluators, and discussions were made on the way forward.

Data Collection and Analysis

Agronomic data like, growth habit (fast/ slow), plot cover, plant height, leafiness and yield data (herbage dry matter yield), total number of farmers participated in training, field visits and field days, farmers' perception on the characteristics of technology, stakeholders participation were collected and analyzed using SPSS statistical package software. Descriptive statistics such as mean, standard deviation (SD), frequencies, and percentages were used to analysis the data.

3. Results and discussion

Training of farmers and other stockholders

Training was given by researchers, who came from Bako agricultural research center on issues such as grazing land improvement techniques, general grass land management and utilization system to farmers, district experts and development agents (DAs) to improve their knowledge and skills on the technologies. Accordingly, a total of 187 participants (153 farmers, 12 experts, 6 supervisors and 22 Das) were trained (Table 1). Of the total trainees, 62.03 % were male and the rest 37.96 % were females.

Table 1. Training participants across five demonstration districts

Farmers		Experts		DA's		Total
Male	Female	Male	Female	Male	Female	
94	59	8	4	14	8	187

Farmers' technology evaluation and selection

Technical groups (Researchers, Experts and DA's) and farmers jointly evaluated the technologies based on set criteria. Growth habit (fast/slow), early maturing at 50 % blooming stage, biomass (plot cover), plant height, leafiness, logging, weed offensive and species diversity were identified as the most important selection criteria by the participants. A total of 108 farmers composed of men and women participated in the selection process. Participant farmers scored each technology by each trait that was considered important by them and ranking of technologies were done on a scale of 1-5; 1 being the highest score, representing superiority and 5 representing very poor. Biomass yield and growth habit were considered as the most important selection criteria for each grazing land improvement treatments. The total and mean score result showed that T3 (application of 110 kg/ha urea and

100 kg /ha NPS) and T2 (application of 150 kg/ha urea) were the most preferred technologies and ranked as first and second, respectively, by participants at all districts (Table 2).

Table 2: Total and mean score ranks for Grazing land management technologies in the study areas

Treatments/ Technologies	Guduru			Guto Gida			Bonaya Boshe			Diga			Overall Rank
	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	Total Score	Mean Score	Rank	
Control	31	3.44	3rd	23	3.56	3rd	27	3.00	3rd	26	2.89	3rd	3rd
UREA	36	4.00	2nd	35	3.89	2nd	36	4.00	2nd	36	4	2nd	2nd
U+NPS	41	4.56	1st	43	4.78	1st	44	4.89	1st	43	4.78	1st	1st

Scoring of farmer's selection criteria was made against: 1=growth habit (fast/ slow), 2= Early reach at 50% blooming stage, 3= Biomass (plot cover), 4= Plant height, 5= Leafiness, 6= Logging, 7= weed offensive and species diversity

On-farm herbage yield performances

The following figures show the analysis result on herbage yield performance of the technologies demonstrated across study districts. Accordingly, the highest average herbage dry matter yield (12.44 t/ha) was recorded in T3 (110 kg Urea/ha + 100 kg NPS/ha) and followed by T2 (150 kg urea/ha) with 8.71 t/ha yield and the T1 (control/farmers' practice gave lower yield, 5.5 t/ha (fig 1 and 2). The two technologies had a yield advantage of 55.76 % and 36.83 %, respectively, over the control one across the study districts.

Fig 1.Mean of herbage DM yield ± SE (ton ha^{-1}) of natural grazing land across locations during 2017.

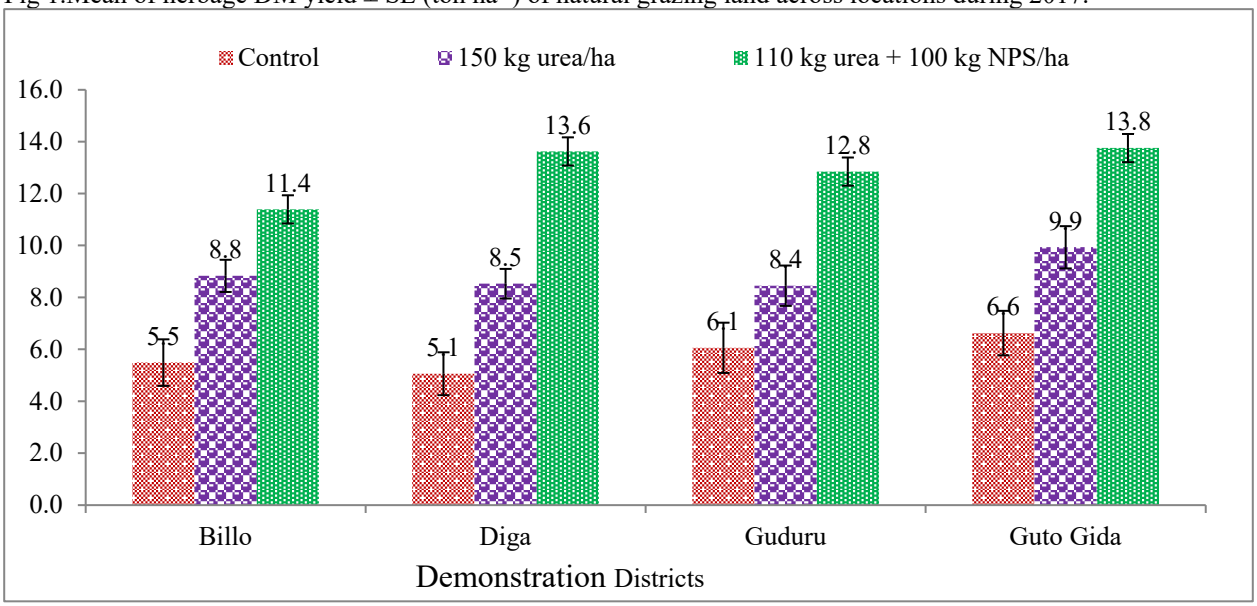

Fig 2.Mean of herbage DM yield ± SE (ton ha^{-1}) of natural grazing land across locations during 2018.

4. Conclusions and Recommendations

The demonstration activity was conducted in five AGP II districts using FRG approach in two consecutive years, 2017-2019. Two inorganic fertilizers (Urea and NPS) in sole and in combination and farmers' practices were used for demonstration. The results indicated that application of fertilizer either sole urea or mixed with NPS gave promising herbage DM yield at all demonstration sites. The participant farmers and other stakeholders got better knowledge and skill of using the technologies. Based on the yield and participatory evaluation results, combination of urea and NPS at a rate of 110 kg and 100 kg/ha, respectively, were selected as a best technology at all locations followed by T2 (150kg Urea/ha). Therefore, the combination of Urea and NPS fertilizer at a rate of 110 kg and 100 kg/ha, respectively, was recommended to be promoted to a large scale in the study areas and other places with similar agro-ecologies.

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