



Cattle Urine technology to maximize maize plant biomass yield; applicable to small holder farmers by evaluating the biomass yield and palatability of harvested maize fodder using dairy cows at Gondar, North West Ethiopia

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ARTICLE INFO

Article history:

Received: 6 October 2014;

Received in revised form:

19 November 2014;

Accepted: 1 December 2014;

Keywords

Biomass yield,
Cattle Urine Technology,
Diluted Water,
Maize Plant.

ABSTRACT

The trial was conducted from March 11- 17 May 2014 in the University of Gondar forage development garden. Water diluted Cattle Urine technology was examined for the current livestock rise vs feed shortage particularly in the dry season of the year. With the aim of improving the biomass yield of Maize (*Zea mays* L.). The used land was beforehand Elephant grass cultivated garden to reduce the residual effect of the soil. To address the aims 2m x10m trail was examined for 65 days; in all eight treatments each with three replications; the seed were local and traditionally used by farmers purchased and used to germinate. The seed were soaked in water for 24 hours and germination was seen at six days of sowing. Treatments (T) were 10:1, 8:1, 6:1, 4:1, 2:1, and 1:1 (water: urine) ratio as well as Urea to DAP (Positive control) and the last with no urine, DAP & Urea fertilizer to (negative control). Treatments (Ts) 1, 2, 3, 4, 5, 6, 7 and 8 each with three replications used respectively. Maize plant height in cm was 213.83; 199.39; 183.28; 181.38; 181.33; 166.28; 128.83 and 80.07 from 1 to 8 (Ts) respectively. Maize plant 2mx10m Biomass Yield in kg was 55; 38; 32; 31.33; 29.33; 22.67; 5.67; and 4.17 from 1 to 8 (Ts) respectively. The average over all treatments (Ts) maize plant estimated Biomass Yield in tons/ha was 82.5; 57; 48; 47;44; 34; 8.2; and 6.25 (Ts) respectively.. What has been observed from the trail was that; more diluted water to Urine ratio T1 (10:1) had much improved maize biomass yield; than the rest of treatments even from positive control trials. In the positive control trial drop-down biomass yield was pragmatic; this might be due to firing effect of the inorganic fertilizers; hence; jog-drop-watering was used that might not be sufficient enough to dilute like that of rainy water and causes to burn the roots. The harvested maize plant fodder was 100 percent palatable in feeding dairy cows. In conclusion ten parts of water with one part of cattle urine Technology can boost maize biomass yield. Urine collection method and storage technique to be further studied to exploit the cattle urine as nitrogen source is suggested.

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Introduction

The use of chemical fertilizers in Ethiopia 1999/2000 was only ~35 kg ha⁻¹ on average [1]. Nitrogen consumed in excess of animal requirement is excreted in faeces and urine, contributing to environment pollution [2]. A 650-kg dairy cow is estimated to excrete 116 kg N/yr [3], 12% of which could be lost by ammonia volatilization [4], making dairy cows major N polluters in animal husbandry. [5] observed Urinary Nitrogen Excretion from Plasma Urea Nitrogen in Dry and Lactating Cows. Urine processing for efficient nutrient recovery and reuse in agriculture has been reported by [6]. The city of Durban has collected urine from dry toilets and used it as fertilizer, according to an article published by [7].

Urine contains 42 to 45% nitrogen, which calculates to 262.5 to 281.25% protein equivalent (n% x 6.25). Urine has been used as a valuable plant nutrient for centuries in many parts of the world, particularly in the Far East. Human being passes about 1.5 litres of urine every day. The fact is that urine is a very valuable product as it contains not only nitrogen but also phosphorus and potassium in smaller quantities, these nutrients

are very valuable to plant growth, because it helps to build protoplasm, protein and other components of plant growth. It certainly promotes leafy growth. Leaves become more numerous, go greener and larger and fleshier with urine application. Phosphorus is important in the root formation, ripening of fruits and germination of seeds, although the percentage of phosphorus compared to nitrogen in urine is low. Potassium is also essential for promoting good fruit (and flower) development. Urine is particularly valuable for grasses like maize and leafy green vegetables, and onions, which respond to the high nitrogen content of urine. Increasing the dietary concentrations of protein and sodium changing the amount of corn silage can also affect urine output [8], Current environmental regulations are usually based on nitrogen (N) and phosphorus (P) concentrations in the soil and on crop removal rates of P and N.

Usually increasing protein (especially rumen degradable protein) increases urine output with little effect on fecal output, however, sometimes the increase in urine output is countered by a decrease in fecal output resulting in little net change in manure

output. According to [9], all dietary N in excess of animal requirements is excreted in urine. Effect of dietary CP on milk production and milk composition, digestibility, and urinary excretion in cow has been reported by [10].

Maize (*Zea mays* L.) is an important food and feed crop of the world. Maize ranks first in production and yield among main cereals in Ethiopia. The improvement efforts made so far focused on grain yield and no attention has been given to yield and quality of the stover [11]. Due to rapidly increasing human population and a subsequent need for cultivable land, more grazing land is being put under cereal production mainly maize in sub humid climatic conditions of Ethiopia. It is, therefore, important to have a high grain and quality stover yielding varieties to improve animal feed availability in the maize based systems.

The daily urine output may vary with individual animals and diets, 0.5-2 l and 20-30 l for sheep and cattle, respectively. Add tap water to a constant final weight (4 kg for sheep, 50 kg or even higher for cattle). So the final volume of diluted urine is the same for all animals and every day. The advantages are: (first) it is easy to bulk the daily samples if needed (just by taking an equal volume of all daily samples); (second) it is easy for the analysis since all samples can be further diluted by a same factor. The supply of microbial protein to the animal per unit of feed ingested, usually expressed as g microbial N/kg digestible organic matter fermented in the rumen (DOMR), varied by almost 4 folds (14-60 gN/kg DOMR, [12]). This variation is due to the influence of various factors relating to the diet or rumen environment. The effects of many of these factors have not yet been conclusively demonstrated or quantitatively defined.

Purine derivatives (PD) concentration in straight urine is very high and precipitation (particularly of uric acid) can occur during storage. This will make it difficult for representative sampling for analysis. Dilution by 3- 4 times will prevent the occurrence of precipitation. Normally dilute the urine just after collection (i.e. before storage) as follows:

Plant growth is a process of biomass accumulation [13] and is consequence of the interaction of the photosynthesis, long-distance transport, respiration, water relations and mineral nutrition processes [14].

Low soil fertility is one of the main problems that constrain crop and animal feed production in Malawi. This problem is more critical on sandy soils and degraded areas especially in the high lands of Malawi and Ethiopia due to washed out by rain and erosion. Increase in human population in Malawi and Ethiopia decreasing the availability of arable land so that shifting cultivation, and the traditional bush fallow systems of cultivation that have been practiced for time immemorial to restore soil fertility, are no longer feasible [15]; [16]; [17], [18].

Now a day, it is no longer possible to produce high maize yields without the addition of external fertilizer inputs, especially inorganic fertilizers. However, inorganic fertilizers are too expensive and not affordable by majority of Malawian and Ethiopian Farmers because of poverty. Over the last decade, the situation has been exacerbated by the removal of subsidies on farm inputs, increasing land degradation owing to agricultural expansion, deforestation and the weakening of the Malawi [19].

Thus, besides inorganic fertilizers, there is need to find cheaper alternative sources of nutrients that can be used to restore, or replenish, soil fertility of degraded soils in a sustainable manner.

It is against this background that this study was conducted with the over all objectives of evaluating the potential of Cattle Urine technology diluted with water to improve soil fertility and maize Biomass yield under small holder farmers management practices at Gondar North West of Ethiopia. (i) Maize Plant ear height (ii) Maize Plant height (iii) Maize Plant Biomass yield in kg 60 to 65 days of planting (iv) to evaluate the palatability of harvested Maize plant by feeding dairy cows.

Materials and methods

Study area

The Maize (*Zea mays* L.) trial was conducted from March 11- 17 May 2014 in the University of Gondar forage Elephant grass development garden. The study was undertaken at Gondar; North Gondar Administrative Zone of Amhara Region, Ethiopia. *The Amhara National Regional State (ANRS): a brief description of study area.* The ANRS is located in the north-western and north-central parts of Ethiopia. It has a total area of ~170,000 km², which is divided into 11 administrative zones (provinces) and 105 districts (*woredas*). Subsistence agriculture is the principal economic activity in the ANRS. The subsistence agriculture in the region is characterized by a mixed farming system where crop production and livestock rearing are practiced concurrently by farming households. Crop production accounts for the lion's share in annual incomes of households. Owing to the variegated agro ecological conditions prevailing in the region, different types of crops are produced: cereals, pulses, oil seeds, and horticultural crops. Cereals occupy the largest area under the crops. [20] estimated that 81% of the total cultivated land, which is estimated at 4.2- 4.3 million ha [21], was under cereals in the 2000/01 cropping year. For instance, 91% of the total cultivated area was cropped during the main crop season (*meher* season) in 2000/01 cropping year [20]. Land degradation and drought are the major physical challenges to agriculture in the ANRS. The rugged topography, expansion of cultivation into steep lands owing to increasing population pressure, intense grazing pressure, and torrential rains are linked with land degradation mainly due to soil erosion by water.

Location and climate of the area

Based on Gondar and Gondar zuria district from University of Gondar; the town having different localities. The near by localities are all in all mid-highland (*woyna dega*) with the average temperature of minimum 18 and maximum of 25 °C.

Data required

Data used for the study was generated both the optimum amount of water and urine mix to have utmost vegetative yield. Each plot was 2m x 10m meter trial at different water and urine mixes. Both the positive and negative control was also used to compare and contrast each other.

General characteristics of the study

Methods of collecting urine

By far the simplest method of collecting and storing urine is for cattle to use container or plastic drum. The simplest are funnels mounted over 20 litre plastic containers. The urine diverting pedestals is also another suitable method for collecting urine. The urine diverting pedestal has a pipe which can be used to convey urine into a storage vessel like a 20 litre plastic drum. Care has taken to ensure than faecal matter does not enter the urine section. Pedestals mounted over removable buckets can also be used to collect urine. "Potties" filled at night in the barn can also collect urine – a well established method. Urine collectors can also be made which fit into conventional flush urine, the urine being decanted into plastic bottles and be stored in plastic containers which are capped before use or processing.

Storage of urine

Urine was stored in bottles (20 to 25 litres plastic milk bottles for instance) or containers for long periods with provision ammonia is not allowed to escaping. Deposits of the phosphorus and magnesium salts were deposited however on the base and side walls of the container. A small flexible tube was placed through the side wall of a 20 to 25 litre plastic container and allows the phosphorus laden sediments to settle out. Decanting the upper half may produce a product which as a higher proportion of nitrogen in relation to phosphorus. Shaking and stirring the remaining urine in the lower half of the container may produce a liquid with a higher proportion of phosphorus, released from the sediments of calcium phosphate and magnesium ammonium phosphate, once stirred and shaken. Once stored, urine usually turns darker. The exact constituents of urine vary from one cattle to another.

Application of urine

Urine was applied for preparation of soil at time of sowing and on wards the maize plant. Urine was applied three times in a week with water up to the end of harvesting in different combination i.e water to urine ratio of 10:1, 8:1, 6:1, 4:1, 2:1, and 1:1 (water: urine) ratio as well as Urea to DAP (**Positive control**) and with no urine, DAP & Urea fertilizer to (**negative control**) Treatments (Ts) 1, 2, 3, 4, 5, 6, 7 and 8 each with three replications respectively.

Sampling procedure

Resource constraints was decided, although sample size was sufficiently large to permit statistical analysis, financial, human resource and time constraints was taken in to account prior to sample selection. The methodology proposed was split plot design used.

Data collection

All the following 1 to 8 treatments (Ts) respectively used; and each with three replications were examined and followed for about to 65 days.

Treatments each with three replications were.

1. 2m x 10m plot land was used to watered 10:1 (water to urine ratio) mix three times/week
2. 2m x 10m plot land was used to watered 8:1 (water to urine ratio) mix three times/week
3. 2m x 10m plot land was used to watered 6:1 (water to urine ratio) mix three times/week
4. 2m x 10m plot land was used to watered 4:1 (water to urine ratio) mix three times/week
5. 2m x 10m plot land was used to watered 2:1 (water to urine ratio) mix three times/week.
6. 2m x 10m plot land was used to watered 1:1(water to urine ratio) mix three times/week.
7. (Urea & DAP) mix once at the time were plant had germinated was used (positive Control).
8. 2m x 10m plot land was used to watered (with no urine, and no Urea to DAP) (Negative control)

The amount of urine used; in water to urine mix; the growth and status of maize growth (vegetative growth); the total amount of maize biomass production in the trail; positive and negative controls were registered: After germination Ash (*Amed*) were once used to correct the Phosphorus (P) and Potassium (K) shortages.

Statistical methods

The statistical analysis to be used in the study would vary depending on the type of variables and information obtained. However, the quantitative data was analyzed using descriptive statistics (percentage, mean comparison, mode, median, standard deviation, etc

Hypothesis

Ho: The water to urine mix has no impact on productivity of maize biomass yield per hectare.

Hi: The water to urine mix has impact on productivity of maize biomass yield per hectare.

Results

The Maize (*Zea mays* L.) trial was conducted in the dry season of the area from March 11- 17 May 2014 in the University of Gondar Elephant grass forage development garden. Before sowing; the seed was soaked in water for 24 hours and then sowing was done 11March 2014. Germination was started as of six days of sowing. The cattle urine was collected and stored in 20 - 25 litres of plastic container Figure 1.



Figure 1. Urine collected and stored at the time of Milking.

The cattle urine was diluted with water and watered the maize plant morning and evening three times per week up to the end of the harvesting time 65 days of planting. In each treatment rows the Ash (*Amed*) was once treated and /or spread to correct the shortage of the phosphorus (P) and potash (K) indicated in Figure 2. With in a month a small plot of land can be able to produce and feed animals a green fodder; if there is feed dearth in the area as per figure 3.



Figure 2. Ash (*Amed*) was treated and /or spread to correct shortage of P/K



Figure 3. In 30 days Maize plant Biomass yield

As indicated in the Figure 4 below the result was awfully promising in alleviating the feed shortage of animals with in 60 to 65 days of germination. More cattle urine to water concentration has little effect on maize biomass yield based on this trial; than water diluted treatments; this might be because of the fact that; as urine concentration increases ablaze effect on plants that deter vegetative growth.



Figure 4. In 60 days Maize plant Biomass yield

Treatments (Ts) were 10:1, 8:1, 6:1, 4:1, 2:1, and 1:1 (water : urine) ratio as well as Urea to DAP (Positive control) and the last with no urine, DAP & Urea fertilizer to (negative control). Treatment (Ts) 1, 2, 3, 4, 5, 6, 7 and 8 each with three replications respectively. The average over all treatments maize plant ear height in cm was 139.94; 129.44; 118.06; 116.33; 108.95; 96.5; 64.72 and 39.4 in (Ts) respectively. The average over all treatments maize plant height in cm was 213.83; 199.39; 183.28; 181.38; 181.33; 166.28; 128.83 and 80.07 in (Ts) respectively. The average over all treatments maize plant

biomass Yield in kg was 55; 38; 32; 31.33; 29.33; 22.67; 5.67; and 4.17 in (Ts) respectively. The average over all treatments maize plant estimated Row biomass Yield in kg/ha was 27500; 19000; 16000; 15667; 14667; 11330; 2833; and 2083 in (Ts) respectively. The average over all treatments maize plant estimated Row Biomass Yield in tons/ha was 27.5; 19; 16; 15.67; 14.67; 11.33; 2.83; and 2.08 in (Ts) respectively. The average over all treatments maize plant estimated Biomass Yield in tons/ha was 82.5; 57; 48; 47.44; 34; 8.2; and 6.25 in (from 1 to 8 Ts) respectively. What has been pragmatic from the trail was that; more diluted water to Urine ratio T1 (10:1) has much improved maize biomass yield than the rest of treatments even from positive control trials. In the positive control trial drop-down biomass yield was observed this might be due to firing effect of the inorganic fertilizers; hence; jog-drop-watering in the dry season of the area was used; that might not be sufficient enough to dilute like that of rainy water and causes to be on fire the roots.

In the dry season of Ethiopia the only means of feed source for animals is free grazing in the communal grazing land areas. In dry season on one hand; the animals are suffering from feed scarcity because the huge burden of livestock population in the over grazing areas. On the other hand the animals anguish from internal and external parasites grazing in communal grazing sits. In the mean time the animals in-search for feed are conjecture from place to place and causes to destroy each and every plant by deep grazing, trampling and over grazing.

In Ethiopia; the huge burden of animals in communal grazing areas, the shortage feed, and the soil erosion is provoked. All animals are put together for grazing. The infected and non infected animals are grazing together to share the free grazing land. In this case no question for the chance of transition of the disease from one to others. The Ethiopian high lands animals remain vulnerable to health problems and leads for soil erosion. The animals body condition score drops and livestock productivity is reduced to the bare minimum level. To tackle this problem in the dry season composed cattle urine; diluted with water Technology could assuage the issue. Diluted urine watered maize plant in back-yard (small plots of land) area; and using for stall-fed and/or feeding zero grazing animals solve (decipher) the feed shortage with in one to two months time Figure 5.



Figure 5. In the farm; back yard the animals; can be fed using water urine diluted plot

In Ethiopia; it is not uncommon that; the number of unproductive human labour above all women and children are not small in number. The country has uncultivated huge number of land; cheap human labour and plenty of livestock population. The numbers of rivers those flow through-out the year are many in number. On the other hand the inorganic fertilizer price is exorbitant to maximize the productivity of the land. In one cattle per day from 20-30 litres of urine can be collected. This can be either done by women or children.

Table. 1. 2m x 10m plot test; Green Fodder Maize Plant Biomass Yield within 65 days of planting

Treatments (Ts)	Replication	Average plant ear height in cm	Average plant height in cm	Average Biomass Yield in Kg	Estimated each Row Biomass Yield in Kg /ha	Estimated each Row Biomass Yield in Tones /ha	Estimated Treatment Biomass Yield in Tones /ha
1	R1	135.67	210.33	54	27000	27	82.5
	R2	141	211.67	55	27500	27.5	
	R3	143.17	219.5	56	28000	28	
average		139.94	213.83	55	27500	27.5	
2	R1	136.5	195.33	36	18000	18	57
	R2	126.33	206.83	38	19000	19	
	R3	125.5	196	40	20000	20	
average		129.44	199.39	38	19000	19	
3	R1	108.17	185.67	30	15000	15	48
	R2	117.67	176	30	15000	15	
	R3	128.33	188.17	36	18000	18	
average		118.06	183.28	32	16000	16	
4	R1	115.33	173.33	28	14000	14	47
	R2	121.17	189	36	18000	18	
	R3	112.5	181.83	30	15000	15	
average		116.33	181.38	31.33	15667	15.67	
5	R1	109	188.83	28	14000	14	44
	R2	115.17	186.17	34	17000	17	
	R3	102.67	169	26	13000	13	
average		108.95	181.33	29.33	14667	14.67	
6	R1	98	170.67	24	12000	12	34
	R2	95	167.33	24	12000	12	
	R3	96.5	160.83	20	10000	10	
average		96.5	166.28	22.67	11330	11.33	
7 PC	R1	74.5	141.17	6	3000	3	8.2
	R2	61.17	118.83	5	2500	2.2	
	R3	58.5	126.5	6	3000	3	
average		64.72	128.83	5.67	2833	2.83	
8 NC	R1	41.4	85.2	4	2000	2	6.25
	R2	39.3	78.6	4.5	2250	2.25	
	R3	37.5	76.4	4	2000	2	
average		39.4	80.07	4.17	2083	2.08	

NB; PC (Positive control); NC (Negative control)

Integrate human labour; huge uncultivated land; livestock resources and the Countries Rivers as source of water together can feed animals. The table 1 treatment analysis has indicated that treatment one which is 10:1 (water to urine) ratio has optimum biomass yield than the concentrated water to urine treatments.

In the trial from treatment one (T1); 10:1 (water to urine) ratio on average 82.5 tons/ha of green fodder can be harvested than the negative control treatment (T8) which has only 6.25 ton/ha of maize biomass yield. The T1 has much improved performance and more productive than the positive control treatment (T7) having only 8.2 ton/ha green fodder. The reason behind was nothing but; the urea 46% N and Diammonium Phosphate (DAP) 18% N & 46% phosphate mix was used once at the time of sowing.

Beyond that; in day today basis that could not be affordable to apply the inorganic fertilizer three times per week till harvesting in the developing world like Ethiopia. The water diluted urine application is cheap; accessible affordable and easy to use in the developing countries with in back yard and/ or small pots of land based on Figure 6.

After harvesting at the age of 65 days the treatments each replication were weighed Figure 7; registered and fed for Milking Dairy Cows in the University of Gondar to examine the palatability of the biomass yield of Maize plant.



Figure 6. Water diluted Cattle Urine; if supported by Ash (Amed) can feed our animals

The palatability was 100 percent Figure 8; & 9; Forage development is the only means to undertake animal feed shortage; because crop production has given first priority in Ethiopian cultivated land, than animals feed. This is in consistent with [20] estimated that 81% of the total cultivated land, which is estimated at 4.2- 4.3 million ha [21], was under cereals in the 2000/01 in Ethiopian calendar cropping year.



Figure 7. Shows each treatment replications were weighed to estimate the biomass yield.



Figure 8. After weighed fed for dairy cows voraciously fed the maize fodder



Figure 9. Shows that how it is palatable and attract animals to be fed.

Conclusion

The trial was proved that; the water to urine mix has impact on productivity of maize biomass yield per hectare. In the developing world; like Ethiopia that pastoralists considered the livestock population as means of Bank to deposit their wealth can be supported by diluted water to urine application feeding. This trial also not only cheap; accessible and affordable to the livestock owners; but also; can boost productivity milk and meat; hence; it was 100 percent palatable voraciously. In the other way the technology; what has been tested was experimented in the dry season of the year; it alleviates the livestock owner wariness in feed accessing; reduction of disease from infection from communal grazing sites. What makes this trial to be more likely was nothing; but; as the dilution with water increases the biomass yield increases. This helps to use the urine for more land to be cultivated.

In Ethiopia; if stall-feeding; and /or feeding on zero-grazing by the reduction of free grazing problem is going to be solved; hence; many advantages also comes side by side. Some of them are (a) women income will be amplified; (b) those children engaged to keep animals in free grazing can go to school (c) soil erosion and land degradation will be reduced (d) deforestation and hill side degradation will be diminished (e) hard currency to purchase Inorganic fertilizers will be used for infrastructure expansion like; constructing road; school; health centers and basic necessities. Therefore; more water diluted cattle urine technology can be able to surrogate inorganic fertilizers like urea as N source. Then; by training livestock owners; step up in animal feeding can be achieved. In this case the way how to collect urine; how to store urine till in use; and nutritive values of each water to urine ratio biomass yield needs further suggested assignments to be done.

Acknowledgement

I would like to thank University of Gondar Higher officials particularly Professor Mengesha Admasu (president for University of Gondar); Professor Afework Kassu (vice president for research and community services); Dr. Desalegn Mengesha (vice president for academics); Ato Solomon Abrha (vice president for Administration); Dr. Yinges Alemu (vice president for Business) and Dr. Achenef Melaku Dean for the faculty of veterinary medicine for financing the research trail and valuable comments. I would like to pass my heart felt thanks for my wife Miss Muluken Simenh; My kids Natnael Mulugeta; Abel Mulugeta and my Daughter Blen Mulugeta for there support in conducting a research; Data collection; and Advice.

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