Ethiopian Institute of Agricultural Research

Cattle Urine collection, Handling and Application User's Manual

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Preface

The fundamental premise for preparing this manual is to enable farmers to collect, store and use cattle urine from their homes and villages as an alternative to urea fertilizer, which has become increasingly expensive. Since the traditional experiences and research in our country regarding the use of cattle urine fertilizer are limited, it is necessary to revise the existing manual in accordance with our context by examining the experiences of other countries and recently obtained on-farm and station research findings.

We would like to express our deepest gratitude to those who have helped us with ideas, resources, and encouragement to prepare this manual in a simple and concise manner. Finally, we would like to extend our gratitude to the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the Integrated Soil Fertility Management Project (ISFM+) and the Ethiopian Institute of Agricultural Research (EIAR), who have played an irreplaceable role in funding, collating knowledge, editing, publication and distribution of this manual.

1 Background

For the last three decades, the tremendous human population growth has led to greater demand for food. However, as production and productivity have not increased to the required levels, our country has been ranked among those countries that are not self-sufficient in food production. The agricultural sector is responsible for most of the country's employment opportunities, foreign currency earnings, food and nutrition supply, and the national gross domestic product. However, it is essential to understand that the sector faces real challenges: production growth is not proportional to the fast population growth, poor soil health and fertility limit agricultural productivity, as well as economically poor farmers have limited investment options [1].

Since the late 1960s, when urea and diammonium phosphate (DAP) chemical fertilizers were introduced via “Freedom From Hunger” to Ethiopia, there have been tremendous improvements in the production of maize, teff, wheat, barley, rice, and other crops. Research and farmers' observations suggest that most crops fail when planted without these fertilizers. As a result, Ethiopia spends much of its foreign currency on importing fertilizers: For example: 783.862 million USD were spent to buy 19 million quintals of chemical fertilizer in 2020[18].

Nevertheless, challenges like the high cost and delays in the distribution of mineral fertilizers are seriously affecting the contribution of the inputs to crop production and the increase in productivity on farms.

In order to reduce the social and economic pressure that could occur as a result from the challenges described, it is necessary to research and deploy fast-acting organic fertilizer alternatives. This will not only reduce the demand for chemical fertilizers, but also ensure a sustainable increase in productivity. By using organic fertilizers such as compost, vermicompost, bio-slurry and cattle urine, 25-50 per cent of urea can be substituted to achieve the equivalent yield increase as with mineral urea fertilizer. In this regard, organic fertilizers such as cattle urine should be further explored.

2 Potential of cattle urine

Studies show that 52% of the total nitrogen consumed by cattle is excreted in the form of urine while 28% are excreted in the form of faeces [13]. This shows the potential of cattle urine in organic nitrogen fertilizer. Cattle urine consists of 95 per cent water, 3 per cent urea and 2 per cent minerals. Research from India, Nepal, South Africa, Kenya, Indonesia, Ethiopia, and other countries proved that the application of cattle urine allows for cost-effective sustainable production and improved crop quality in crops such as cauliflower, mustard, tomato, mango, rice, wheat, fodder corn and sorghum. Cattle urine has advantages over cattle faeces because it requires little money, time, energy, and knowledge to prepare and use. It contains nitrogen, phosphorus and potassium with average proportions of 11:2.5:1, making it an ideal organic fertilizer [13]. In addition, it contains micronutrients and chemical compounds such as hormones and enzymes that accelerate plant growth, improve soil health, and

Table 1. Variables for the calculation of the national cattle urine nitrogen supply potential

Item	Quantity	Unit
Total number of cattle	65,000,000	cattle
Average amount of urine per cattle	3.5	litre/day/cattle
Days per year	365	day
Total volume of urine to be harvested per year	83,037,500,000	litre/year
Average Nitrogen content of urine	10	gram/litre
Amount of N to be obtained per year	830,375	ton

As shown in Table 1, the total amount of Nitrogen that could be obtained from the country's cattle population per annum is computed to be 830,375tons of Nitrogen. This could be 18,051,630 quintals (1,805,163 tons) in urea terms, which is in fact close to the total amount of mineral fertilizer that the country imported in 2020 at a cost of 783.862 million USD (19 million quintals). This calculation demonstrates that, if we could use even half of the potential supply of cattle urine in our country, the total amount of urea imported in 2020 could be covered.

3 Purpose of cattle urine application

The additional application of cattle urine to agricultural land is done for the following purposes:

- To improve crop growth and productivity in a sustainable manner [3]
- To improve the nutrient accumulation (quality) of crops by increasing nutrient use efficiency from the soil [2 and 3]
- To improve soil fertility and health by increasing the content of soil nutrients, minerals, enzymes, and hormones [4]
- To increase the disease and pest resistance of crops [13]
- To prevent spoilage of harvested products during storage [3 and 5]

4 Cattle urine collection methods

The main issue that requires attention when using cattle urine is its collection, which can be done by two different methods: direct collection using a bucket and indirect collection from the cattle shelter or barn.

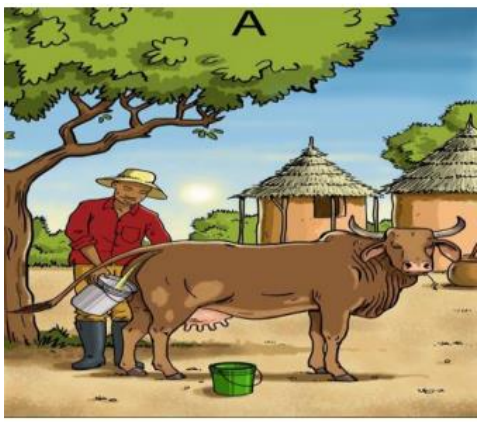

Figure 1: Direct urine collection method

4.1 Direct Collection

The direct urine collection is usually done when the cattle urinate in the barn or in the pasture (mostly when they wake up from lying down), using equipment such as troughs or iron buckets. When it is not possible to wait for the sleeping cattle to wake up on its own, the cattle can be woken up by the urine collector as well. Upon collection of the urine with a clean and wide-opened container such as a trough or bucket, it should immediately be transferred into a large container with a lid. As more than one cattle may urinate at the same time, it is advisable to increase the number of collectors and objects as required. Although this method is relatively cost-effective, simple, and clean, it requires human intervention. As the cattle release more and better-quality urine at dawn, it is advisable to carry out the collection at this time.

4.2 Indirect collection

Indirect cattle urine collection involves the use of a prepared pit or buried container that the urine reaches through a canal or pipe with the help of gravity. The method is mainly suited for cattle stationed in stables and requires the structure to be gently sloped and the stable floor to be impermeable to urine (using materials such as dense cobbles, concrete, timber, bamboo, etc.). Figure 2 shows an example of such a stable. A container should be installed under the floor to collect and store the urine flowing through the channel. After collection, the collected urine should be filtered with a clean cloth and transferred to a large container. Although, this method is relatively inexpensive, requires less manpower and yields larger amounts of urine than from direct collection, it has the disadvantage that the collected urine is often mixed with feces.

Figure 2: Collection of urine from the stable

5 Necessary Precautions

Studies indicate that cattle urine is sterile (free of microbes) when it is released from the cattle [16]. However, it can be contaminated by microbes on its way out. Enzymes such as urease, which converts urea to ammonia and hence causes nitrogen to be volatilised, are found on stables, soils, dung etc and have the potential to contaminate the collected

urine resulting in poor quality. Signs for poor quality of cattle urine include a strong unpleasant typical smell of urine, white residues on appliances (indicating phosphorus loss) and high salinity. Therefore, the following precautions should be taken during the collection of cattle urine:

1. It should be ensured that the object used for storage is made from plastic material.
2. Before and after collection and storage, the used containers should be thoroughly cleaned with water and soap.
3. As far as possible, urine should not come into contact with contaminants such as soil, faeces, etc.
4. Urine should be transferred to a clean container immediately after collection.
5. The urine should not be exposed to air, by keeping the storage container tightly covered and closed.
6. The storage container should be shaken occasionally to prevent the urine from curdling at the bottom of the container.

6 Use of cattle urine

Cattle urine can be applied to plants/crops in combination with other ingredients or on its own. It can also be used in a balanced mixture with manure as a liquid natural fertiliser or as an ingredient for compost preparation.

Cattle urine can be used in one of the following forms:

A. **Fresh urine**: Fresh urine can be applied to crops or soil within 24 hours of collection. However, this type of use is not common.

B. **Stored urine**: Stored urine can be used after careful storage for at least 3 weeks. This type of use is very common and easy to implement.

C. **Fermented urine:** Fermented urine is produced by adding different ingredients that trigger fermentation such as lactic acids and bacteria.

D. **Processed urine**: The substances contained in cattle urine can be extracted, enriched, and used subsequently. This method requires technology and financial resources.

7 Cattle urine storage

Due to the large volume required per unit area, the limited volume available per farm household and the short growing season, cattle urine needs to be stored for some time before use. Properly stored cattle urine can be preserved for up to 6 months [6]. Therefore, in order to keep the urine clean and safe, it is necessary to follow the instructions below:

1. Check the availability of collection materials (jerrican, roto, barrel etc.) that are not subject to corrosion and that are large enough for the desired volume.
2. Make sure that the storage container is clean and has a proper lid (to control ammonia volatilization and prevent air exchange)

3. Do not add water to the urine during storage time.
4. Refrigerate the urine container.
5. Store the urine for at least three weeks before use.

8 Application of cattle urine fertilizer

8.1 Crop type

In principle, cattle urine fertilizer is suitable for all types of crops. However, as supplies are limited, it is advisable to give priority to crops produced in small areas that have high economic value, such as garden vegetables and fruits.

8.2 Possible application methods

Cattle urine can be used as both a fertilizer and a pesticide. Although the method of application varies depending on the intended use and crop, the methods of cattle urine application can be grouped into 3 main categories:

A. **Soil application**: Cattle urine can be applied to the soil in a straight line of 3-4 cm from plants and must then be sufficiently covered. The application can be done either before or after crop emergence. This is the preferred method of application whenever fresh cattle urine is used.

B. **Soaking seeds or the roots of seedlings**: The main aim of this method is to improve emergence and increase the number of roots in seedlings [13]. One liter of plant leaves soaked in cow urine (1:1) for 10 days is added to 5 L of panchagavya. The mixture is kept for 25 days, filtered and used in 3% for 30 minutes before planting [13] and [20].

C. **Foliar Spraying**: Foliar spraying of cattle urine is a widely used method because it serves as both as fertilizer and as bio-pesticide, while being relatively effective and simple.

8.3 Foliar Spraying

8.3.1 Equipment

When applying cattle urine to crops or soil, the following uniforms (e.g. overalls, boots, gloves, mask), jugs, buckets, sprayers and a clean cloth for filtering are required.

Figure 3: Cattle urine spraying equipment.

8.3.2 Growth stage of the crops

As the main purpose of using cattle urine is to supply N to plants, its application must take into account the growth stage of the crop, when there is a high need for nitrogen by the crops. The nutrient uptake of most crops is slower in the early stages of growth, increases as growth accelerates and decreases when growth stops. Therefore, it is advisable to spray the leaves with cattle urine during the vegetative growth phase. For most crops, this will be on average between the 3rd and 7th week after sowing.

8.3.3 Spraying time

When spraying leaves with cattle urine, the right time and weather conditions should be considered:

Cattle urine should be applied when the soil is moderately moist. However, to minimise Nitrogen loss and ensure proper nutrient uptake, it should not be applied during periods of heavy rainfall. The best time to spray is in the morning or evening (during periods of low sunlight) and as soon as the rain stops.

Figure 4: Cattle urine spraying with different types of equipment

8.3.4 Dose calculation

As with any natural fertiliser, it is important that cattle urine is applied in a precise dose, although overdosing will not cause much damage to the crop. As N is the nutrient with the

highest availability in cattle urine, it is often used as the basis for calculating the dose. The following information is needed to calculate the dose in litres:
A = Recommendation for the amount of N for the intended crop (kg per area)
B = Nitrogen content of the cattle urine (in percent)
C = The percentage of the total recommended N to be replaced by N from cattle urine (in percent).
The calculation then can be done using the following formula: $Dose = \frac{A*C}{B}$
Example: Suppose the recommended N fertilizer rate for a certain crop is 69 kg ha^{-1} and N should be fully supplied from cattle urine (C = 100%) with a N content of 1 per cent (B=1%), then the amount of cattle urine fertilizer to be applied per hectare will be 6900 litres ($\frac{69*100\%}{1\%}$).

For cattle urine with 1% N content, the calculation can be simplified by multiplying the amount of N needed (A) by 100 (for example, 69 x 100 = 6900 litters). The volumes of urine required for different crops on different areas is listed in Table 1 of the Annex of this brochure.

- To accurately calculate the amount of cattle urine required, the N content of the urine would have to be tested in a laboratory. If this is not possible, an average urine nitrogen concentration of 1 per cent (1 gram of nitrogen per 100 ml of urine) can be assumed.
- Since cattle urine contains further substances such as enzymes and hormones, which also contribute to the prevention of crop disease and pest as well as crop growth, the overall effect will be greater than the nitrogen contribution alone.

8.3.5. Frequency of spraying

Several findings indicate that applying cattle urine fertilizer on crop leaves in split form, just like urea fertilizer, will enhance its efficiency. For most annual crops, it is common to spray 3 - 6 times throughout the growing season. However, this still requires further context-specific and detailed research. According to findings so far, it is advisable to evenly divide the urine and apply it in the 3rd, 5th and 7th week after sowing.

8.3.6. The importance of diluting cattle urine with water

If the cattle urine to be sprayed is fresh, it should be diluted at least 3 times with clean water. This is because the ammonia and salt in the urine will damage the seedling and cause it to die [17]. On the other hand, according to the confirmatory studies conducted in Ethiopia (Annex Table 2), spraying undiluted cattle urine that has been refrigerated or carefully stored for more than one month does not harm crops such as wheat.

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Annex

Annex Table 1. Volume of cattle urine fertilizer (in L) required to spray selected crops on selected areas.

Crop vegetable	N recommendation (kg/ha)	Urine required to supply full N* for 1 ha	Urine required to supply half N** for 1 ha	Urine required to supply full N for 0.25 ha	Urine required to supply half N for 0.25 ha	Information source
Teff	60	6000	3000	1500	750	[8]
Maize	88	8800	4400	2200	1100	[9]
Onion	105	10500	5250	2625	1313	[10]
Garlic	105	10500	5250	2625	1313	[11]
Lettuce	69	6900	3450	1725	863	[12]
Wheat	60	6000	3000	1500	750	[14]

*Full N: when all of the recommended N is to be supplied from urine.

**Half N: when half of the recommended N is to be supplied from urine

Annex Table 2. Response of wheat yield (ton) to combined application of urea and cattle urine fertilizers at field.

Urea-Cattle urine combination	Farmer 1		Farmer 2	
	Above-ground biomass yield	Grain yield	Above-ground biomass yield	Grain yield
NO urea and Cattle urine (negative control)	4.5B	1.6C	5.18C	2.45C
Full N from urea	6.4A	4.2A	7.73AB	3.33AB
75%N from Urea + 25% N from Cattle urine	7.4A	3.9AB	8.35A	3.94A
50%N from Urea + 50% N from Cattle urine	7.2A	3.8AB	7.52AB	3.47AB
25%N from Urea + 75% N from Cattle urine	6.5A	3.5B	6.07BC	2.92BC
(LSD)(%)	1.4	537	1729.8	881.3

LSD= least significant difference

Note: Values having no common letter in a column are statistically different.

Annex Table 3. Composition of ingredients for panchagavya preparation [19]

Constituents	Qty
Cow dung	7kg
Cow ghee	1kg
Cow urine	10L
Water/sugar cane juice	10L
Cow milk	3L
Cow curd	2L
Tender coconut water	3L
Jaggery	3Kg
Well ripened banana	12 nos.

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