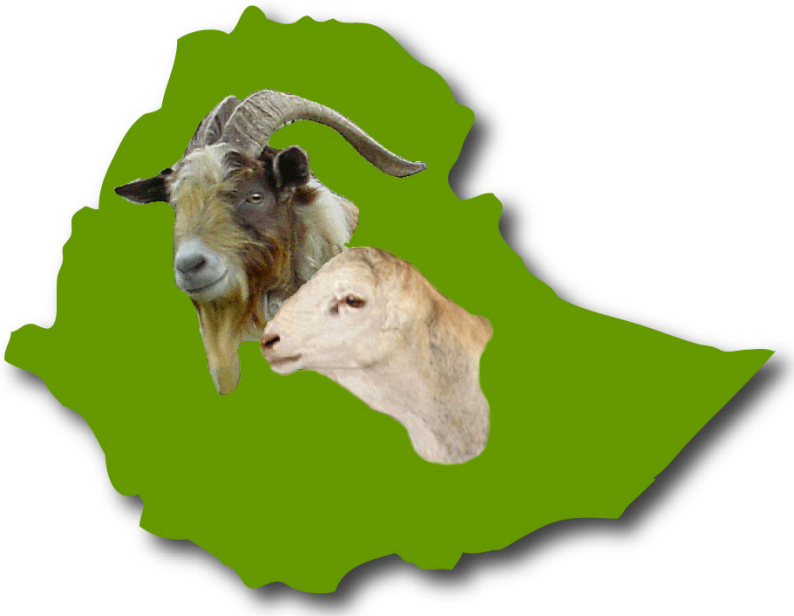
TECHNICAL BULLETIN No.2

UREA-AMMONIA TREATMENT OF LOW QUALITY ROUGHAGES



ESGPIP

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FOREWORD

This fact sheet titled "Urea-ammonia treatment of low quality roughages" is produced by the Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP). The ESGPIP is a USAID funded Project with the objective of improving the productivity of Ethiopian sheep and goats.

The fact sheet is intended to serve as an extension aid for Kebele Development Agents (KDA's) to promote the treatment of low quality roughages that form a major feed base for Ethiopian sheep and goats. It is also believed that the information contained in this fact sheet is also useful for other users engaged in business ventures based on sheep and goat rearing and also production of other types of ruminants.

Tefera Gebre Meskel,
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May, 2007

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Urea-Ammonia Treatment of Low Quality Roughages

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1. Introduction

The fact that fertilizer-grade urea is available in many developing counties such as Ethiopia makes it a preferred treatment technique for improving the nutritional quality of low quality roughages (LQR) such as crop residues and agro-industrial by- products, e.g., bagasse. The simplicity of its application is an added advantage of the technique.

2. How the technique works

Ammonia is released through urea degradation done by the action of microorganisms. These microorganisms are normal inhabitants of LQR that produce urease in the presence of moisture. With adequate moisture and suitable temperature, urea is degraded to ammonia which then permeates through the straw. Nitrogen released through this process is bound to the straw, thus increasing the total nitrogen content. Digestibility of the fibrous LQR is also increased by the action of the treatment.

3. Method of treatment

3.1 Amount of urea, water and LQR

The most common recommended level of urea is 5 kg per 100 kg of material (5% urea measured on air-dry LQR). The moisture or water level in the LQR to be treated determines how much water should be added and it may range from 0.3 to 1 liter of water per kg straw with a minimum being applied in areas with water scarcity.

An appropriate level of water is necessary for effective urea treatment (N-bound in the straw- increase) as well as packing of the material to exclude air. However, care should be taken to avoid use of excess water as it will lead to risk of mold growth and leaching of urea to the bottom of the pit or trench. The table below gives recommended amount of water to be added to achieve a final moisture content of 30%.

Table 1. Recommended amount of water to be added to achieve a final moisture content of 30%

Water to add (liter or kg per 100 kg of residue)	Initial dry matter of LQR (%)	Expected moisture content in the final treated material
23	85	30
30	90	30

3.2 How to estimate the initial dry matter

With some experience, the initial dry matter content of LQR can be estimated by handling. A very dry material (i.e., 90 or 95% dry matter) is brittle and does not stick to the hands. Conversely, a wetter residue (i.e., 85% dry matter) feels a little sticky and moist. It also tends to bend rather than break easily.

3.3 Application

Urea is weighed and dissolved in a measured quantity of water according to Table 1. A hanging scale as shown in Figure 1 could be used to weigh the urea. For measuring water, a measuring cylinder or any locally available material could be used.

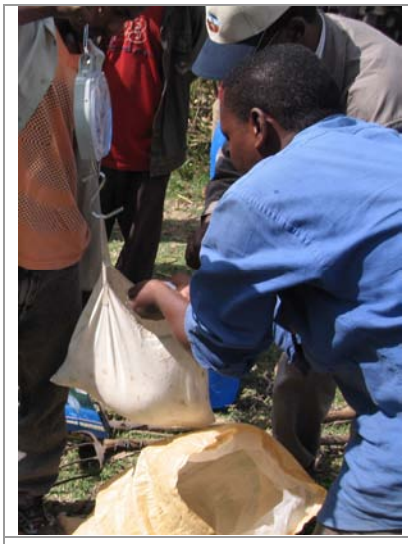


Figure 1. Weighing of urea

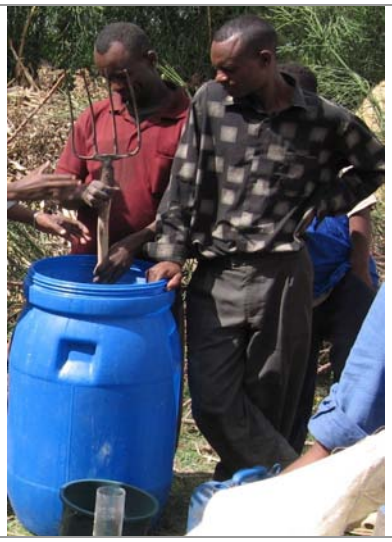


Figure 2. Mixing Urea with water

Urea is added to the LQR by first mixing the weighed amount of urea in the water to be added (Figure1). Then the urea-water solution is sprinkled on the residue as it is added to the pit in different batches. A good way of doing this is to add 10 kg of residue and then sprinkle the appropriate amount of urea-water solution (this would be 2.3 liters for 10 kg of straw with an initial dry matter concentration of 85% or 3 liters for dry matter content of 90 %). After each batch of LQR and urea-water solution is added to the pit, there should be thorough mixing with some type of tool (Figure 2) or by hand so that the solution is uniformly spread on to the LQR to be treated. This can be done in the pit or on a plastic sheet on the ground prior to packing in the pit.

4. Pit or Trench

There are many different designs of pits or trenches for urea treatment. A common recommendation is 1 m wide, at least 2 m long and 1 m deep (Figure 3). A 1 x 2 x 1 m pit will typically hold between 150 and 200 kg of common LQR, with the top of the pile being at or slightly above ground level.

Figure 3. An empty 1 x 2 x 1 m pit for urea treatment

Figure 4. Pit lined with *Enset* leaves

The pit should not allow air or rain water to enter the LQR being treated. Therefore, the pit is typically lined with material such as heavy plastic.

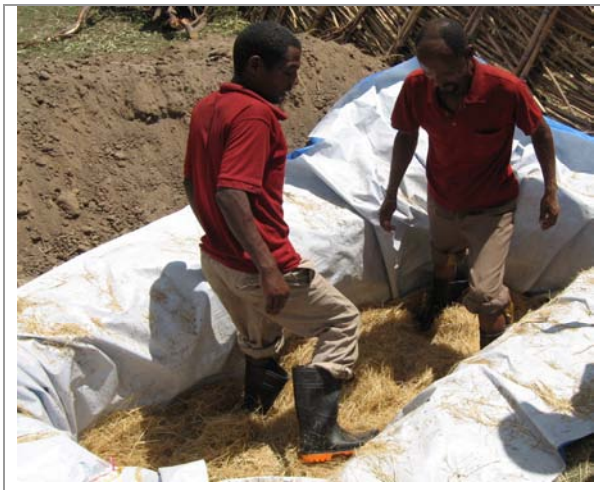
A concrete pit, placed above ground, lined with plastic will produce a good result. But concrete, bricks, and plastic may not be available or may be too expensive. Fortunately there are other alternatives. For example, Figure 4 shows lining a pit with *enset* leaves, green ones nearest to the sides of the pit and dried leaves to the inside closest to the treated material. In fact except for the shape, the pit is similar to that normally used in *'kocho'* fermentation. Depending upon availability, banana leaves or bamboo leaves could also be used. In areas with more rain, stacks can be placed against a wall or, as is seen in India, a fine meshed wire such as chicken wire can be used to contain the straw. The treated residue should be packed (Figures 5).

It is useful to construct more than one adjacent pit so that treated LQR from one pit can be used while the next pit is being treated. This helps to ensure continuous supply of treated residue for feeding.

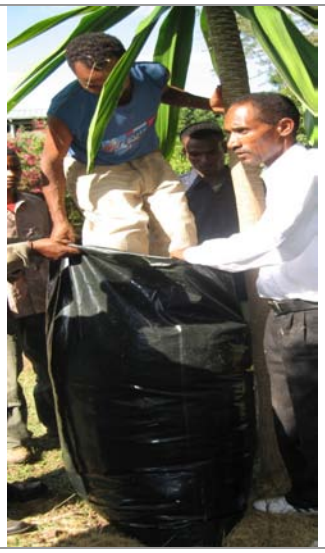
Apart from pits or trenches, plastic bags (Figure 5b) that can hold 20 to 25 kg of treated straw may be used. Such bags have the advantage in that individual bags can be opened when they are actually needed to feed animals.

5. Creating an air tight condition

An airtight condition is easily achieved by applying a plastic cover. When straw is stacked against firm structures (walls, inside pits, meshed wire), it can be compacted by trampling. Wet straw can be compacted better and will not allow air to enter. Chopping LQR like Maize and Sorghum stover before treatment helps better compaction and treatment.



Packing *teff* straw mixed with urea-water solution in a pit lined with heavy plastic.



Packing treated straw in a plastic bag

Figure 5. Packing treated straw to remove air

After covering the top of the pit for sealing with plastic or other locally available materials such as green leaves, placing soil over the pit will aid in packing and ensuring that rain water does not enter the treated LQR. Construction of a shade over the pit will help to avoid entry of rain water into the pit in high rainfall areas (Figure 6).

Figure 6. A shade over urea treatment pit

6. Length of Treatment

A number of factors influence the length of time needed for most effective urea treatment. One of the most important ones is outside temperature. Higher temperatures lessen the length of time needed, and cooler temperatures increase the length of time required. Because longer treatment times than necessary do not have adverse effects, it is commonly recommended that the pit remains closed for at least 3 weeks and preferably 1 month.

7. Use of Urea-Treated Low Quality Roughages (LQR)

When feeding urea-treated LQR, the pit should be opened from one side as necessary to remove the needed amount of residue. The remaining part should remain closed. This prevents air from entering to minimize chances for spoilage. It is best to open the pit as seldom as possible, such as no more than once per day.

The treated LQR will be higher in digestibility and crude protein than the untreated material. Therefore, some farmers will feed urea-treated LQR to their animals with the highest nutritional requirements, such as lactating or fattening animals. Other farmers will feed limited amounts of the treated LQR as a supplement, with the remainder of diets being untreated LQR or grazed forage.

Major changes that take place as a result of ammoniation include, color change (Figure 7) and odor of ammonia.

Fig. 7. Treated straw (left) and untreated straw (right)

An adaptation period may be needed for animals that have not previously consumed urea-treated LQR. This allows them to become familiar with the feedstuff and, in particular, with the ammonia odor. The level of treated LQR being fed can be gradually increased over a period of 1 to 2 weeks, perhaps being mixed with feedstuffs previously being given. Adaptation will be most rapid when animals are given little choice. Such an adaptation period is also a good idea when adapting ruminants to any diet containing non-protein nitrogen, although this is rarely a concern for crop residues properly treated with urea. In some cases residual ammonia might lower intake. In such circumstances the treated straw should be aerated for a few hours or overnight before feeding to allow the ammonia odor disappear.

By treating with urea, animal performance can be increased or a greater number of animals can be fed with the same level of performance (i.e., growth or milk production). Animals fed urea-treated LQR may require no supplemental concentrate or will need

lower levels to achieve a desired level of animal performance compared with animals fed untreated LQR. Feeding urea treatment of LQR alone will lead to some increase in production, but the full potential will only be realized when the correct supplements are added. A supplement of bypass protein such as cottonseed cake or nougseed cake is required for high performance.

8. Socio-economic considerations

There has to be a good economic reason for a farmer to feed treated straw -and the effect has to be visible. For these reasons straw treatment has been most successfully taken up when fed to responsive animals as a basal diet like in fattening programs.

9. When to treat straw (calendar for treating straw with urea)

The treatment of crop residues can be done any time as long as the residue, water and urea required for the treatment are available. The best period recommended, however, is just after harvest because:

- water and forage supplies are still available at this time;
- the farmer has ready cash for purchasing the urea and the time to do the treatment, a family of 4 can treat about 1 ton of straw in 4hrs;
- the treatment operation can be carried out whilst the traditional stack is being constructed; and
- the weather is conducive.

10. Summary

Treating low quality crop residues such as wheat or *teff* straw, maize residue, or bagasse with urea is an easy method to increase digestibility and productivity of animals. Generally, 5 kg of urea is mixed with water and used to treat each 100 kg of crop residue resulting in a mixture with about 30% moisture. This is commonly done in pits that must be lined with plastic, *enset* leaves, or other materials that do not allow water to enter. Following mixing of urea, water and straw, the pits must be sealed for at least 3 weeks. Animals must be adapted to consuming the treated straw.