

Theme 2: Forage conservation

# TREATMENT OF STRAW WITH UREA

## (Level 3)

Topic	Training & information Content
2.1	Fodder conservation and storage
2.2	Estimating ideal time of harvesting
2.3	Guideline for silage making
2.4	Fermentation process in silage
2.5	Treatment of straw with Urea
2.6	Making of urea/molasses/mineral lick
2.7	Management of silage pit (feed out)
2.8	Estimating fodder supplies for dry season feeding & planning of feeding management



## 1. You will learn about (learning objectives):

- Benefits of straw treated with urea in feeding a dairy cow.
- Factors affecting treatment of straws with urea.
- How to treat straw with urea.
- Different types of straw/stover that can be improved.



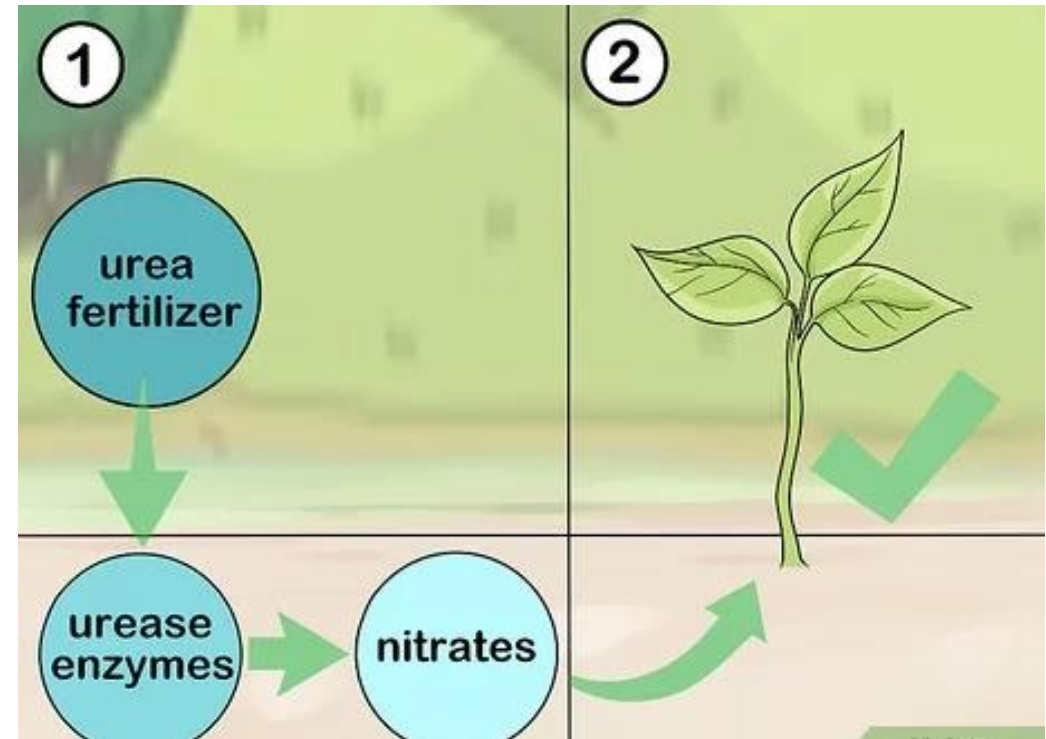
## 2. Introduction

- Urea as a synthetic fertilizer is relatively easy to use, store and dissolve in water.
- Urea treatment of straws is a chemical treatment procedure with on-farm practical potential.
- The procedure can be done in different ways, depending on the local conditions and preferences.
- There are however some rules given on treatment of straws regarding concentration of urea, duration of treatment, amount of water to be used and way of stacking/heaping/piling.



### 3. What is Urea?

- Urea is a white crystalline solid organic compound, widely used as a synthetic nitrogen fertilizer.
- Pure urea has a nitrogen concentration of 46.6%, equivalent to a crude protein content of 291 grams (g) per 1 kilogram (kg) of urea since protein itself has only 16% nitrogen.
- Urea is easily broken down to ammonia by urease enzyme that is produced by soil or rumen microorganisms.



How urea is broken down in the soil for use by plants. Same procedure applies in the rumen.

## 3.1 Urea Cont'd...

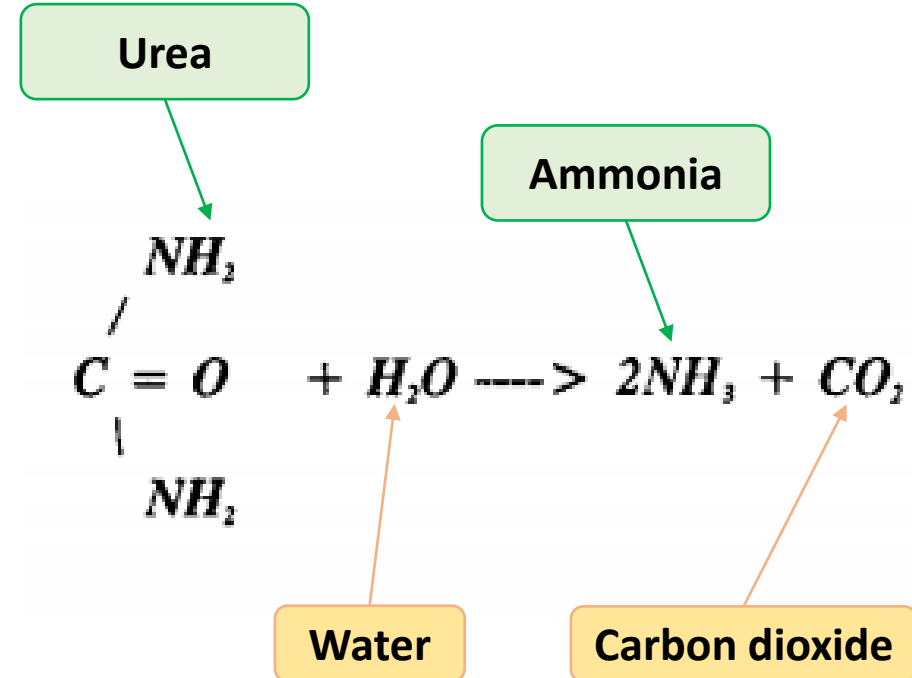
- Urea is a non-protein nitrogen (NPN) compound. This means the nitrogen portion of urea is used as a building block for the production of microbial protein by rumen microorganism.
- Note that urea contains no other useful feed components such as energy, minerals or vitamins.
- Excessive amounts of urea and/or insufficient mixing of urea with the straws can be dangerous/lethal for cows when eating the mixture.



## 4. Why straws are treated with Urea

How Urea is broken down in the rumen

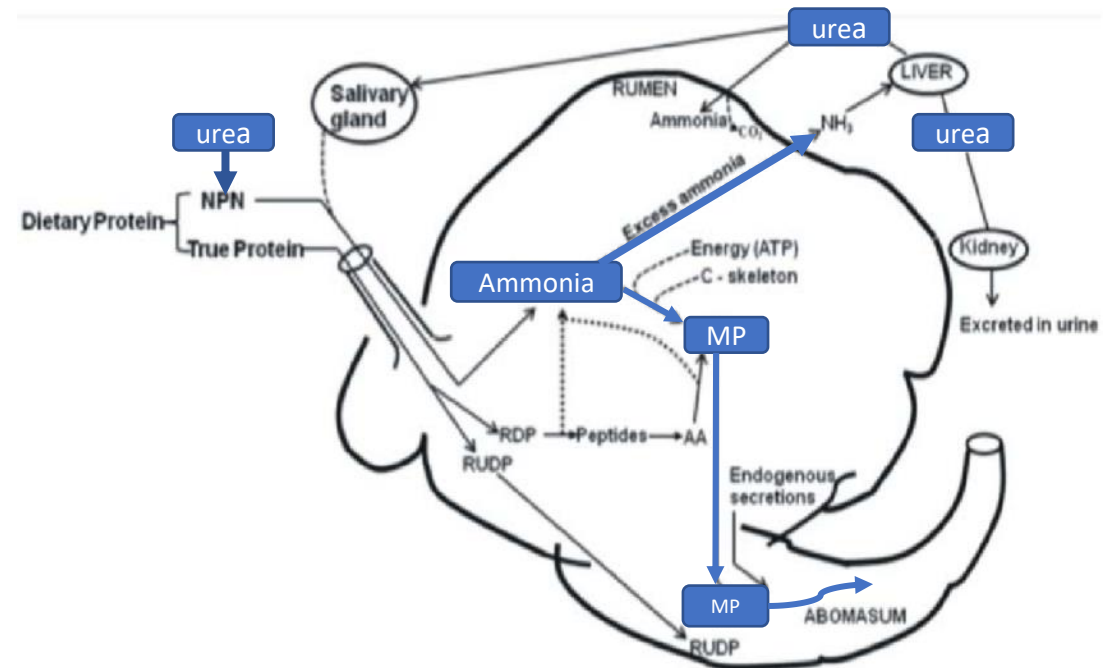
- As a non-protein nitrogen (NPN) source urea can replace part of the dietary protein for ruminants.
- Ruminants (using rumen microbes) convert urea to protein, producing ammonia and carbon dioxide.
- The ammonia released from urea can go to two pathways in the animal. The first is in the production of microbial protein, ultimately serving as a protein source for the host ruminant.
- The second is the liver where it is detoxified and excreted in urine.



## 4.1 Why straws are treated with Urea Cont'd...

- When too much ammonia escapes the rumen because microbes are not able to utilize enough of it for protein, the capacity of liver for excretion can be overwhelmed and a toxicity can occur.
- It is therefore vital that there is right concentration of urea is used and that there will be sufficient bacterial action to produce protein.

### Urea (NPN) in the rumen



MP → Microbial protein

## 5. Urea utilization in the rumen

- The level of bacterial action is determined by the urea fermentation potential (UFP) of the total digested feed material.
- When there is a higher level of fermentable energy in the feed than required by the rumen to convert the ammonia into protein, the feed will have a positive UFP.
- If there is insufficient energy or the feed already contains significant crude protein, the UFP will be negative. Thus, maize will have a positive UFP and fescue hay and soybean meal will both have a negative UFP.
- These results indicate feedlot rations high in energy will usually have the best potential for the use of urea as a protein source.
- However, combining several feeds that dilute urea as a protein source can result in formulation of a good protein supplement for cattle on high energy diets.



Source: <https://extension.psu.edu/urea-in-beef-cattle-rations>



## 6. Benefits of treating straws with urea

- Increases nitrogen content, improved palatability and digestibility of straws.
- During the treatment process, ammonia is generated from urea. In the presence of water it forms the alkali named ammonium hydroxide. The alkali makes the straw cell walls better available for rumen fermentation.
- The treated straw is softer than untreated straws.
- Increased feeding intake: the cow after a period of adaptation eats 30% more than from a untreated straw.
- Urea treatment of straws is more achievable because of the easy availability of urea and its quick breakdown into ammonia compounds under higher ambient temperatures (tropics).



## 7. Factors affecting treatment of straws with urea

- Various factors affect the ammoniation process during treatment of straw with urea, ultimately determining its nutritional quality;
  - i. Urea concentration.
  - ii. Water requirement.
  - iii. Methods of applying the urea/water mixture (spraying).
  - iv. Compaction of the stack.
  - v. Duration of anaerobic period.
  - vi. Type of straw/stover used.
  - vii. Storage method.



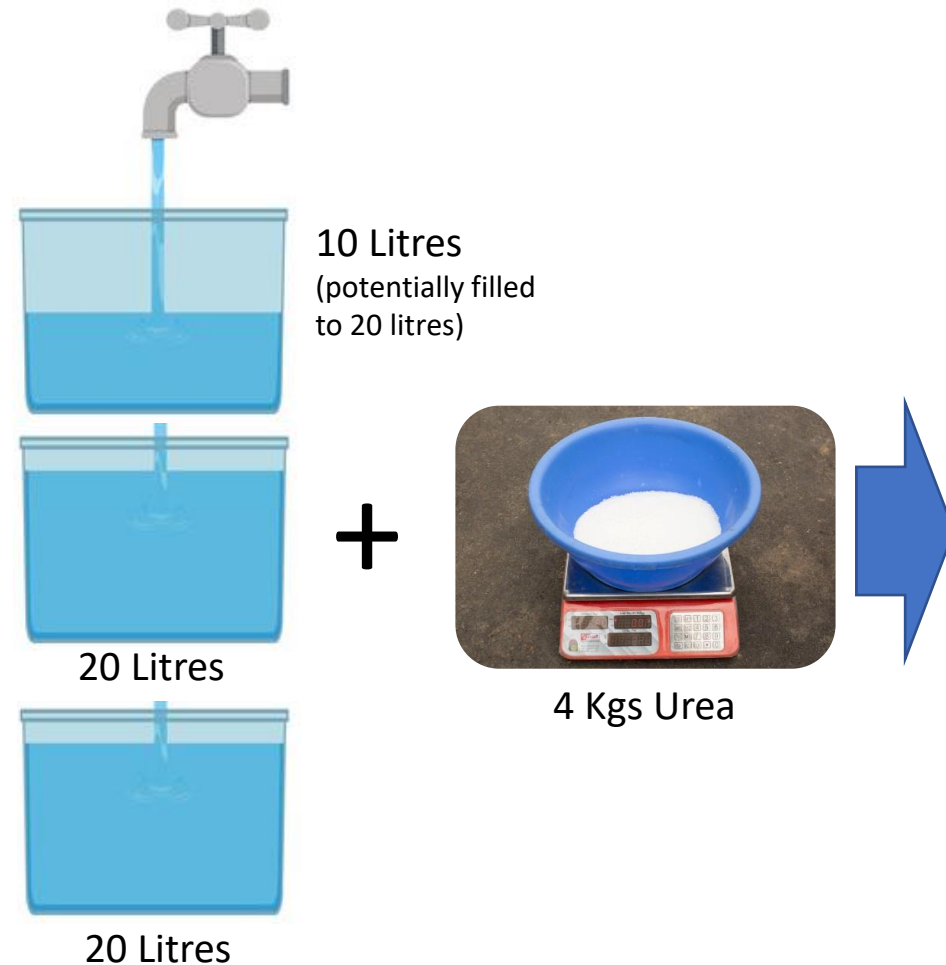
## 8. Urea concentration

- An amount of 4 kg of urea to treat 100 kg of air dry straw/stover has been found to be an optimum level.
- Levels lower than 3.5 kg may not produce sufficient ammonia for effective treatment while levels above 4 kg do not further increase straw quality.
- A farmer can weigh the 4 kg of urea in a small bucket, mark the level and subsequently use that measure for repeated weighing.



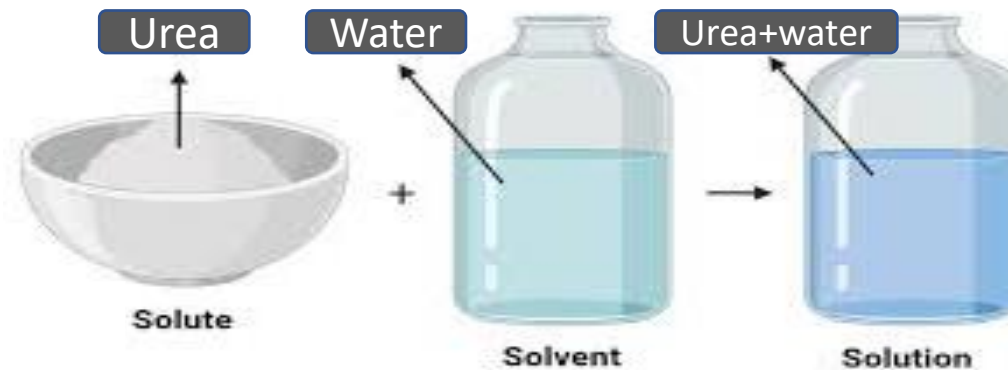
## 9. Water requirement

- The moisture level in straws/stovers to be treated is not very critical to the process, provided it is not too low.
- Water however is essential as it helps in the hydrolysis of urea.
- It is also required to form the alkali and to act as a vehicle for ammonia to penetrate the cell walls. To achieve this, 50-60 litres of water can be used to dissolve 4 kg of urea and to spray it over a layer of 100 kg of air-dried straws.



## 9.1 Water requirement Cont'd...

- A number of straw bales can be weighed and counted to calculate how many are required for 100 kg of straw for treatment.
- With chopped straw, the number of bags filled with chopped straws required for 100 kg of straw can be weighed and calculated.
- With regard to water measurement, buckets of a known volume or milk cans of 25 kg capacity can be filled with water to get a total of 50-60liters to dissolve 4 kg of urea.
- In absence of milk cans or any other of these measurement procedures, it is possible to develop locally applicable methods, perhaps more adjusted to the amount and type of straw to be used.



## 10. Method of spraying

- For spraying of the urea solution over a layer of straw, a watering can or a back spray can be used to achieve uniformity.
- Use of a broom and a bucket has also been found to be effective to spread the water.
- Spread about 20-25cm of straw on the ground and spray the urea solution on it and mix up the straw.
- Spread the second layer and repeat this process. This way helps to spray the whole solution on the straw and press it to squeeze off the air in it.
- It is advised to mix the water-urea mixture regularly in between use to avoid unmixing of the mixture.



Watering can



back spray

## 11. Compaction of the stack

- Once a layer of 100 kg has been treated, a farmer can then add another layer of 100 kg of straw which is placed on top and again sprayed with the water-urea.
- This process is repeated to make a stack/heap. Ensure that the moisture in the stack is not more than 50%. The ideal temperature for this process in the stack is 30-35°C.
- A compact stack has two advantages.
  - The effectiveness of the ammoniation process is better.
  - There are less chances of mold growth which leads to spoilage of the straw.



## 11.1 Compaction of the stack Cont'd...

- Different types of straw and chop size can affect compaction. It is easy to compact straws chopped in smaller sizes than long straws.
- Chopped wheat straw compacts very well during compaction of the stack.
- Dense compactness cannot be easily achieved with loose rice straw. Although, bundles are better than loose, unchopped rice straw.
- After successful compaction, cover and seal the stack air tight with a plastic sheet to protect it from air and moisture entering.



Long straws



Chopped straws



## 12. Addition of molasses

- In another processes, molasses is used with urea and water.
- For 100 kilograms of straw, 4 kilograms urea is mixed with 100 litres of water and 10-15 kilogram molasses is added to this mixture.
- The spraying of the water-urea-molasses mixture on the straw follows the process/procedures explained earlier.



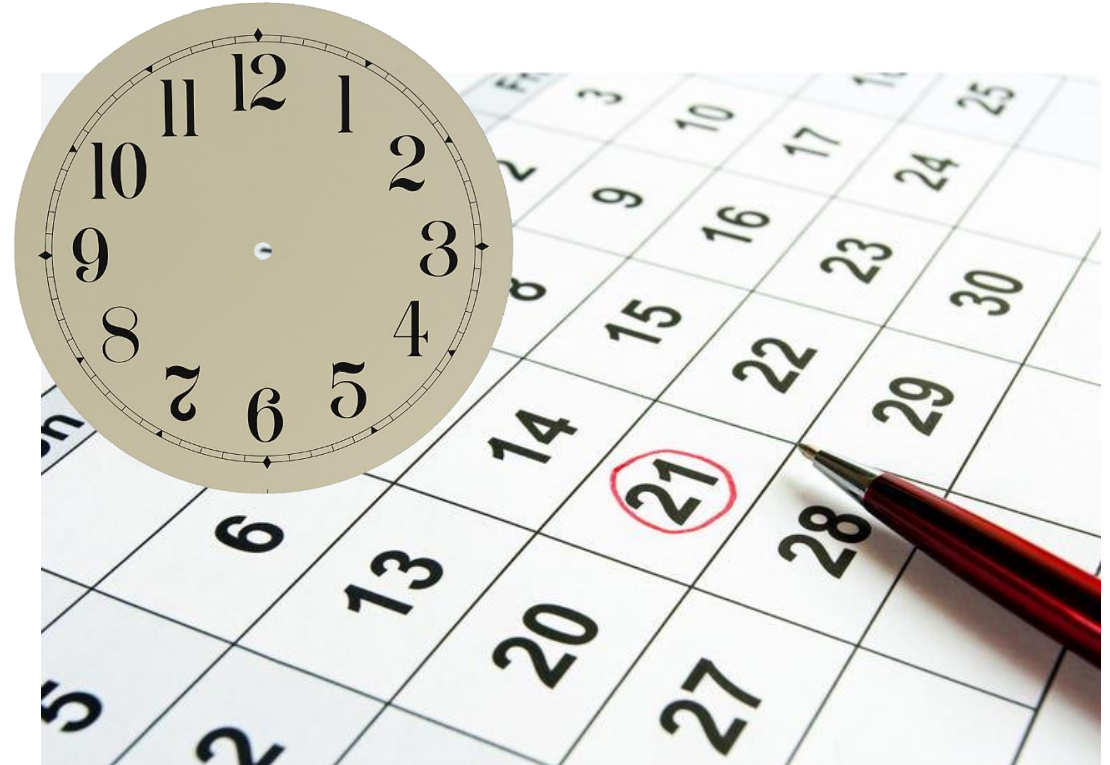
## 12.1 Effect of addition of molasses

- Addition of molasses has different effects on the straws.
  - **Without molasses:** The quantity of the protein in the straw increases when only urea is used in treating the straws.
  - **With molasses:** When molasses is used, then in addition to increase the protein content, the energy content is also increased and animals therefore take in more energy.



## 13. Duration of treatment

- Since the temperature of the clamp/silo affects the rate of hydrolysis of urea to ammonia, the duration of anaerobic period can be variable, depending on the region and season.
- The anaerobic period may vary from 1-4 weeks. In a warm climate like in the tropics, e.g. East Africa region, 7-14 days is effective.
- The duration of the anaerobic period can also be decided upon by considering the local conditions as well as the scale of the clamp/silo.
- However, temperature and anaerobic periods are inversely correlated and more time is required with lower environmental temperatures.



Take note of calendar days

## 14. Type of crop residues treated

- The type of crop residues used and their initial nutritional quality affects the effectiveness of treatment.
- The poorer the initial quality of the straw/stover, the higher the effect of the treatment with the water-urea mixture, possibly because better quality straw have more cell soluble and lower fiber content.
- Stover, i.e. coarse straw has a generally higher initial nutritional quality than slender stemmed straw, and they will benefit less from treatment.
- Furthermore, if moldy straw/stover are used for the treatment with water-urea mixture, expect a reduction, rather than an improvement in the quality of straws.



## 15. Storage method

- A key factor which determines economics and practicability of the urea treatment of straw is the use of storage structures for the treatment of the straw.
- Farmers generally prefer storage methods based on existing traditions, but new ways are found acceptable depending on their cost.
- Sealing can be done with materials like polythene.
- Farmers can also use various storage structures like earthen pits, lined and covered with polythene, clamps with cemented floor, cemented silos, and containers.



## 16. Effect of treatment on straw quality

- Urea treatment improves digestibility, intake and crude protein content of the straw.
- The increase in crude protein content caused by urea treatment is in the order of 4 to 5 percentage units, due to the addition of ammonia.
- Crude protein content increases are higher than what would be required in relation to the increased digestible energy availability in the rumen.
- The higher digestibility and intake is mainly caused by the increased rate and extent of cell wall degradation.

### Nutritious Value Increase by enrichment:

Kinds of the Straw	Proteins	
	Before enrichment	After enrichment
Wheat Straw	2.8%	6.6%
Rice Straw	6.1%	13.5%
Maize Stems	10.7%	21.2%

Source: [http://uvas.edu.pk/doc/advisory\\_services/Dairy-farming/english/3-wheat-straw.pdf](http://uvas.edu.pk/doc/advisory_services/Dairy-farming/english/3-wheat-straw.pdf)

## 17. Treated versus Untreated straws

- **Dung:** In some cases, the dung of animals on treated straws gets slightly stickier. No negative health aspect is ascribed to this.
- **Milk:** No negative residues of treated straw rations are known to enter milk.
- The use of pesticides and herbicides should not be overlooked, though some are reported to be denatured in alkaline environments and the problem is not confined to the use of treated straw alone.
- **Toxins:** Provided the straw is not moldy, there are no reported cases of more mycotoxin due to treatment.



## 17.1 Treated versus Untreated straws Cont'd...

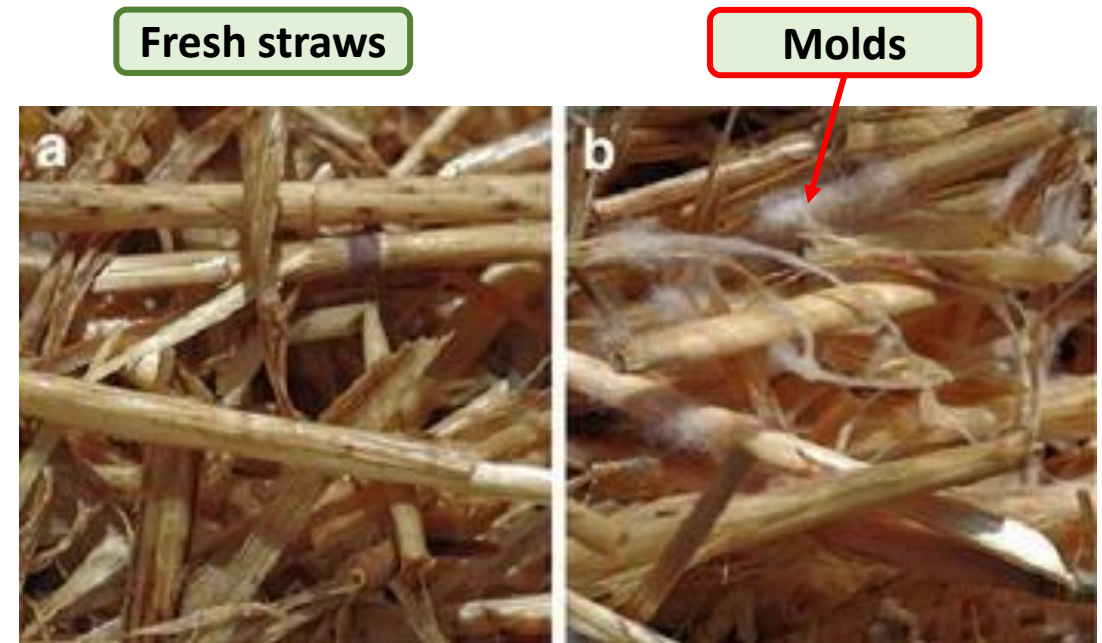
- If the straws have fungal growths, mycotoxins that cause abortion or other ill effects are produced. Fortunately, ammonia produced during treating straw with urea can serve as preservative to prevent mold growth.
- Urea toxicity due to feeding treated straw is unlikely or even impossible if urea and straws are well mixed, because intake of straw is rather slow.
- High levels of ammonia is expected in the rumen due to feeding of treated straw, but this is unlikely to occur.





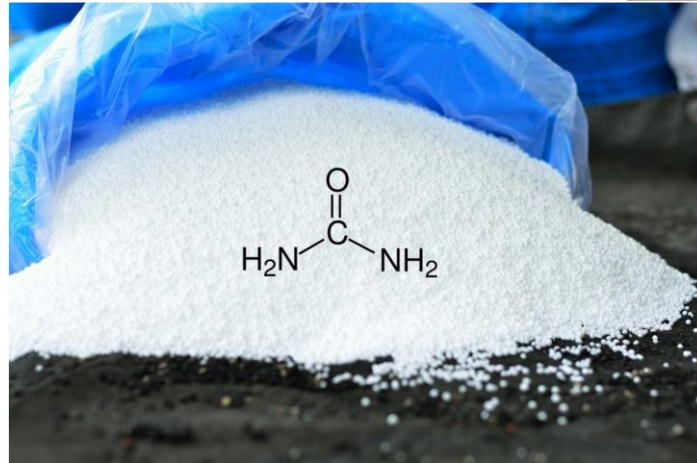
## 18. The major constraints of urea treatment

- Despite these beneficial effects observed by farmers, the continued use of urea treatment after initial demonstration has been disappointing due to constraints like:
  - Sticky dung produced by the animals.
  - Pungent smell from ammonia.
  - Fear of fungal spoilage of straw in open stacks.
  - Toxicity if urea is not well mixed with water/straw.
  - Toxicity if fed in excess.



## 19. Feeding urea treated straws

- Feeding treated straws alone does not meet the nutritional requirements of a cow.
- A farmer should add more nutritive forage species/varieties in the cow's ration.
- The urea treated straws together with the other forages should be mixed to make a total mixed ration.



## 20. Take home message/Summary

1. Urea treatment improves the nutritive value of straws in terms of crude protein, palatability, intake and digestibility.
2. The effectiveness of the urea treatment depends on factors such as:
  - Type of straw
  - Concentration of urea used in the water-urea solution
  - Moisture level in the clamp
  - Environmental temperature
  - Method of application (spraying, watering can, broom)
  - Compaction and duration of the anaerobic period
  - The method of storage.

Some of these factors are governed by local conditions.

