Animal Production

Level II

Learning Guide # 49

Unit of Competence: Assist Crop Residues Treatment and Urea Molasses Block Preparation

Module Title: Assisting Crop Residues Treatment and Urea Molasses Block Preparation

LG Code: AGR APR2 M15 0919 LO1- 49

TTLM Code: AGR APR2 TTLM 0919V1

LO2: Determine the method of treatment

Instruction Sheet	Learning Guide # 49

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Assessing advantages of different types of treatments.
- Selecting appropriate type of treatments
- preparing appropriate ingredients for treatment

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- assess advantages of different types of treatments.
- select appropriate type of treatments
- prepare appropriate ingredients for treatment

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 4.
3. Read the information written in the information "Sheet 1, Sheet 2 and Sheet 3.
4. Accomplish the "Self-check 1, Self-check 2 and Self-check 3" **in page - 14, 16 and 19** respectively.

Information sheet – 1	Assessing advantages of different types of treatments

1.1. Chemical Composition of Crop Residues

Crop residues are potentially rich sources of energy as about 80 percent of their DM consists of polysaccharide, but usually underutilized because of their low digestibility, which limits feed intake. These constraints are related to their specific cell wall structure, chemical composition and deficiencies of nutrients such as N, S, P and Co, which are essential to rumen microorganisms. The cell wall fraction includes cellulose, hemicelluloses, lignin, cutin, lignified protein, silica and ash, which are present in most crop residues. Including cereal straws from teff, pulse crops including pea, beans, lentils, chick pea and vetch are very important feed resources. However, straws are mainly characterized by highly lignified cell wall material, which mostly constitutes up to 80% of the dry matter (DM). These cell walls are mainly made up of structural polysaccharides and lignin. The composition of readily available storage carbohydrates and proteins are much lower than in most other forages and agro-industrial by-products. In some cases the mineral content of straws can be quite high. Generally, there is clear difference in chemical composition of straws of different crops; there is also variation within the different parts of a single plant. Higher CP, lower fiber contents and relatively higher in sacco degradability of different varieties straws of faba bean and field pea than cereal straws and maize stovers.

The primary factors limit utilization of crop residues are low digestibility, low protein content, high crude fiber and low palatability. Their low digestibility due generally to the high fibrous contents consists mainly of 30-40% cellulose; 25-35% hemicelluloses and 10-15% lignin on DM base. Thus, to increase digestibility of crop residues, it is important to release the linkage between cellulose, hemicellulose and lignin or to modify the compact nature of these tissues, so that lignified tissue might separate from non-lignified one. There have been attempts to do that by mechanical, chemical or biological treatments. Recent years, much interest has been forwarded to develop new bio-techniques for improving the nutritive of lignocelluloseics fibrous using biological treatment in solid substrate fermentation under non-sterile conditions. This study was conducted to evaluate the effect of fungal treatment in solid state on chemical composition and nutritive values of rice straw and corn stalks.

1.2. Factors Affecting Nutritive Values of Crop Residues

Nutritive value of a given feed is generally determined by nutrient composition, intake and utilization efficiency of digested matter. Species of plants, stage of maturity at harvest, cultivars and proportion of leaf to stem ratio are important plant factors determining their nutritive value. For instance, the lower organic matter digestibility (OMD) of wheat stem as compared to the leaf fraction and sheath is due to higher content of neutral detergent fiber (NDF) and lignin in the stem portion. Contrarily, the OMD of rice straw is lower for its leaf sheath and leaf fraction as the concentration of NDF and lignin is much higher in these parts than in the stem.

1.3. Advantages of treatment of crop Residues

Treatment of crop residues increase voluntary intake by improving palatability, dissociate cellulose and hemi-cellulose from lignin and silica, the dissociation increases microbial action, the microbial action resulting in increased digestibility of organic nutrients, increase energy availability by reducing losses in digestive processes, increase surface area for providing more exposed surface for the microorganisms and their enzymes resulting in high digestibility, enrich the crop residues with deficient nutrient either by treatment or supplementation, very often combination of both is used for efficient utilization and balancing the diets of the animals, reduces the bulkiness through densification, increases keeping quality and storage duration, removal or neutralization of harmful constituent in the feeds, reduce feed wastage and refusal during feeding, make animal production cost effective and economical and ensure balanced intake of nutrients by reducing the slope of feed sorting.

1.4. Methods for improving nutritive value of low quality roughages

The main dry matter intake in cattle in riverian areas of arid and semi-arid of Ethiopia is through the crop residue. Improved utilization of these residues is very important because low quality roughages have both physical and chemical constraints to obtain optimum animal production.

Ruminants despite their unique and highly efficient digestive system are not able to extract sufficient energy to grow and produce milk from low quality or highly lignified crop residues. As crop residues are such an important feed source for livestock in the tropics there is a major interest in improving their digestibility and hence their feeding values. The objective of crop residue treatment is to increase the digestibility of straw and/or the amount of it voluntarily consumed so that digestible energy intake by animals from straw is increased.

Nutritive value of low quality roughages can be improved by:-

- ✓ physical (chopping, grinding, steaming, soaking and pelleting)
- ✓ Chemical (treating with 1-2% NaOH, Ammonia 3%, and Urea 4-5%)
- ✓ Biological (Microbial treatment and modifying rumen ecology) using organisms that can degrade lignin or break the bonds between lignin and cellulose in plant cell walls.
- ✓ An appropriate combination of two or all of these methods.

1.4.1. Physical treatment

Crop residues can be ground, soaked, pelleted or chopped to reduce particle size or can be treated with steam or pressure cooked. Grinding and pelleting of grass hay decreased dry matter degradability in cows from 73 to 67%, which was mainly due to a decreased fermentation rate (9.4-5.1%/h) and decreased total retention time of the solids from 73 to 54 hours, resulting in an increased intake. The use of steam treatment in a high pressure vessel at different pressures and for a range of different treatment times increased the degradation in vitro in rumen fluid after 24 hours and the rate of degradation, but could not enhance the potential degradability of the fibrous fractions (NDF, ADF and hemicellulose). Physical treatments of crop residues have received an appreciable amount of research. Many of these treatments are not practical for use on small-scale farms, as they require machines or industrial processing. This makes these in many cases economically unprofitable for farmers as the benefits may be too low or even negative. However, small machines to grind or chop rice straw may be feasible. Numerous physical treatments processing techniques to enhance the utilization of crop residues by ruminants have been used, with varying degrees of success. In this section, the more common methods - including chopping, water soaking, steam treatment, grinding and pelleting will be briefly reviewed.

1.4.1.1. Chopping

Chopping crop residues used to reduce wastage, reduces possibilities for selected consumption, affects the ultra -structural makeup of fibers, and reduces particle size, increases consumption, increases digestibility and this is expected to be due to increased rate of passage and better fermentation in the rumen. Physical treatment usually implies a reduction of particle size mainly by chopping the crop residue. Stover and straw are chopped to about 2cm in length before feeding. Grinding involves fine chopping or grounding of straw by grinder.

1.4.1.2. Water soaking

Water soaking affects the physical & chemical characteristics through swelling of the fiber, softening of particles, loosening the linkages within structural CH_2O, ultimately effects palatability and improves intake after soaking 12 hours before feeding.

1.4.1.3. Grinding and Pelleting

Grinding and pelleting increases voluntary intake, improves (uniformity, density, dustiness, handling, wastage rate) but higher rate of passage and depression of DM digestibility compensated by higher intake. Ground crop residues are often pelleted or cubed before feeding.

1.4.1.4. Steam Treatment

Steam treatment is a physical treatment that helps to degrades cellulose and hemi-cellulose, increases voluntary intake, and increases digestibility.

Advantages of physical treatment

- Chopping and Grinding decreases particle size, increases surface area and bulk density of both leaf and stem fractions, and hence raises feed intake. The increase in intake due to chopping and grinding is generally higher with low quality than with high quality residues.
- Reduces selection of the feed by animal, hence reduce wastage.
- Benefits derived from pelleting include a further increase in density, decreased dustiness and easier handling. Pelleting usually increases straw intake due to quicker passage.
- Generally the net benefit of feeding ground and/or pelleted crop residues in practice is increased feed intake and animal performance.

Disadvantages of physical treatment

- Digestibility of ground or pelleted straws is depressed primarily due to faster passage rate.
- Cost of labor and machinery input

1.5. Chemical treatment

Since the beginning of the 19th century, attempts have been made to improve the digestibility and nutritive value of crop residues. A major breakthrough was chemical treatment to remove encrusting substances (cellulose, hemi-cellulose and lignin).

Many chemicals have been screened for their potential to enhance digestibility. However, only **four** are being routinely used: sodium hydroxide (NaOH), calcium hydroxide Ca $(OH)_2$, ammonia (NH_3) and urea.

The modes of action of chemical treatment on crop residues especially with alkalis involve;

- ✓ Hemi-cellulose solublization.
- ✓ Increases in cellulose and hemi-cellulose digestion
- ✓ Increases in digestion rate for cellulose and hemi-cellulose.

1.5.1.1. Urea treatment

The non-protein N content of fertilizer grade urea is 46.7 percent. Its formula is CO $(NH_2)_2$. It is decomposed into ammonia and CO_2 by urease at ambient temperature. Urease is an enzyme that converts urea into ammonia. The chemical reaction is:

$$CO(NH_2)_2 + H_2O \xrightarrow{\text{Urease enzymes. Ambient temperature}} 2NH_3/ + CO_2$$

Urea is widely used to generate ammonia for improving poor quality fibrous feeds. This is because of its low cost or relatively easy availability compared with other chemicals used for treatment of crop residues lower effect on environmental pollution, its added value of nitrogen over other alkalis like sodium hydroxide for rumen microorganisms and ease of application. Urea as feed for animals can be supplemented to concentrates to save on protein costs or supply some readily soluble non protein nitrogen along with other nutrients such as phosphorus, sulphur and some readily available energy that can improve the rumen function. Supplementation is possibly achieved either by spraying the roughage with urea solution or by incorporating urea in urea molasses blocks.

Urea treatment has, however, emerged as the method of choice for use at farm level in the tropics as it is best adapted to the conditions of smallholder farmers. The major advantages of using urea for crop residue ammonization are that it is easy to handle and transport, and it does not pose any risk to those handling and using it. Moreover, fertilizer grade urea is readily available and relatively cheap compared to either aqueous or anhydrous ammonia.

Urea dosage needed to treat straw may vary a lot. The recommended dosage is 4-5 percent urea on DM basis, taking into consideration the effect of ammonization and costs.

- ✓ Urea can be transported conveniently at normal temperature and pressure.
- ✓ It is harmless to humans.
- ✓ Treating straw with urea does not need complex equipment and the sealing conditions are not as strict as with anhydrous ammonia.

1.5.1.1.1. Methods of Treatment with Urea

There are many variations in the methods of treatment of low quality roughages with urea. However, the principal method consists of dissolving urea in water and sprinkling it on layers of stover or straw. The level of urea used varies, but it is commonly between 4 - 5% of air-dry mass of the straw/stover, and the amount of water used also varies from as low as 0.2 liters per kg of straw to as high as 1 liter per kg of straw. The treatment of the straw can be done in pits, clamps (three sided wall structure built on the ground) using polyethylene sheets as inner linings. Airtight conditions are important during the treatment period, especially for small quantities of straws. Polyethylene sheet is very effective for excluding air, but a number of locally available materials such as banana leaves, soil, jute bags and cow dung are also used. The treatment period depends on the temperature of the surrounding and may be as low as 1 week in warm areas and up to 8 weeks in cold environment.

Table. Nutritive values of straw before and after urea treatment

	Before	**After**
Crude protein	3–5%	7–10%
Digestibility	40–50%	45–55%
Intake		+20–40%

1.5.1.1.2. Factors affecting the Effectiveness of Urea Treatment

Urea treatment affected by level of urea, treatment temperature, curing period, moisture content, structure used and type of straw. Presence of urease particularly affects the process of ureolysis that requires the hydrolysis of urea to ammonia in the presence of the enzyme urease in the straw or stover to be treated.

The moisture content of crop residues to be treated is critical for the success of urea treatment. In the application of moisture during urea treatment of crop residues, more emphasis should be given to the final moisture content of the crop residue rather than the quantity of water to be added, as there can be variations in initial water content of the materials used for urea treatment. The final moisture content is recommended to be between 30-60% for effective ureolysis and ammoniation of straws. Final moisture content of less than 30% in urea treated crop residue reduces severely the process of ureolysis and hence, the ammoniation process as a whole. It may as well result in loosely packed material as it causes difficulty of compression and packing. The optimum temperature for ureolysis lies between 30-60^{o}C and the rate of ureolysis doubles or decreases by a factor of 2 for every ten-degree rise or fall in temperature, respectively. Ureolysis can be completed within 1-7 days at temperatures between 20 & 45^{0}c. However, the activity of urease is severely reduced or even canceled when temperature falls below 5^{o} C to 10^{o}C.

During Application rates prepare the ingredients 100 kg straw, 100 liters water, 10 liters of molasses and 4-5% urea. Most experiments indicated little improvements in digestibility from increasing the level of ammonia above 3 to 4 percent. However, recommended treating straw with 5% urea as it has produced satisfactory results in Africa and Asia.

1.5.1.2. Sodium hydroxide treatment

Sodium hydroxide (NaOH) treatment of crop residues basically followed the procedure, where NaOH is applied at 3-5 percent and the moisture content is 20-30 percent of DM. Alkali treatment may saponify the ester bonds between lignin and carbohydrates or the phenol acid-carbohydrate complexes in plant cell wall. Through these effects, structural carbohydrates in both lignified and unlignified plant tissues become more digestible, with consequent increases in rate and digestibility.

Advantage- The treatment with NaOH results in increases in crop residue palatability and digestibility, and in animal performance.

Disadvantage- Although NaOH treatment works effectively in improving the nutritive value of crop residues,

- ✓ Expensive
- ✓ Corrosive
- ✓ Its use may result in significant excretion of sodium ions in animal excreta.
- ✓ Long-term accumulation of sodium may lead to soil fertility problems and environmental pollution.

Thus, application of NaOH treatment of crop residues is not popular with the farmers at present.

1.5.1.3. Calcium hydroxide treatment

Since limestone is available cheaply, the use of calcium hydroxide $Ca(OH)_2$ to treat crop residues attracted a great deal of interest. Calcium hydroxide is generally less effective in treating crop residues than other alkaline sources, such as NaOH or NH_3.

Advantage-Cheap availability of Limestone

Disadvantage- less effective

Combining $Ca(OH)_2$ with urea or other alkalis seems to solve this problem. Combining $Ca(OH)_2$ with urea increased the CP content, DM digestibility, DM intake and weight gains of animals.

1.5.1.4. Urea-ammonia treatment

Ammonization is the use of ammonia treat crop residue to improve feeding. The main component of crop residues (straw) is fiber, including cellulose and hemi-cellulose that can be digested by ruminants. Some cellulose and hemi-cellulose are bound to lignin and resistant to microbial attack. The role of ammonization is to destroy this link, so these fractions are available to the animal.

Advantages

- ✓ Ammonization usually increases digestibility by 20 percent.
- ✓ It improves palatability and consumption rate (feed intake).
- ✓ Addition of nitrogen (non-protein nitrogen) to treated residues that increase its crude protein up to 1-2 times.

- ✓ Absence of chemical accumulation in soils (Pollution).
- ✓ Ammonization reduces mould development, destroys weed seeds, parasite eggs and bacteria.

1.5.1.5. Ammonia sources for crop residue treatment

The sources of ammonia to treat straw include anhydrous ammonia, urea, ammonium bicarbonate and aqueous ammonia.

1.5.1.5.1. Anhydrous ammonia

Anhydrous ammonia means "ammonia without water." Its formula is NH_3, and its N content is 28.3%. The normal dosage is 3 percent by weight of the straw DM. It is the most economical source of ammonia. At normal temperature and pressure, anhydrous ammonia is a gas.

Disadvantage

- ✓ Expensive
- ✓ Expensive pressure containers are required not only to keep it as a liquid, but also to transport and store it. Requires expensive equipment and machinery
- ✓ Potentially dangerous and toxic material, and stringent safety precautions need to be observed when using it.
- ✓ Its natural ignition temperature is 651°C. If the ammonia content in the air reaches 20 percent, an explosion from self-ignition could occur. Attention should be paid to possible ammonia explosions, even though it seldom happens.

1.5.1.5.2. Ammonium bicarbonate

The nitrogen content of ammonium bicarbonate is 15-17 percent; its formula is NH_4HCO_3. It can be decomposed into NH_3, CO_2 and H_2O at a suitable temperature (above 60°C).

The chemical reaction is:

$$NH_4HCO_3 \xrightarrow{\text{Heating}} NH_3 / + CO_2 + H_2O$$

The dosage of ammonium bicarbonate, estimated by its N content, is 14-19 percent of straw DM.

Advantages

- ✓ It is available as a major product of the fertilizer industry
- ✓ It is easy to use.

Disadvantage

- ✓ It does not decompose completely at low temperature, thus in cold climates the effectiveness of treatment with ammonium bicarbonate is not good.
- ✓ Less effective

1.5.1.5.3. Aqueous ammonia treatment

Aqueous ammonia is a solution of ammonia in water. The concentration is quite variable, but the usual value is 20 percent. At this concentration, the normal dosage is 12 percent by weight of straw DM. It is only adapted to areas near to fertilizer factories because its low N content makes transport expensive.

1.5.1.6. Urea- molasses treatment

The use of molasses with urea for the treatment of crop residues is a common practice in Ethiopia. Molasses is used to provide energy and improve the palatability of the treated crop residues.

The recommended ratio is 4kg urea: 10kg molasses: 80 -100 lit of water: 100kg of straw/Stover. But the amount of water is determined based on the following factors as:

- Moisture content/dry matter of the straw
- Weather /climatic condition of the environment

1.5.2. Biological Treatment

Biological treatment of fibrous crop residues using fungi to improve nutritive value has a long research-history to find microbes which improve digestibility (by delignification) and increase protein content, whilst minimizing loss of biomass. Recent years, much interest has been forwarded to develop new biotechniques for improving the nutritive value of lingo-cellulose fibrous using biological treatment in solid substrate fermentation (SSF) under non-sterile conditions. The use of fungi and/or their enzymes that metabolize lignocelluloses is a potential biological treatment to improve the nutritional value of straw by selective delignification; it is currently too early to apply this method in developing countries due to the difficulties and lack of technology to produce large quantities of fungi or their enzymes to meet the requirements.

Many species of white-rot fungi which are effective lignin degrader's have been used to assess their ability to improve the nutritive value of fodder for ruminant nutrition. To extract the enzymes from white rot fungi that are responsible for breaking down the bonds in lignin and within the matrix of cell wall carbohydrates, but without also extracting enzymes affecting hemicelluloses and cellulose. Using these enzymes on wheat straw the *in vitro* NDF degradability (IVNDFD) increased.

Effective microorganisms (EM)

Effective microorganism technology has been used in the fields of agriculture and forestry recently. This technology is totally natural and environmentally friendly. A product of this technology includes the photosynthetic lactic acid bacteria, ferments and products that are formed by the metabolism activities of these ferments and bacteria (enzymes, vitamins etc.) This microbiological fertilizer has a positive effect in growing plants; to their development and metabolism. Effective microorganisms (EM) are various blends of common predominantly anaerobic microorganisms in a carbohydrate-rich liquid carrier substrate (molasses nutrient solution) of EM Research Organization. The efficacy of EM on agricultural crops has been studied throughout the world.

Self-Check-1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Reason out why crop residue low in digestibility (4 points)
2. Mention factors that limit utilization of crop residues (3 points)
3. Discuss methods of improving nutritive value of low quality roughage. (4 points)

Note: Satisfactory rating – 7 points   unsatisfactory rating –below 7 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score: ______________

Rating: _____________

Name: ______________________________   Date: __________________

Short Answer Questions:

1. ____
2. ____
3. ____

Information sheet – 2	Selecting appropriate type of treatments

To improve the feeding value of crop residues several treatment systems have been advocated and thrived, often depending on;

- Practical problems
- Cost of the treatment
- Quality of the treated crop residue
- Response of animal fed on treated crop residues

Of the four chemicals (sodium hydroxide, calcium hydroxide, anhydrous ammonia, and urea) most tested as improving agents for crop residues, urea is the best qualified for use in smallholder systems in the tropics.

The reasons to prefer urea ammonia to treat crop residues to improve its feeding value over other methods are:

1. It is usually available as a product (ammonium nitrate) with which farmers are familiar.
2. Sufficient urease to ensure breakdown of urea to ammonia does not appear to be a problem in a warm climate.
3. Urea breaks down the ligno-cellulose bonds of the residue, increasing rate and extent of rumen microbial digestion.
4. It improves the nitrogen status of the residue.
5. It is relatively safe and easy to use.
6. It is easy to transport, if necessary in small quantities.
7. There are no recorded social or cultural reasons (as could be a constraint to widespread use of urine) prohibiting its use.
8. There is no damage to the environment

Self-Check-2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. On what ways improving feeding value of crop residue treatment taken out (4 points)
2. Why urea is prefer to treat crop residue than others (3 points)

Note: Satisfactory rating – 4 points unsatisfactory rating –below 4 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score: ____________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions:

1. ____

2. ____

Information sheet – 3	preparing appropriate ingredients for treatment

To prepare ingredients for the treatment, the following information points should be decided;

- ✓ The type of treatment
- ✓ The concentration of ingredients per unit of crop residues
- ✓ The amount of crop residues to be treated

3.1. Concentration or amount of ingredients per unit crop residues

Optimum dosages (per 100 kg of straw) are:

- ✓ 2 -3 kg for anhydrous ammonia
- ✓ 4 -6 kg for urea
- ✓ 8-12 kg for ammonium bicarbonate
- ✓ 10-14 kg for aqueous ammonia (20% N).

As a rule 4kg to 6 kg (4%-6%) urea for 100kg air dry straw and stover is recommended. 4kg urea (4%) has been found to be the optimum amount for wheat, teff and barley straw; while 5kg (5%) urea for 100kg maize, sorghum and millet stover is optimum. Normally, treating 100 kg air-dry straw requires either 3 kg of anhydrous ammonia, 8-12 kg of ammonium bicarbonate or 11-12 kg of aqueous ammonia (20% N).

3.2. Moisture content of straw

Moisture content of straw is another important factor determining the effectiveness of treatment. Water is mainly necessary in the process to dissolve the urea to react with the ammonia and to act as a medium for reaction. Ammonia combines with water to form ammonium hydroxide (NH_4) OH with the proportions 100 kg straw: 100 kg water: 5 kg urea, gave good results despite the high moisture content.

On the whole, higher moisture content of straw may improve digestibility. Moisture content can reach 50 percent or more, if straw can be transported and stored without becoming mouldy.

A practical ratio of water to straw/stover is 1:1 (one litre or 1kg of water for every 1kg of straw) although slightly less appears to be equally good (8 liter or kg of water for 10 kg of air dry straw or stover. Too much water can causes a wet mass at the bottom of the heap. Using too little water makes the treated straw dry and reduces compaction.

The table shows the concentration of ingredients to be applied per unit of straw/stover that is 100kg air dry straw or stover

Treatment method	Ingredients			
	Amount (kg)	Straw/stover(kg)	Water (kg)	Molasses (kg)
Anhydrous ammonia	2-3	100	20	0
Urea	4-6	100	100	0
Urea-molasses	4-6	100	80	10
Ammonium bicarbonate	8-12	100	30	0
Aqueous ammonia	10-14	100	20	0

Example

1. The recommended urea: water: straw/stover ratio for urea treatment is 4kg urea: 100lt/kg water: 100kg straw/stover. Determine the amount of urea required for 1000kg air dry straw/stover.

   Amount of urea required = $\frac{\text{4kg urea x amount of crop residue to be treated}}{\text{100kg straw/stover}}$

   $= \frac{4 \times 1000}{100} =$ 40kg urea

2. The recommended urea: molasses: water: straw/stover ratio for urea-molasses treatment is 4kg urea: 10kg molasses: 80lt/kg water: 100kg straw/stover. Determine the amount of urea and molasses required.

   Amount of urea required = $\frac{\text{4kg urea x amount of crop residue to be treated}}{\text{100kg straw/stover}}$

   $= \frac{4 \times 1000}{100} =$ 40kg urea

   Amount of molasses required = $\frac{\text{10kg urea x amount of crop residue to be treated}}{\text{100kg straw/stover}}$

   $= \frac{10 \times 1000}{100} =$ 100kg molasses

The required amount of ingredients should be calculated and then prepared for treatment.

Self-Check-3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Water is necessary in the process of urea dissolve. (3 points)

   A. True B. False

2. What is the practical ratio of water to straw? (3 points)

Note: Satisfactory rating – 4 points unsatisfactory rating –below 4 points

You can ask you teacher for the copy of the correct answers

Answer Sheet

Score: ____________

Rating: ____________

Name: _________________________ Date: _______________

Short Answer Questions:

1.____

2.____

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