ARTIFICIAL INSEMIATION

NTQF Level -II

Learning Guide # 18

Unit of Competence: Treat Crop residues for feedstuffs

Module Title: Treating Crop residues for feed stuffs

LG Code: AGR ATI2 M07 0919 LO1-22

TTLM Code: AGR ATI2 TTLM 0919v1

LO1: Determine the type of crop Residues to be treated

Instruction Sheet	Learning Guide # 18

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

- Identifying the types of crop residues
- Determining and preparing the amount of crop residues to be treated

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 –

- identify the types of crop residues
- determine and preparing the amount of crop residues to be treated

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3, Sheet 4, Sheet 5 and Sheet 6.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3” **in page -6, 10 and 12** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1” **in page -13.**
6. Do the “LAP test” **in page – 14** (if you are ready).

Information sheet – 1	Identifying the types of crop residues

1.1. Introduction to crop residues

Crop residues are fibrous materials that are by-products of crop cultivation. Crop residues have low crude protein content in the range of 3–13% of the dry matter. This is a basic limitation in residues such as straw and bagasse with crude protein contents around the border-line level of 6–7% required to create an appropriate rumen environment to promote dry matter digestibility and intake. Most residues are deficient in fermentable energy and minerals. Crop residues have low palatability and digestibility that leads to poor intake, particularly when fed as the sole roughage. The availability of crop residues is closely related to the farming system, the type of crop produced and the intensity of cultivation. Teff, wheat and barley straws are the major residues available in the highlands. Pulse crop residues like chickpeas, haricot beans and lentils are also important. Residues of maize and sorghum form the bulk in the lowlands. The common practice in utilizing crop residues is feeding in the long dry form

In the farming systems of developing countries, animal production is integrated with crop production. However, as the expansion of crop land from time to time, the availability of grazing land decreases thus limiting the scope for increased livestock production. Under such circumstances crop residue play an important role in supplying feed to ruminant animals. Crop residues are fibrous materials that are by-products of crop cultivation of cereals, pulses, oil plants, roots and tubers and represent an important feed resource for smallholder farmers in developing countries. These residues provide fodder at low cost since they are by- products of existing crop production systems. They are important adjuncts to natural pastures and planted forages and are often used to fill feed gaps during periods of acute shortage of other feed resources. On average, crop residues provide 10 to 15 % of the total feed intake and in some

exceptional cases this could increase up to 50 %. The availability of crop residues is closely related to the farming system, the type of crops produced and intensity of cultivation.

The contribution of crop residues to the feed resource base is significant. Under the Ethiopian condition, crop residues provide 40 to 50% of the annual livestock feed requirement. In most central highlands of Ethiopia, crop residues account for 27% of the total annual feed supply during the dry periods.

1.2. Types of crop Residues

Crop residues are the fibrous parts of crops that remain after the parts edible by human beings are removed. These feed resources are used as livestock feeds since time immemorial. In arid and semi-arid tropics where natural pastures are only seasonally available because of the shortage of moisture, crop residues assume great importance in decreasing the level of feed deficit. These fibrous agricultural by-products constitute an important and often the major fed resources available and utilized by smallholder farmers in tropical livestock feeding systems. Depending on the type of crop, crop residues may be left on the field either as grazing for ruminants or as mulch, or they may be transported to the homestead for stall feeding or other alternative uses such as fencing, building and roofing materials or as fuel.

1.2.1. Cereal crop residues

Cereal crop residues usually consist of the above ground part of cereal plants after grain removal. Cereal crop residues includes; wheat straw, barley straw, teff straw, rice straw, maize stover, sorghum stover, millet stover and oat straw. Due to their rigid structure and poor palatability, intake of crop residues is low. These constraints are mostly related to their specific cell wall structure and chemical composition, but there are also deficiencies of nutrients essential to rumen micro-organisms, such as nitrogen, sulphur, phosphorus and cobalt.

1.2.2. Legume crop residues

The haulms of legume crops such as; groundnut, chick pea, pea, soybean and the dried stalk materials of such crops. Legume straws or haulms possess a higher feeding value than cereal crop residues.

1.2.3. Other residues

There are other roughage feeds available at specific locations such as; the waste materials from oil palm processing plants, cotton waste, sisal waste, pineapple waste, cocoa pods, coffee hulls, etc. The feeding value of these materials varies, but it is usually low. Sugar beet tops and residues can be an important by-product from agricultural production. The energy content could balance the hay silage feeding (with high content of protein). Often, these residues can be obtained from sugar factories.

Various crop residues have their own nutritional values and are used for different animal species. Sweet potato vines and peanut hay are relatively rich in protein, available energy and vitamins, and are mainly fed to pigs in most rural areas. Wheat straw and rice straw have high contents of cell walls, and are basically used for feeding ruminants. Millet straw and soybean straw, in contrast, are fairly palatable for herbivores, and are mostly used as feed sources for horses, donkeys, mules and rabbits.

1.3. Selecting crop residues for treatment

The utilization of crop residues particularly cereal straw and stover for livestock feeding is constrained by its physical nature and nutritional characteristics. Cereal crop residues includes; wheat straw, barley straw, teff straw, rice straw, maize stover, sorghum stover, millet stover and oat straw. Due to their rigid structure and poor palatability, intake of crop residues is low. These constraints are mostly related to their specific cell wall structure and chemical composition, but there are also deficiencies of nutrients essential to ruminal micro-organisms, such as nitrogen, sulphur, phosphorus and cobalt. Feeding value of cereal straw and Stover is limited by its poor voluntary intake, low digestibility and low nitrogen, mineral and vitamin content. Various strategies such as supplementing crop residues with agro-industrial by-products and/or improving quality of the residues through treatment such as physical and chemical (alkali) treatment were identified to be of considerable advantage in improving the feeding value of these fibrous feeds.

Self-Check-1	Written Test

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

1. List crop residue that available in highland (3 points)
2. Mention types of crop residues (3 points)
3. Discuss crop residues that categorized under cereal. (4 points)

Note: Satisfactory rating – 6 points unsatisfactory rating –below 6 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	Determining and preparing the amount of crop residues to be treated

2.1. Determining the amount of crop residue to be treated

The amount of crop residues to be treated depends on:

- The number of animals
- The daily crop residue intake /consumption/ by the animals
- The duration of feeding period /Number of days/

As a rough estimate it can be said that animal's daily straw intake is 2 to 3 percent of live weight (2% to 3% body weight). Maximum of 3 kg of straw for every 100 kg body weight (3% of body weight=3% BW).

So the amount of straw needed to treat for one animal is:

Amount to treat= No. of days x Daily straw intake (% LBW) x LBW of the animal

For more than one animal it is calculated as:

Amount to treat= No. of days x Daily straw intake (% BW) x total LBW of the animals

Example: 1- In the farm there are 10 cows, 8 heifers, and 2 bulls.

Cow										**Heifer**								**Bull**	
1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	1	2
400	360	460	500	380	420	490	550	440	450	320	300	360	290	350	310	240	200	330	600

Determine the amount of crop residues to be treated to feed the animals for 4 weeks taking maximum straw intake of 3% LBW for the above animals listed in the table.

Amount to be treated = 28 days x 0.03 x total weight of the animals

= 28 x 0.03 x 7,750 kg

= **6510 kg** of DM needs to be treated

Example; 2- in the farm there are 8 cows, 6 heifers, 2 bulls and 4 sheep. Determine the amount of crop residue to be treated to fed the animals for 4 weeks taking maximum straw intake of 3% BW. The body weight of the animals in kg is shown in the table below.

Cow								**Heifer**						**Bull**		**Sheep**			
1	2	3	4	5	6	7	8	1	2	3	4	5	6	1	2	1	2	3	4
450	500	350	435	384	425	550	410	210	245	300	265	240	340	560	400	40	35	55	64

Amount to treat = 28 days x 0.03 x total weight of the animals

= 28 x 0.03 x 6258 kg

= 5256.72 kg of DM need to be treated

2.2. Materials and Equipment's required

1. Crop residues
2. Measuring balance
3. Bridge or suspended balance (to measure the animals)
4. Heart girth tape (incase bridge balance is not available use heart girth tape to measure body weight of the animals)
5. Chopper (manual or mechanical chopper)
6. Calculators
7. Note book

2.3. Preparing crop residues for treatment

- The baled or collected and stacked crop residues should be chopped into pieces to about 2-10 cm long.

- The general principle is that thick and hard crop residues, such as maize and sorghum Stover, should be cut shorter, while soft materials such as teff, wheat and barley straw may be a little bit longer.

Chopping before treatment

- Facilitates easy feeding
- Saves plastic (packaging material)
- Easy for compaction during treatment
- Reduces the danger of puncturing the plastic (packaging material)

Self-Check-2	Written Test

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

1. List on what amount of crop residue to be treated depends (3 points)
2. Determine the amount of crop residues to be treated to feed the animals for 4 weeks taking maximum straw intake of 3% LBW for the below animals listed in the table (4 points)

Example: - In the farm there are 10 cows, 8 heifers, and 2 bulls.

Cow										**Heifer**								**Bull**	
1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	1	2
500	460	460	500	380	420	490	550	440	450	320	300	360	390	350	310	240	200	330	600

.

3. List materials and equipment that required for crop residue treatment (4 points)
4. What are the advantages of chopping before treatment? (5 points)

Note: Satisfactory rating – 10 points unsatisfactory rating –below 10 points

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

Information sheet – 3	Selecting, maintaining and using Suitable PPE

Appropriate personal protective clothing and equipment should be selected and used in order to avoid the hazards and risks. The important personal protective clothing and equipment used during crop residue treatments include:

- ✓ Overall
- ✓ Plastic Boots
- ✓ Plastic or leather gloves
- ✓ Respirator
- ✓ Safety goggle

Self-Check-3	Written Test

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

1. List PPE that used for crop residue (6 points)

Note: Satisfactory rating – 3 points unsatisfactory rating –below 3 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. _____

Operation sheet -1	Procedures in treating crop residue

Techniques to select and prepare crop residue treatment as follows:-

Step 1: Identify and prepare crop residue for treatment

Step 2: Identify animals to be fed

Step 3: weigh animals

Step 4: calculate weight of crop residue to be treated

Step 5: Identify materials required for treatment

Step 6: carryout crop residue treatment

Step 7: Feed to livestock depending animal species

LAP Test	Practical Demonstration

Task. Carryout treatment of cereal crop residue

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ARTIFICIAL INSEMIATION

NTQF Level -II

Learning Guide # 19

Unit of Competence: Treat Crop residues for feedstuffs

Module Title: Treating Crop residues for feedstuffs

LG Code: AGR ATI2 M07 0919 LO2-19

TTLM Code: AGR ATI2 TTLM 0919v1

LO2: Determine the method of Treatment

Instruction Sheet	Learning Guide # 19

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, Sheet 3, Sheet 4, Sheet 5 and Sheet 6.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3” **in page -29, 31, 34,** 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 (SSF) 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 crop residue 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 crop residue treatment

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

1.4.2. 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.

1.4.2.1. 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.

1.4.2.1.1. 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%

1.4.2.1.2. 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.

1.4.2.2. 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.

1.4.2.3. 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.

1.4.2.4. 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.

1.4.2.5. Ammonia sources for crop residue treatment

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

1.4.2.5.1. 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.

1.4.2.5.2. 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:

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

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

1.4.2.5.3. 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.

1.4.2.6. 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

1.4.3. 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.

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. _____
3. _____

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.

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

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

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.

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

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

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

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

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. _____
3. _____

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ARTIFICIAL INSEMIATION

NTQF Level -II

Learning Guide # 20

Unit of Competence: Treat Crop residues for feedstuffs

Module Title: Treating Crop residues for feedstuffs

LG Code: AGR ATI2 M07 0919 LO3-LG-20

TTLM Code: AGR ATI2 TTLM 0919v1

LO3: Prepare appropriate packing material for treatment

Instruction Sheet	Learning Guide # 20

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

- ✓ Determining type of packing materials and equipment
- ✓ Preparing packing materials and equipment

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 –

- ✓ determine type of packing materials and equipment
- ✓ prepare packing materials and equipment

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 and Sheet 2.
4. Accomplish the “Self-check 1 and Self-check t 2” **in page -44 and 47, respectively**.

Information sheet – 1	Determining type of packing materials and equipment

The treatment needs time for reaction. Therefore the straw has to be stored during treatment. The storage should be airtight. If airtight condition is not maintained ammonia (NH_3) will escape and the occurrence of mould will increase and the treated straw will be poor quality. Until now recommendation is to keep or store the straw completely airtight. It should be made clear that any system which is airtight will suffice. There are different storage systems which can be stalk on the ground, pit on the ground or pit/bunker in the ground.

1.1. Stack method

This type of storage method implies a pile of crop residues on the ground surface. On flat and dry ground, plastic sheet is placed underneath and the crop residue is laid in a stack. The top is covered with plastic and sealed all round with soil. Sandbags, or any other suitable objects, are placed on top to prevent the top cover from being blown away by the wind.

Advantages of this method

- ✓ Low cost and flexibility of placement
- ✓ Easy to load and unload
- ✓ Stronger walls are required in case a pit is constructed

Disadvantages of this method

- ✓ Ammonia may leak through small opening that reduces straw quality.
- ✓ Easy damage of the plastic sheet by sunlight, not durable
- ✓ Only suitable for anhydrous ammonia treatment of crop residue

1.2. Pit/bunker method

This storage method involves storing the treated crop residue above or in the ground by building walls.

1.2.1. Tower (above ground) silo

Tower silos are constructed from brick, and are several meters in diameter and 10-20 m in height. The advantages of this type of silo include: long life, small space required, low storage losses, and possibility for mechanization. Both the filling operation and daily extraction can be mechanized. However, tower silos are expensive.

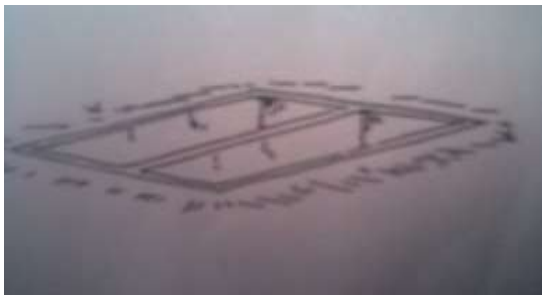
1.2.2. Cellar silo

The cellar type is the most common silo on individual farms. Round or square concrete silos are usually built inside houses for protection from the weather. Advantages are lower cost and easy management. Size can be adjusted according to scale of production. A disadvantage is high effluent loss, especially with clay walls.

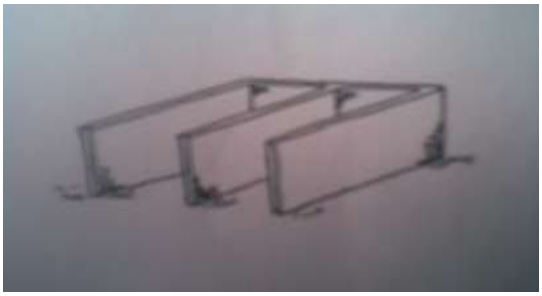
1.2.3. Trench/ bunker silo

This type is generally built underground or semi-underground, with two solid walls of 1.5-2 m in height. Advantages are similar to the cellar silo, but the trench silo is more suitable for mechanization. The tractor can be driven on top from one side to the other for compaction purposes. After compaction, it is covered with a plastic sheet pressed down with soil, sandbags or straw bales to maintain anaerobic conditions.

On many dairy farms, trench silos are built on the surface of ground. This type of silo has vertical walls of 0.4-0.5 m in thickness and 3-4 m in height. This design makes mechanization more convenient, and may also prevent bottom leakage.



Pit in the ground



pit on the ground

Advantages

- ✓ Pit or bunkers are easy to manage and avoid rodent damage to plastic films.
- ✓ Silos or bunkers constructed with cement are the best, since they save on plastic (only one sheet is needed, to cover) and minimize repairs.
- ✓ Once a silo or bunker is constructed, it can be used for several years. In addition, the
- ✓ Pit or bunker facilitates the estimation of straw weight.

Disadvantages

- ✓ Difficult to load and unload
- ✓ Water may collect inside
- ✓ Especially in sand soils the wall tends to cave in, making the straw dirty.

N.B: The treated crop residue needs to be properly packaged and stored. In both stack and pit/bunker storage methods plastic film is required to cover the crop residue stack or to line the bottom and walls in case of pit/bunker method. Therefore, the amount of packaging materials required needed should be calculated before treatment.

1.3. Determine the size and amount of plastic film for stack method

1.3.1. Measurement of the stack density

Weighing the stack is a basic task for straw treatment. It is well known that it is important to use the correct amount of ammonia gas or urea: too little ammonia is ineffective; too much ammonia increases the cost and has no further effect on treatment. The exact weight of straw must be known so that the correct amount of ammonia can be applied. But weighing is difficult under field conditions. A simple method is to first measure the average density of stack for various straws, then to multiply it by its volume. Stack density depends upon plant species, moisture content and particle size. Of course, density also varies with time. In order to get reliable data, it is necessary to measure many stacks (at least 8 for each straw type). Density is expressed in kg/m^3.

In old stacks, volume is measured first, and then it is weighed. New stacks are weighed before stacking and volume measured after. It is very easy to calculate the volume of rectangular and cylinder stacks. The volume of stack with irregular shape may only be estimated.

General guidelines in determining of crop residue stack density

The average density of air dry teff, barley and wheat straw ranges **55 and 79 kg/m^3** for new and old whole straw respectively. The average density of air dry maize and sorghum stover ranges **79 and 100 kg/m^3** for new and old, whole stover, respectively.

For chopped crop residue average density is 100kg/m^3

Based on these guidelines the volume of a given weight of straw/stover could be determined, so that the amount of plastic film required could be calculated. However, if the crop residues is chopped the density increases, that is the amount of crop residue increases as compared to un-chopped straw/ stover.

Example: based on the above general guidelines calculate the average volume of

1000kg new stack of wheat straw

1000kg old stack of wheat straw

1000kg new stack of maize stover

1000kg old stack of maize stover

1000kg chopped crop residue

Answers – use the formula Density= mass/volume

The average volume of 1000kg new stack of wheat straw = 1000kg/55kg/m^3= 18.2 m^3

The average volume of 1000kg old stack of wheat straw = 1000kg/79kg/m^3= 12.7 m^3

The average volume of 1000kg new stack of maize stover = 1000kg/79kg/m^3= 12.7 m^3

The average volume of 1000kg old stack of maize stover = 1000kg/100kg/m^3= 10 m^3

The average volume of 1000kg chopped crop residue = 1000kg/100kg/m^3= 10 m^3

The amount of film required can be calculated by the size of stack.

Size of bottom sheet: Length = Length of stack + (0.5-0.7) m (overlap)

Width = Width of stack + (0.5-0.7) m

Size of covering sheet: Length = Length of stack + height x 2 + (0.5-0.7) m

Width = Width of stack + height x 2 + (0.5-0.7) m

1.3.2. Determining Size of pit or bunker

To determine size of pit or bunker to build depend on; density of straw, animal type (daily straw intake 2 to 3 percent of live weight (2 to 3% body weight), number of animals and number of days. Generally it should be known how much straw (air dried) can be placed per m^3 of bunker; how much ammoniated straw an animal requires per day.

Straw density- Average weight of air-dried and chopped crop residue (wheat, teff, barley and maize) is about 100 kg per m^3, but could range 70-110 kg (air-dry: straw per m^3. It will be low when the straw is very crisp and dry and higher when the straw is moister (chopping can again increase the density. Once the volume required is known the dimensions of pits are governed by width of the polythene and the reasonable height.

Example: if 1000kg of chopped crop residue is required to treat, the volume of the pit/bunker is calculated as: Volume = Weight/Density = 1000kg/100kg/m^3 = 10m^3

Therefore, to treat 1000kg crop residue 10m^3 pit need to be dig out. This means that pit of 1m length, 1m width and 1m high is adequate to treat 100kg crop residue.

1.3.2.1. Recommended pit/bunker dimensions

The height or depth of the pit should not be more that 1.5 m high or deep.

The width of the pit should not be more than 3m wide

The length of the pit depend on the amount of crop residue to be treated, however it should not be more than 15m long.

The following table shows the dimensions of pits, there volumes and the amount of crop residue to be treated.

Length	Width	Height	Volume	Quantity to be treated
4.4ft	3ft	3ft	$40ft^3$	100 kg straw
1.25m	0.9m	0.9m	$1m^3$	100kg straw
11.7m	3m	1.5m	$52.56m^3$	5256kg straw

Self-Check-1	Written Test

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

1. List storage systems of treated crop residue (3 points)
2. Mention advantages of stack method in storing crop residues (3 points)

Note: Satisfactory rating – 3 points unsatisfactory rating –below 3 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	Preparing packing materials and equipment

Materials, equipment's and tools required for the urea ammonia treatment of crop residues are listed below. The amount of materials depends on the amount and type of crop residues, type of treatment pit or packaging materials.

1.1. Materials

- ✓ Urea
- ✓ Water
- ✓ Polyethylene plastic sheet
- ✓ Molasses
- ✓ Crop residue (cereal straw or stover)

1.2. Tools and equipment's

- ✓ **Suspended measuring balance**- to measure urea, water and crop residues.
- ✓ **Bucket**– to contain urea, urea and water
- ✓ **Barrel or open container**- to contain urea solution
- ✓ **Wooden stick**- to stir and dissolve urea in water
- ✓ **Watering can**- to sprinkle urea solution on the crop residue
- ✓ **Machete or chopper**- to chop the crop residue to the required size
- ✓ **Spade**
- ✓ **Pick axe**
- ✓ **Wheel barrow**
- ✓ **Sacks**

To prepare the packaging materials and storage of crop residue follow the following steps:

Stack method

- ✓ Determine the amount of crop residue to be treated
- ✓ Determine the volume of crop residue to be treated

- ✓ Measure the width of the plastic film (sheet)
- ✓ Select elevated flat area and clear it from vegetation
- ✓ Cover the area with the plastic sheet

Pit/bunker method

- ✓ Determine the amount of crop residue to be treated
- ✓ Determine the volume of crop residue to be treated
- ✓ Measure the width of the plastic film (sheet)
- ✓ Decide the height or depth of the pit
- ✓ Calculate the length of the pit
- ✓ Select elevated flat area and clear it from vegetation
- ✓ Measure the length and width of the required size, and mark it
- ✓ Start digging the ground and make a pit or bunker
- ✓ After reaching the required depth or height
- ✓ Level the bottom and cover the bottom and walls with plastic sheet
- ✓ Now the pit/bunker is ready for treatment

Self-Check-2	Written Test

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

1. What is the advantage of wooden stick in crop residue treatment? (3 points)
2. Mention tools and equipment's in crop residue treatment(3 points)

Note: Satisfactory rating – 3 points unsatisfactory rating –below 3 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. _____

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Animal Production

Level II

Learning Guide # 21

Unit of Competence: Assist Crop Residues Treatment

Module Title: Assisting Crop Residues Treatment

LG Code: AGR APR2 M15 0919 LO1- 21

TTLM Code: AGR APR2 TTLM 0919V1

LO4: Complete treatment and store

Instruction Sheet	Learning Guide # 21

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

- ✓ performing treatment of the crop residue
- ✓ Maintaining a clean and safe working area
- ✓ Storing the treated crop residue
- ✓ Determining targeted animals to be fed according to treatment types

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 –

- ✓ perform treatment of the crop residue
- ✓ maintain a clean and safe working area
- ✓ store the treated crop residue
- ✓ determine targeted animals to be fed according to treatment types

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3, Self-check 4, Self-check 5 and Self-check 6” **in page -53, 56, 57, 61** respectively.
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1” **in page -62-64.**
6. Do the “LAP test” **in page – 65** (if you are ready).

Information sheet – 1	Performing treatment of the crop residue

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 straw. The level of urea used varies, but it is commonly between 4 - 5% of air dried 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 treated straw can be stored in various ways. However, airtight storage produces the best result. The treatment of the straw can be done in pits, 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. Treatment time and temperature are inversely correlated and more time is required in colder climate. Once treated and if properly covered to preserve anaerobic conditions, the urea-ensiled material can be stored for several months. The pit shouldn't be opened before it is necessary to use the treated feed.

Table. Time required for urea treatment of crop residues over different temperature ranges

Temperature (^{0}C)	Treatment time
<5	> 8 weeks
5-15	4-8 weeks
15-30	1-4 weeks
>30	<1 week
>90	< 1 day

Procedures of crop residue treatment

1. Determine the amount of crop residues to be treated. This depends on:

- ✓ The type and number of animals
- ✓ Daily crop residue intake of animals
- ✓ Body weight of the animal/s
- ✓ Duration of feeding period

2. Prepare crop residues for treatment. This includes chopping the residues into pieces to about 2-10 cm long.
3. Determine the amount and size of packaging material requirement
4. Determine the amount of ingredients and prepare for crop residue treatment

   The standard procedure in the urea treatment is to use:

   - ✓ 4% urea (4Kg urea/100 kg straw)
   - ✓ Maximum of 1:1 = water: straw ratio
   - ✓ A treatment duration= Minimum 14 days and maximum 28 days

The standard procedure in the urea-molasses treatment is to use:

- ✓ 4% urea (4Kg urea/100 kg straw)
- ✓ Urea: molasses: water ratio= 4kg urea: 10kg molasses: 80kg water
- ✓ A treatment duration= Minimum 14 days and maximum 28 days

5. Properly stack or store the treated crop residue

Self-Check-1	Written Test

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

1. Discuss the difference between straw and stover (3 points)
2. What is the relationship between temperature and time for treatment of cop residue? (3 points)

Note: Satisfactory rating – 3 points unsatisfactory rating –below 3 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	Maintaining a clean and safe working area

1.1. Cleaning and maintaining working area

Effective workplace housekeeping can help get the job done safely and properly. Workplace housekeeping includes keeping the work area neat and tidy, keeping slip and trip hazards off of the travel area, removing fire hazards from the work area and maintenance of buildings, equipment and vehicles.

A good workplace housekeeping system will provide for proper inspection, maintenance, upkeep and repair of tools, equipment, machines and processes. Tasks and the equipment required to carry them out should also be set up in a fashion that minimizes the number of times items have to be handled.

Common Hazards

Poor workplace housekeeping can often lead to workplace injuries from:

- ✓ Being hit by falling objects
- ✓ Tripping over objects on the floor, stairs and platforms
- ✓ Slipping on wet, greasy, dirty or icy surfaces
- ✓ Hitting projecting items and stacked materials
- ✓ Cutting, puncturing or tearing the skin on projecting nails, wire, etc.

Safe Procedure

- ✓ Flammable, combustible, toxic and other hazardous materials should be stored in approved containers in designated areas.
- ✓ Materials are to be stored in a safe and orderly manner. If materials are to be piled ensure that the stacking (height, placement) doesn't render the pile unstable.
- ✓ Waste should be regularly collected and disposed of in an approved manner. Place clearly labeled containers in suitable locations for the easy collection of recyclable materials and wastes.
- ✓ Clean spills as they happen and properly dispose of any absorbent material immediately.

- ✓ Replace or fix broken or damaged items at the earliest opportunity.
- ✓ Keep areas well lit and replace or clean light fixtures as required.
- ✓ All tools should be returned to the designated storage area after use. Do not place any tool or object where it may pose a hazard.
- ✓ Where practical, provide/use mechanical appliances for carrying materials and supplies.
- ✓ Keeping the work site tidy, wearing the proper footwear and working at the appropriate pace are all critical for preventing any injuries in workplace and making the area safe.

Self-Check-2	Written Test

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

1. List common hazards that occur at poor workplace housekeeping (5 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. _____
3. _____

Information sheet – 3	Storing the treated crop residue

After treatment the treated crop residue has to be stored properly. It has to be protected from flood. Selecting treated crop residue storage method

In the selection of crop residue storage and packaging materials the advantages and disadvantages of each method should be considered.

- ✓ If durable and long lasting storage method that can be used for several years, the pit/bunker with concrete walls should be constructed. However, it is expensive.
- ✓ Less expensive but that can last longer can be constructed by digging the pit and covering the walls with plastic sheet.

Selection of plastic film/sheet

The basic requirements for plastic film are that it is non-toxic, durable and suitable for sealing. The plastic often used is polyethylene.

Thickness, width and colour of polyethylene plastic sheet are determined by practical situations.

- ✓ Thick film (about 0.12 mm) is used for maize and sorghum stover; thin film (less than 0.12 mm) for barley, teff and wheat straw.
- ✓ Width of film is determined by the size of stack and market availability.

Color of plastic sheet- If used in the open air, black colour should be preferred, because it is durable and absorbs solar energy, which heats the stack and shortens treatment time. If used indoors, film colour has no obvious influence on treatment, sunlight, rainfall, contaminated substances/any foreign bodies.

Self-Check-3	Written Test

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

1. By what problems stored treated crop residue may be affected? (3 points)
2. Mention advantages of plastic film or sheet in sealing treated crop residues (3 points)
3. Why black color of plastic sheet is selected at open air in crop residue treatment? (4 points)

Note: Satisfactory rating – 6 points unsatisfactory rating –below 6 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 – 4	Determining targeted animals to be fed according to treatment types

4.1. Quality evaluation of urea treated crop residues

There are three methods to evaluate quality of ammoniated straw: sensory evaluation, chemical analysis and biological tests.

Sensory evaluation

Properly ammoniated straw is soft, brownish yellow or light brown, and with a light fragrance after excess ammonia has evaporated. If straw appears white or grey and is sticky or clumps, it means that it has been attacked by mould. This damaged straw should not be used as feed. Of course, this situation seldom occurs if treatment is correct. Mould normally results from high moisture content, defective sealing or delayed ventilation after opening. If, after ammoniation, straw colour is nearly the same as before treatment, it means that ammoniation did not go very well, but it can still be used as feed.

Chemical analysis

By chemical analysis, the components of straw such as fiber component (NDF and ADF) and crude protein (CP) can be measured, but by itself it cannot give an estimate of overall nutritive value and animal intake.

Biological evaluation

The most reliable method of evaluation of straw quality is through biological tests such as feeding the treated straw and measurement of digestibility, feed intake animal performance.

4.2. Incidence of Fungi or moulds development

Sometimes fungi or moulds will develop in the heap. This is mainly due to poor compaction; too much water or an initial poor straw quality the pattern of occurrence is not always predictable. Incidence of mould increases when the duration of treatment extends Better sealing and compaction certainly reduces the incidence of moulds of different kind occur both in too moist

and too dry heaps. The moulds of different kind occur both in too moist and too dry heaps. The moulds can have either beneficial or negative effects. Generally speaking one should avoid feeding moldy straw.

4.3. Feeding treated crop residue

Aeration

After opening the pit of ammonia treated straw, the treated crop residue has a strong smell of ammonia. This strong smell of ammonia reduces the appetite of the animal therefore it should be aerated for a time before feeding.

Class of animals that treated crop residues can be feed

Ammoniated cereal straws and stover can be offered to beef cattle, heifers, sheep (ram and ewe), goats (bucks and does), and lactating cows as sole roughage or as large proportion of the diet. However, do not feed urea treated crop residue to young calves, lambs, kids, pregnant cows that are at the last stage of pregnancy (7 months pregnancy). And also do not fed urea treated crop residue to monogastric animals such as poultry (chicken), swine (pigs).

Supplementation

In addition to treated crop residues animals should be supplemented with grass, tree levees and concentrate to improve the productivity of the animals. Basically the treated straw should be fed and considered as medium quality grass. Feeding of minerals is necessary. The constant supply of plenty of clean drinking water and common salt should be given.

Self-Check-4	Written Test

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

1. List methods of evaluation quality treated crop residues (3 points)
2. Why molds or fungi develop in the heap of crop residues? (3 points)
3. List animals that do not allowed to feed urea treated crop residues. (5 points)

Note: Satisfactory rating – 6 points unsatisfactory rating –below 6 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. _____

Operation sheet -1	Procedures in performing crop residue treatment

Steps **Procedures**

Step- 1 **Pit/bunker method-**Build the pit, cover the floor and sides of the pit with plastic sheet

Stalk method- Select an area with an elevated, dry and even surface, then covered it with plastic sheet.

Step -2 Weight the crop residue using weighing scale

Step -3 Spread the chopped crop residue on the floor

Step -4 Fill water can with water

Step -5 Measure and take urea, pour in to water container

Step -6 Mix the urea and the water thoroughly using wooden stirrer to make urea solution

Step -7 Sprinkle the urea solution on the crop residues and then thoroughly mix the solution and the straw/stover

Step- 8 Compact the straw/stover by trampling with your foot to remove air as much as possible

Step -9 Repeat step 2, 3, 4, 5, 6, 7, and 8 until enough straw has been treated to suite the requirement

Step- 10 **Pit/bunker method** - Cover the pit with polyethylene sheet and load it with stones, woods or soil to prevent ammonia escaping

Stalk method- Seal the top and the sides by rolling them with the bottom plastic sheet to prevent ammonia escaping

LAP Test	Practical demonstration

Task. Perform crop residue treatment

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