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Conservation of fodder in the form of : Hay

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India is basically an agrarian country with large livestock population making dairy and livestock industry an important subsidiary occupation of farmers. It contributes to the economy of the country by providing milk, meat and wool. India has recently emerged as largest producer of milk in the world but livestock productivity is very low as compared to the developed countries. Low productivity of the animals is ascribed chiefly due to inadequate supply of nutrients. Both quantitatively and qualitatively, there exists a huge gap in availability and supply of feed nutrients which is further compounded during lean and scarcity period (Singh and Majumdar, 1992). Poor supply of nutrients to livestock during scarcity period is a matter of concern. So, there is urgent need for preservation of nutrients from forages including fodder tree leaves available during the flush period for feeding livestock during lean period (Mahanta and Pauchauri, 2005). Successful animal production requires an adequate supply of nutrients throughout the year. The nutrients from forages can be preserved either as silage, hay or high temperature dehydration. Forage can be profitably preserved either as silage or hay for providing nutrients during scarcity.

Preservation of fodder in the form of hay: *HAY*: Hay refers to forage that are harvested and dried and stored as 85-90 per cent dry matter. Hay is a leafy dry fodder, green in colour and free from moulds. It should contain less than 15 per cent moisture.

Principles of hay making : The principle of hay making is to preserved nutritional value of forages through drying it to a level at which the activity of microbial decomposers is inhibited. Forage can be harvested at the stage of proper nutritive value and be preserved as hay for feeding it during lean period. A moisture content of 10-12 per cent is optimum level for halting the microbial activity (Jones and Harris, 1980).

Suitable crops for making hay: Crops with thin stems and more leaves are better suited for hay making as they dry faster than those with thick stem and small leaves.

Procedure of hay making: Good quality hay is prepared by adopting the following procedure.

– The quality of the hay is directly related to the stage of the growth of the fodder species, the leaf-stem ratio and the moisture content. Thus, the fodder crops, namely cowpea, velvet bean, *Guar*, *Moth*, *Jowar*, *Bajra*, Sudan grass, teosinte and oats, should be cut for hay-making at the flowering stage. Pasture and the cultivated grasses are cut at 50 per cent blossoming or slightly earlier to prevent the lignification of the cellulose, losses of protein, energy and palatability which are caused owing to the advancement of plant growth. Lucerne and *Berseem* are cut for hay-making at 30-40 days intervals.

– The fodder crops should not be harvested immediately after irrigation. They should rather be harvested in the afternoon and before applying irrigation, so that they have less moisture and more of dry matter. They will also take less time to dry.

– Though the fodder species may be dried as such, yet the best-quality hay is made by chaffing the species into small pieces with a hand-driven chaffing machine or with a power-driven chaff-cutter. The chaffed material is spread evenly in thin layers and is turned two or three times daily. In the evening, the half-dried material is raked and collected in the form of a cone so as to prevent the

exposure of the material to dew-fall at night. On the second day, the material is again spread evenly after the dew as disappeared. The material is turned frequently, depending upon the climatic conditions, namely, the degree of sunshine, the wind velocity, and humidity. In the case of lucerne, *Berseem* and cowpea, the leaves are very brittle and fall down quickly.

– The hay made by adopting the above steps, and possessing about 15 per cent moisture is finally transported to the hay-barn. It should retain the green colour, good aroma and flavour. It should preferably be stored at a low temperature and humidity so as to prevent losses owing to the oxidation of the carbohydrates. The losses may be as high as 40-50 per cent if not stored properly.

Factors affecting hay quality:

– Stages of maturity at harvest
– Leafiness or leaf stem ratio
– Colour
– Foreign materials
– Odour and conditions.

Stages of maturity at harvest: Younger the plant better in quality. As plant mature, their lignin content (a component of fibre) increases and traps nutrients within indigestible cell walls. Leguminous fodder crops (e.g. cowpea, *Berseem* and lucerne, etc.) should be harvested as the flower initiation stages, while grasses (e.g. oat) and similar fodder crops should be harvested at the pre-flowering stage. At this stage, the crop has maximum nutrients and green matter. After flowering and seeding, grasses contain fewer nutrients.

Leafiness or leaf stem ratio: Leafiness is an excellent indicator of hay quality. This refers to the ratio of leaves to stems present and is also related to the stage of maturity. As a grass matures, stems increases, thus, decreasing the quality of forages. Leafiness in legumes is particularly critical because legumes loose their leaves during curing and handling more readily than grasses. Leaves contain more amount of carbohydrate, protein vitamin and minerals than the other part of plant. Hence, preserve leafiness, hay must be cut early and carefully cured and handled.

Colour: Colour can be definitive characteristics of hay. The desirable hay colour is the bright green. Green hay is rich in carotene, whereas straw coloured or brown hay is poor in carotene. Different colour of hay indicate its quality :

Golden yellow colour hay: Sun bleached hay is light golden yellow in colour. Sun bleaching reduces palatability and carotene content. The amount of carotene in hay is directly proportionally to its degree of greenness.

Yellow coloured hay: Yellowing of the plants indicates over matured when cut.

Dark brown coloured: Hay that has been exposed to rain or to heavy dews or fog has a characteristics dark brown or black appearance. Avoiding rain damage is a goal in haymaking.

Brown coloured hay/heat damaged hay: Brown hay indicates heating from microbial (mold) growth and fermentation. This results when the hay is stored at too high moisture content. This hay has a distinctive musty, mouldy, odour. Moulds consume nutrients in the hay, particularly sugars and starches and producing carbondioxide and water.

Foreign material in the hay: Foreign materials in hay can be divided into injurious and non-injurious categories. Injurious foreign material is material that will harm the animal if eaten. This includes poisonous plant and matter such as wire or nails. Non-injurious foreign material includes weeds, stubbles, chaff and sticks.

Smell: The smell of new mowen hay is the standard by which hay odor is judged. A fresh aroma, freedom from mold and relatively high carotene content add to its palatability and feed value. Hay should be free from dust, mold, insect and disease damaged.

Characteristics of good quality hay:

– Hay should be nutritious, therefore, prepared form plants cut at an appropriate stages of maturity when it has the maximum when it has the maximum nutrients.

– Good hay should be leafy. The leaves are generally richer in proteins, minerals and vitamins then other plant of the plant.

– Hay should be green in colour. The green colour indicates the amount of carotene which is precursor of vitamin A.

– Hay should be soft and pliable.

– Hay should be free from weeds and stubbles.

– The moisture content in hay shouldn't exceed 15 per cent.

– It should have the smell of and aroma of characteristics of the crop from which it is made.

Methods of hay making: There are several methods that are used in hay making:

Artificial dehydration (Methods): Forage artificially dried by using large capacity dehydrators. Technique consists passing the green fodder through a revolving tubular structure at a very high temperature and gradually coming down to a lower final temperature at the outlet in 3-5 minutes. Subsequently it is compressed in the form of wafers or pellets of desired size. Loss of nutrients is least.

An economically viable unit will need about 8000 tonnes of green forage in 8 months of a year.

Drying in fields: Cut at proper stage, dried in the same field where it is grown. Frequent turnings required according to sunrays, then after dried forage is collected or bundle making is done. Major disadvantages of this method are loss of colour, quality (leaves are lost and carotene also), if rain occurs whole forage may spoil.

Wooden structures/Tripod stand: Structures are made by using bamboo sticks in hut shape, many structures are made in lines. Cut forages are dried in fields for 3-4 days for wilting, then spread over on tripods in thin layer and dried hay should contain 15 per cent moisture. During winters, cover forage material in night hours and if rains, it should be kept in shape. This method results in better quality hay than field method and gives 10 per cent more hay than field drying.

Hissar method: Forages are cut using fodder cutting machine then sun dried on threshing floor. Major advantages are that it takes less time, less loss of leaves and good quality. The disadvantages are that, this method is more expensive than others. Moreover, juicy forages may turn black and not preferred by the animals. In this method, length of forage is kept 4-5 cm and the crops like *Jowar, Bajra* can also be used.

Hay making shed: In this method, first of all field drying (40-50% dry matter) is done then air is blown through heated/unheated devices and within 2-4 days process is over. Method is used in western countries, sophisticated and costly.

Gable shaped structure of hay making: A gable shaped structure has been developed at IGFRI for efficient and economical method of making good quality hay. Galvanised woven wire fencing material (width 120 cm, diameter of wire 2.4 mm, mesh size 33 x 14 cm) are utilized for the purpose. Several rows of angle iron poles (height 115 cm, consecutive poles 350 cm apart, rows of poles 350 cm apart) are erected on the ground. Two rolls of wire fencing material are spread along each row of posts. Wires are fixed at ground by wooden pegs. This method is better than others though need more expenses.

Nutrient losses during hay making : The field loss during haymaking includes:

– Respiration losses
– Leaching losses
– Shattering losses
– Bleaching losses
– Storage losses

Respiration losses: Even after harvesting, plant cells alive and functioning the moisture content falls below 35-40 per cent. Sugar are the primary plant carbohydrates lost during storage respiration. Hay that dried quickly will lose 2 to 6 per cent dry matter due to respiration while hay that dries very slowly may lose 15 per cent dry matter due to respiration. Harvesting hay when good drying weather is expected will reduce respiration losses considerably.

Leaching losses : Leaching by rain can cause upto 20 per cent nutrient loss. Rain may prolong the enzyme action within the cells, thus, causing greater loss of soluble nutrients, and may also encourage the growth of moulds.

Shattering losses :

During the drying process the leaves loose moisture more rapidly than the stems, so becoming brittle and easily shattered by handling. The loss due to shattering of leaves is in hay making is of importance, in case of legumes. Hay moisture content is the largest single factor contributing of leaf loss. When the hay become too dry and brittle than the losses are excessive.

To avoid those losses hay should never be over dried or handled during warm periods of the hay. Hay should be stored in above moisture content of 15 per cent.

Bleaching losses: During the process of drying much of the carotene, a precursor of vitamin A is lost with bleaching. In general, the carotene content of freshly cured hay is proportional to the greenness. With severe bleaching, more than 90 per cent carotene may be lost.

Storage losses: The amount of storage losses are directly related to several factors *viz.*, moisture content at bailing and the time of storage, storage conditions like relative humidity, air temperature, and air movement, forage species and the epiphytic microbial populations present on the hay (Tomes, 1989).

Hay that is stored at moisture contents greater than 20 per cent can develop mould and lose dry matter and quality to bacterial degredation. Storage losses are related to microbial growth and to subsequent heating. All hay stored at moisture contents of 15 per cent.

Benefits of hay making :

– It can be kept for longer periods of time with little loss of nutrients if protected from weather.

– A large number of crops can be successfully used for hay production.

– It can be produced and fed in small or large amounts.

– It can be harvested, stored and fed by hand or the production and feeding can be completely mechanized.

– Hay can supply most nutrients needed by many classes of livestock.

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