When green fodder is fed to the animals, adequate supply of all the nutrients is essential for favourable growth as well as health. The animal feed mainly contains water, organic matter and minerals. Organic matter constitutes essential components like proteins, fats, fiber and carbohydrates. The protein content is generally expressed as crude protein (CP; N x 6.25) which include true protein as well as the non-protein nitrogenous compounds. The proteins are utilized by animals for producing lean meat and milk. The fats are used as a source of energy. The cell wall and fibers of the fodder are indicated as crude fiber (CF) which is less digestible. The ruminant animals can digest a part of fiber for use as a source of carbohydrates. The minerals in feed make the animals healthy and some of them are secreted in milk. The animals domesticated mainly for milk production require calcium (Ca) and phosphorous (P) in adequate quantity in their feed.

The animal feed can be divided into two parts, one for the maintenance and other for production purposes. The maintenance ration is a portion of the diet which enables the animals to carry on essential processes of life without gain or loss of weight. Whenever excess ration in the form of quality as well as quantity is supplied to the animals, it is used for growth.
and production in the form of milk (Sen, 1978). It is therefore, essential to supply animal adequate nutritional fodder for obtaining maximum production.

When the nutritive value of animal feed is evaluated, proximate analysis system is used (Maynard and Loosly, 1969). The main components of this system are crude protein (CP), crude fiber (CF), crude fat, soluble carbohydrates, expressed as nitrogen free extract (NFE), total carbohydrates (TC), ash, minerals and moisture. It is very simple scheme of analysis to evaluate nutritional status of animal feed.

Green foliage of fodder crops usually have more than 20% crude fiber and these are referred as forage crops. The leguminous forage or fodder crops are rich in protein and calcium, while contain relatively low proportion of indigestible silica. Non – legumes, on the other hand are poor in protein content and are relatively rich in indigestible lignin and silica. The performance of farm animals, particularly for the production, largely depends on the nutrient composition of the fodder with which they are fed. Table 1 gives an account of the chemical composition of six non-leguminous and six leguminous fodder crops. The data on chemical composition of the fodder species was adopted from the research work undertaken by Bhuktar (1995). A comparison of the nutritive values of leguminous fodder with that obtained from the non-legumes (Table 1) clearly indicates that the leguminous foliage is rich in protein content. The crude fiber content is low in the foliage obtained from the leguminous
fodder crop. The values on ash and acid soluble ash content indicated that the non-leguminous fodders, are rich in acid insoluble ash which is termed as silica, an indigestible component. The leguminous fodder is normally poor in carbohydrates content as indicated by the values of total carbohydrates (TC) and nitrogen free extract (NFE) or the soluble carbohydrates. The data in Table 1 clearly indicates that the leguminous fodder crop contain high quantity of calcium and adequate amount of phosphorous. The data presented in table 1 which has been collected from the earlier reports clearly indicated that the leguminous fodder crops are nutritious than the non-leguminous crops as these are rich in protein, calcium, fat and phosphorous content and as they contained relatively low proportion of fiber and carbohydrates.

The data presented in chapter V on intercropping indicated that productivity of less nutritious non-leguminous crop like maize, *Sorghum*, generally high per unit land area in comparison to the productivity of legumes. The legumes like *Dolichos* produced less green fodder which was nutritious. Intercropping was found to give a higher yield in some cases. Cultivation and feeding of leguminous species alone is un-economical and inconvenient. This is mainly because of low productivity and the problem bloat in animals. It is desirable to mix the foliage of both the crops for feeding purpose for which intercropping has been suggested.
It is felt that intercropping is useful in cultivating and harvesting both types of crops for feeding as a mixture and a such a feeding pattern will provide a balanced diet to the animals.

**Conservation of green foliage**

From the earlier chapter during this investigation it is clear that large production of green fodder could be obtained from various fodder crops viz., maize, *Sorghum, Dolichos* and cowpea with the use of fertilizer nitrogen or by adopting the practice of intercropping. Production of green fodder in large quantities is possible in monsoon and winter i.e. during *kharif* and *rabi* season respectively. During summer, however, irrigation facilities are not available in several parts of this region. It is therefore, difficult to raise fodder crops and obtained green foliage for animal nutrition. This results into acute shortage of fodder during summer. In order to overcome this situation, the surplus feed available during favourable season can be conserved for use during scarcity.

There are two methods of conservation of green fodder viz., making of hay or silage. During hay making the green fodder is dried naturally to remove moisture in it and the dry plant material is used for animal nutrition whenever required.

Forage crop cut at pre-flowering stage and dried for storage is called as hay. It is more nutritious and palatable as the entire crop is cut at a pre-flowering stage. Hay making is less expensive method of conservation and provides animal feed which is green, free from mould and has pleasant
smell. In India hay making is popular method of conservation as it is cheap and as the foliage can be dried naturally. Patil (1990) prepared hay from several crops and concluded that good quality of hay can be made by drying the foliage in sun and / or shade.

**EXPERIMENTAL**

During present investigation attempts were made to prepare hay by drying the foliage of maize, *Sorghum*, bajra, hybrid Napier and *Dolichos*. For this purpose the foliages were harvested early in the morning and batches of one kg green foliage were kept in sun, shade 6 – 8 hours in sunlight then shade or covered with black cloths for drying. The loss in weight due to drying was measured after every four hours, during 6 a.m. to 6 p.m. every day, till constant weight. The dry matter content of the foliage was simultaneously determined by drying the samples of foliage in oven at 95°C. The loss of water from foliage was measured by calculating relative water content (RWC) as described by Harris and Thaine (1975) using following equations.

\[
\text{RWC} = \frac{W_t - W_d}{W_s - W_d} \times 100
\]

Where

\begin{itemize}
  \item \(W_t\) is the sample weight at time \(t\),
  \item \(W_s\) the saturation or initial weight, and
  \item \(W_d\) is the dry weight.
\end{itemize}
The drying rates for five crops were compared by plotting RWC against time. The results obtained on drying rates are presented in Table 2 to 6 and illustrated in Fig. 1 to 5.

RESULTS AND DISCUSSION

Table 2 gives information on drying rate of bajra under sun, shade, sun – shade, and under covered conditions. The foliage kept for drying in sun dried within 144 hours while that in shade it required more than 172 hours for drying. The figure 1 clearly indicated that the drying rate was more in sun then that in the shade.

When dried in sun, maize took 198 hours for drying which reduced to 168 hours when it was covered with black cloth. When green foliage of maize was dried in shade 248 hours were required for its complete drying (table 3). Thus as experienced with bajra the drying rate of maize foliage was higher in sun than that in the shade. The relative water content (RWC) of sun dried bajra was 4.0 while that of maize was 8.1; shade drying of these two crops gave higher values for RWC, 9.0 and 11.2 % respectively.

Green foliage of Sorghum and hybrid Napier grass showed a similar trend as was observed with bajra and maize. Both the crops took 192 hours for drying in sun, while 240 and 285 hours respectively due to the drying in shade. Covering of the foliage with black cloth had as very little influence on the drying rate. The RWC of sun dried Sorghum was 5.5 in comparison with 8.2 for shade drying (Table 4). On the other hand, the RWC for hybrid Napier grass when dried in sun, was 7.6 in comparison to 14.2 % due to
shade drying (Table 5). In all these four crops i.e. bajra, maize, *Sorghum* and hybrid Napier initial drying in the sun and than in shade had no advantage over shade drying alone (Table 2 to 5 and figures 1 – 4), however, when the foliages were covered with black cotton cloth the drying rates were at part of sun drying with a slight improvement.

*Dolichos* being a leguminous crop, can produced hay with a high nutritive value. Therefore, while making hay it should be dried carefully. During present investigation the foliage of *Dolichos* dried in 176 hours when kept in sun, with RWC of 5.2 % when open while 8.0 % when covered with a black cloth. The drying of *Dolichos* delayed to 264 hours due to drying it in shade with a RWC of 14.3 %. Slight improvement in the drying rate and RWC content was observed when shade drying was done for initial 8 hours following drying in sun.

The dry matter content in the hay prepared from bajra, maize, *Sorghum*, hybrid Napier grass and *Dolichos* were 19.73, 17.77, 26.95, 16.66 and 18.2 % respectively. It can thus be concluded from the data presented in Tables 2–6 and illustrated in figures 1–5 that sun drying is more quick than drying foliage in shade as was also experienced by Bhuktar (1995) and Patil (1990). It is desired that the hay should be with less than 20 % moisture and the results obtained during present study gave the product with a describable value.

The plates showing samples of hay prepared during present investigation gives an idea about the quality of hay in respect to its colour
and appearance. The colour of the varied hay with the method of drying and the hay samples which were prepared by drying in shade were green in colour. The samples of hay which were covered by black cloth during drying also retained green colour. However, sun dried hay samples were either pale green or yellow in colour indicating high intensity of senescence and loss of chlorophyll. It is felt that hay making of the foliage from these crops be undertaken by drying it simultaneously sun and shade to retain its colour for better palatability. This method of drying will also protect the loss of nutrients from the foliage during drying.

Various methods of making hay have been suggested by various workers from different places. In order to avoid nutrient losses during hay making and prevent mechanical damage and shattering of leaves the use of tripods constructed from rods have been suggested by Zimmer (1971). At Indian grass lands and fodder research institute (IGFRI), Jhanshi, Mukherjee (1970) constructed trench type racks for preparing hay from the leguminous fodder. It is felt that proper methods of hay making will provide good quality of animal feed and there is a need of developing cheap method for making good hay particularly from soft leguminous foliage.

Another method of conservation of green fodder is the preparation of silage. Silage is a product formed when green plant material is fermented in absence of air (Narayanan and Dabadghao, 1972). When the green plant material is stored under anaerobic condition, lactic acid bacteria multiply rapidly and the lactic acid formed due to their activity preserves the
nutrients in the resulting silage (Allen et al., 1937). The preservation of green fodder as silage depends on rapid acidification on the mass by lactic acid producing bacteria which reduce the pH of the material within the range of 3.8 to 4.2.

The foliages from non-leguminous crop contain sufficient fermentable carbohydrates which result into lactic acid production and subsequent decrease in the pH to a desirable level. The leguminous crops, on the other hand, are deficient in carbohydrates, which result into the production of limited lactic acid without decrease in the pH to a desirable level of 4.2 or less. Several workers (Vartha et al., 1973; Connell and Foxell, 1976) have reported difficulties in making silages from legumes, presumably because of its lower soluble carbohydrates content (Connell and Houseman, 1976).

Studies on the preparation of silage from lucerne and hybrid Napier grass were initiated in this laboratory by Mungikar (1974). It was pointed out that, hybrid Napier grass makes better silage than that made from lucerne (Mungikar and Joshi, 1976). Mungikar (1982) observed that good quality of silage could be obtained from a mixture of lucerne and sugarcane tops. A mixture of Sorghum and cowpea produced better silage but the further studies on the preparation of silage have indicated that the quality of silage can be made good by giving mechanical and chemical treatments to the fodder (Mungikar, et al., 1983; Kasture et al., 1984; Dakore and Mungikar, 1984; Dakore et al., 1986; Kasture and Mungikar, 1987; Reddy

The results obtained with earlier investigations from this laboratory indicated that the crops like *Sorghum*, maize and bajra make better silage due to the presence of carbohydrates in them but the resulting product is not highly nutritious. The nutritious fodder obtained from leguminous fodder crop like *Dolichos* and cowpea cannot be properly preserved as silage due to low carbohydrates content in them. Taking this in view, attempts were made by Bhuktar (1995) to prepare silage from the mixture of leguminous foliage and that obtained from non-leguminous fodder. Table 7 gives an account of chemical composition of silages made from leguminous and non-leguminous foliages as well as from their mixture during the experiments undertaken by Bhuktar (1995). The results indicated that silage samples prepared from *Sorghum* + *Dolichos*, Maize + *Dolichos*, bajra + *Dolichos* and bajra + cowpea were of high nutritive value containing adequate quantities of protein, fat and the minerals. The result obtained on the preparation of silage from fodder mixture indicates that nutritionally superior animal feed can be obtained through making silage from foliage mixture. It is concluded that intercropping can be employed for higher production of fodder and the resulting fodder could be ensiled without separation, for making silage of good nutritive value. This will provide good quality of animal feed for use during the storage of green fodder.
SUMMARY

The overall results summarized in this chapter indicated that leguminous fodder crops give nutritious foliage in small quantity which is difficult to conserve as either hay or silage. On the other hand, non-leguminous fodder crops produced large amount of foliage having low or poor nutritive value and such foliage is easy to conserve as either hay or silage. The practice of intercropping, if undertaken by careful selecting component crops, can produced increased fodder per unit land area. The mixture of foliages obtained from legume and non-legume crops can give nutritionally better quality of animal feed and such a mixture could result into good silage which is nutritionally superior. Further investigations are needed to develop and popularize silage making and to prepare good quality for hay from leguminous fodder. Work of these lines will help in providing adequate nutritious animal feed available throughout the year to get maximum return from animals, particularly in the form of milk and other products.