5.2. WHEAT STRAW - PRODUCTION AND UTILIZATION AS ANIMAL FEED

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INTRODUCTION

In India, wheat is grown on about 24 million hectares, occupying about 50% of the total area under food crops during the winter (rabi) season, and making a major contribution to the total grain production. This chapter describes the production and agronomy of wheat in relation to the quality and quantity of straw produced. It also reviews the effect of environment on straw production, and gives a brief account of the different feeding methods.

PRODUCTION OF WHEAT AND WHEAT BHUSA IN INDIA

Wheat is the major cereal crop in the winter season, particularly in Northern India. Its grain provides a staple food for humans and its straw is a major feed resource for ruminants. The bread type (*Triticum aestivum*) is grown on more than 87% of the area under wheat in the country, on well drained loamy and clay loams in the alluvial plains of Uttar Pradesh, Bihar, Punjab, Haryana, and parts of Rajasthan. The macaroni type (*Triticum durum*) is

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grown on less than 12 % of the area on the black soils of South Rajasthan, M.P., Maharashtra, A.P. and Karnataka. The main wheat producing region is the Indo-Gangetic plain, where the winter is cool and where the crop can be grown for a period of 5-6 months.

Many farmers in states like Punjab, Haryana and Uttar Pradesh separate grain by threshing the crop with power driven machines which yields straw pieces of 1-3 cm in length or finer. This type of straw is called bhusa in those states and it is used as ruminant feed since ages. Wheat bhusa is stored either in a stack or bonga, depending on the availability of space and time. In North West India, wheat bhusa is offered to all categories of ruminant animals throughout the year, either alone or in combination with other feeds, depending on their availability and the type and level of production expected from the animal.

VARIETIES AND THEIR CHARACTERISTICS

For some time the emphasis was on the breeding of disease resistant wheat varieties with a grain quality suitable for "chapaties". Such varieties developed during 1930-1960 were designated under the series as N.P. (New Pussa), Pb.C. (Punjab cross), K. (Kanpur), R.S. (Rajasthan), Hy (hybrid) of M.P. and NI (Niphad). However, these series were fertilizer non responsive and had a tendency to lodge with irrigation and better management. The genotypes are tall, producing numerous long slender leaves (140-150 cm) and the weak straw was accepted as animal feed due to reasons of better digestibility. The major break-through in this respect came after the introduction of the dwarf gene-'Norin 10'. Dr. Norman E. Borlaug,

the Nobel laureate force behind the green revolution arranged to supply India with the four most promising strains in 1962. After extensive tests for suitability, a large quantity of seeds of the two varieties 'Lerma Rojo 64A' and 'Sonora 64' was imported in 1965-66. They had desirable attributes in terms of grain yield, e.g. dwarfness, relatively stiff straw, earliness and good resistance to rusts, as well as a high response to fertilization and irrigation. With additional breeding material supplied by CIMMYT, it was possible for Indian breeders to develop the 'Kalayansona' and 'Sonalika' varieties to suit Indian consumers' preferences. Both these varieties became popular in the country and they helped India to achieve new heights in wheat output. From then on more than 160 wheat varieties have been bred and released in India to suit different growing periods and agroclimatic zones.

AGRONOMIC PRACTICES

Wheat is sown in adequately firm and pulverised soils from loamy to clay loamy by broadcasting in rainfed areas, either by drilling or in a furrow behind the tiller. Sowing is from mid October till the first week of January, and all over Northern India the crop is harvested in April / May.

Loamy soils are ideal for wheat cultivation. Under rainfed conditions, farmers try to conserve soil moisture from late rains. They do so by ploughing the land only once for field preparation, followed by 2-3 harrowings with adequate levelling, and with seed rates of 100 kg/ha. If wheat sowings are delayed beyond November 15 grain yield reduces at a rate of 100 kg/day. There is a corresponding reduction in the total straw production also. Partly this is compensated by increasing the seed rate, under

late sown conditions to 125 kg/ha. For irrigated timely sown high yielding dwarf varieties, 4-5 harrowings are done to make the loamy soil quite pulverized.

Recommended nitrogen, phosphorus and potash levels are 60:40:30 kg/ha, for rainfed varieties, and 120:60:40 kg/ha, respectively for irrigated timely sown varieties. Out of the total, half of the nitrogen, and full doses of P_2O_5 and K_2O are applied at the time of sowing. The remaining nitrogen is applied in two equal doses at the first and second time of irrigation. The first irrigation is done at about 20-25 days after sowing and a total of 3 to 5 irrigations are done at similar interval (20-25 days) depending on soil conditions and rains. Nitrogenous fertilizer and/or irrigation enhance the production of biomass.

EFFECT OF MANAGEMENT ON STRAW QUALITY AND QUANTITY

Just like in all other straws, the effect of management and environment on straw quantity and quality appears to be important and has an over riding impact on the genetic basis of these traits. The major effects of management will be discussed before proceeding to the nutritional qualities and feeding systems of wheat straw.

Field preparation

Unlevelled land, big soil clods and uneven moisture distribution lead to uneven germination, non-synchronized growth, development and maturity of the crop, with subsequently low yield. Some shoots become ready for

harvest while others continue to translocate their soluble nutrients to spike. The secondary tillers remain immature at harvest, they are tender and they contain a high ratio of solubles to cell walls (# 3.3). The result is a reduced quantity, but a relatively good quality straw.

Wheat is sown at 3 - 5 cm depth, along with fertilizers that are kept a little deeper than the seed. As said before, general recommended seed rates are 100 kg/ha. Rich soil can support higher plant densities than sandy and light soil. Late sowing needs a higher seed rate of 125 kg/ha because tillering is poor. During sowing, the control over seed rate is essential to avoid uneven depth and seed pouring. Seed that is sown deep takes more time to emerge and remains immature at harvest time: a loss in terms of grain, a gain in terms of straw quality. Higher seed rates, i.e. plant density, results in thinner and softer straw which splits during threshing, yielding thinner straw particles of relatively better nutritive quality.

Crop management

(Organic) manuring is done at the time of field preparation. Farmers either apply farm yard manure before ploughing, or they grow a green manure crop that is partly fed (e.g. berseem and mustard) and that has stubble and roots to be ploughed under. More organic matter in the soil is believed to result in better nutrient availability. Combined with application of chemical fertilizer and timely irrigation it gives a fast growing bumper crop. The plant stems of the wheat thus grown remain tall, thin and soft with a higher leaf content, resulting in a high grain yield, as well as more straw. Straw obtained from such a crop is also of a better quality, has a better intake and digestibility.

Irrigation and fertilization

Recent results indicate that at levels of nitrogen application from 60-150 kg N/ha, and an increase in the number of irrigations (up to 3) increases yields of both grain and straw. More than three irrigations generally continue to increase the straw quality without further increases in grain yield.

Crops that are infested with insects and other pests give low grain and straw yield. The latter is of inferior quality too. Control by insecticides or pesticides improves both yield and quality of grain, as well as quantity of straw. However, many farmers express apprehension on the effects of these agrochemicals on the animal health and either avoid feeding such straw, or feed it in reduced amounts.

Weeds compete with the wheat crop for soil nutrients and cause the crop plants to be shorter, with smaller spikes. Stunted growth occurs also if the field is poorly fertilized, leading to lower yield of grain and straw of inferior quality. However, in rich soil, a luxuriant crop and high plant population combined with weeds results in thin stemmed straw of low straw and grain yield. Since the leaf content remains low, the straw quality is likely to remain low as well, but together with weeds they provide good stubble grazing.

Rodent attack occurs more in thick bumper crops when the soil contains sufficient moisture for the rats to dig holes. The rats harm the plant and reduce the yield of both grain and straw, though the latter is of better quality.

Straw and harvest management

Wheat is harvested when the grain is dead-ripe about or below 17% moisture and when the straw is golden yellow and brittle. However, a somewhat earlier harvest at physiological maturity does not only yield straw with better leaf content and higher grain yield, but the leaves and stems also remain better digestible and palatable. Unfortunately, threshing by machine requires brittle stems and therefore the farmers allow the harvested crop to remain in the field for sun drying, at the detriment of straw quality. A delayed harvest has the same, negative effect on straw quality. Delayed harvesting causes shedding of spikes and grain loss, because the plant becomes more brittle and fragile. Shedding of leaf leads to reduced straw quality because of the higher nutritive quality of the leaves.

Hand harvesting is generally done at so called ground level (4-7 cm above the ground) by moving while squatting. The lower part of the plant stem is harder, the height of the harvesting is therefore a factor that determines the quality and quantity of the straw. A higher level of cutting would improve the quality, but reduce the amount of straw. Farmers with plenty of straw can cut higher, but not those who have only a small plot of land. Depending on the availability of labour and other feed supplies the farmer can decide the height of cut. Women who tend the animals and/or cut the crop may have a different preference than men in this respect.

Combine harvesting is done at about 25 - 35 cm above ground level. Grain losses are higher in taller, brittle and more fragile matured crops, and also with an inefficient combine. Loose straw that is thrown by the combine contains more leaves, and is of better nutritive value, but the amount of

straw thus obtained is hardly one third of the total obtained while cutting at ground level. Stubbles are incorporated by harrowing them into the field to increase the soil organic matter, or simply to get rid of them.

Combine harvesting is done by large and not by small or marginal farmers. The latter category needs more straw due to non-availability of quality feeds and fodders, and also combine harvest is too costly for many of the small farmers. Lately however, even large farmers realize the value of wheat bhusa because it can fetch some money on the market. Nowadays farmers even prefer feeding of straw of a variety containing more leaf content. A moving thresher has now been developed which harvests the long straw, breaking it simultaneously to bhusa and blowing it into the trolly attached to it. Its adoption still remains to be seen. During the combine harvest in brittle crops the leaves are shaken to the ground and their proper collection remains a topic for further work. Even a moving thresher would not be able to collect it. The hard stubble remaining in the field mainly consists of the stem component of the plant and is of an even lower quality.

Post harvest management and quality of straw

Rains after the harvest of the mature crop leads to the spoilage of the grain, the kernels imbibe water, swell and can germinate. A moist crop is also difficult to thresh and there may be a danger of fire due to overheating. The straw quality may be marginally higher because the leaves will be intact.

Threshing by poor farmers is traditionally done by treading under the feet of cattle/buffaloes on a threshing floor. Simple mechanical threshers and winnowers are now used by most farmers. These motor driven threshers

blow the straw (bhusa) in the same direction as the wind. Heavy particles of straw fall closer to the thresher and the lighter particles - containing finely broken upper stems and leaves - fall furthest. Straw falling near the thresher contains hard and thick stem portions with nodes of lower quality, while the fraction away from the thresher is of better digestibility and intake. It contains more leaves and is thus softer.

When adequately stored, wheat straw characteristically has good keeping quality. Its surface is smooth and does not allow percolation of water into the heap. The upper wet layer may be removed after the rain and can be fed after sun drying. Storage of wet straw causes the growth of fungi. Animals may consume such straw in larger amounts but, it has a lower digestibility and may have a negative effect on animal health also. The stack of wheat straw can be covered quickly by mud in the field, a so called "dhar" in Haryana, or "bonga" in Western U.P. (# 4.6.1.). Straw losses are higher in the dhar than in the bonga system, because the bonga is a tall stack methodically covered either with soft long wild grass or with long leafless wheat straw itself. The bonga is used by villagers to store straw if sufficient space and time for storage is available near the house.

NUTRITIONAL CHARACTERISTICS OF WHEAT STRAW (BHUSA)

Wheat straw contains on dry matter basis 72-76% NDF; 44-49% ADF; 25-29% hemicellulose; 35-43% cellulose; 7-8% ash; 3-4% crude protein and 6-8% lignin. Leaves are always better than stems, and straw on the average contains 87-93% dry matter when dry, depending on environmental

conditions. The digestibility is around 40-43% and intake is 1.5-1.8 kg/100 kg body weight in adult and 1.8-2.2 kg/100 kg body weight in growing heifers, of course depending on the level of production. Even this rate of intake and digestibility usually does not provide sufficient digestible and metabolizable energy to meet the animal's maintenance requirements. In terms of quality as measured in the laboratory, wheat straw ranks lower than - or similar to - rice straw, and it has a considerably lower quality than the stovers from maize, sorghum and millet.

Some farmers feed wheat straw as the main energy staple feed for all categories of ruminant animals throughout the year. Wheat straw is sold and purchased throughout Northern India, and regular wheat straw market can be seen in all small or big cities. In times of feed scarcity the price goes up. Many urban dairies in the North depend mainly on wheat straw as a source of roughage because it can be stored even in the open provided it is protected from rain, even though rain may spoil it to some extent. Wheat bhusa is considered by the farmer as security fodder and is the only fibrous residue transported to and from distant places for marketing. Some differences between paddy and wheat straw are presented in Box 1.

Box 1. Some notes on differences between paddy and wheat straw

Wheat straw in unchopped form is not fed to livestock. No animal is likely to consume wheat straw as such because the stem is hard and difficult for an animal to chew. Therefore, wheat straw is broken or cut to small pieces (1-2.5 cm in length) and then offered to animals. Particularly in the wheat growing areas of the upper Indian states (Punjab, Haryana, Uttar Pradesh), wheat straw is broken to small pieces during threshing, resulting in a material called "wheat bhusa". Separate chaffing as done for paddy straw in paddy growing regions is not generally required. Wheat straw is also stored/stacked in the form of "Bhusa" and not as bundles of long straw as in the case of paddy straw. In West Bengal, threshing of wheat is done differently, and the straw remains long and unbroken like paddy straw. As said earlier, the animals refuse to consume wheat straw in that form, and the straw is either burned or used for thatching. In some areas it is sold to paper mills.

There is a notion in Northern India that chaffing of paddy straw is difficult, but this is only true if somebody tries to cut it by North Indian method. In that case, the chopper reaches the straw but in Eastern India it is the straw, but in Eastern India chopping is done with the help of a foot-knife, running the bundle of straw over that knife. There is also an opinion that urea treatment softens straw and makes it easy to chaff. But to farmers in Eastern India it is the untreated straw which is relatively easier to chop than the softer treated straw.

In the Northern States paddy straw has been introduced relatively recently on a large scale. Farmers are still reluctant to feed it, partly also because of the fear for Degnala disease. Paddy straw is sometimes burned in those states, possibly also because it becomes available in a time when there is not much time to collect/store the straw, or because the feed scarcity is less prolonged. In other States of India, farmers are sometimes reluctant to feed wheat straw, and there it is the wheat straw that is sometimes burned.

Source: R.C. Saha

Table 1. Summary of feeding systems adapted by farmers

Supplementation (#4.3.)	Generally supplemented with either green fodder or concentrate (grain flour), or soaked protein supplements like, groundnut cake, mustard, cotton seed etc.
Chopping (#4.6.2.)	Chopped wheat straw is fed as such by farmers since the straw comes in pieces from the threshing floor
Soaking (#4.6.2.)	In some areas, soaking of chopped wheat straw is a regular practice while in others unsoaked straw is used
Selective consumption (#4.4.)	Animals pick up the softer parts of the straw. The remaining hard particles are left in the manger and either removed to go to the manure pit, or animals may eventually eat it if "sani" is made from it
Urea treatment (#4.6.1.)	Wheat straw can be treated according to various methods, and in conditions similar to all other straws

FEEDING SYSTEMS

Different feeding systems adopted by farmers are listed in Table 1.

Wheat straw in its chopped form is offered in a manger to dry animals (cows and buffaloes) without much supplementation, let alone treatment. Dipping in water is done in certain part of the country (Western U.P., Haryana and Punjab). It is supposed to wash away dust dirt and fine parts that might damage the mucous membrane of the mouth. It is then offered to the lactating and draught animals. Ground wheat flour or dahl chunni is mixed with the straw so that animals consume the left over straw in the manger (#4.4.), and it is believed that this improves the palatability.

Almost all farmers supplement wheat straw with either green fodder, or with homemade concentrate (kitchen wastes also used) while feeding supplements

to milking or draft animals depends on the production or work taken of the animal.

Wheat straw feeding to lactating animals generally is done as one-third of the total DM intake, but the ratio decreases as the milk production increases, depending on the availability and type of green fodder. In the months of June to September, wheat straw is mixed with green fodder such as sorghum, maize or guar. In the months of October-November, it is mixed with green fodder and in the months of December to April with green berseem, oats or sugarcane tops, and in the month of May and June with cowpea and maize fodder. Most of this applies particularly to the conditions in the North.

OTHER USES

In the absence of suitable jungle grass, wheat straw is used to cover the straw storage structure (bonga). For this purpose, soaked long straw is crushed a little for making rope. Long unchopped straw is also used as thatching material by poor or landless farmers/labourers. Wheat straw is a suitable material for mushroom production, particularly for *Pleurotus*. Last but not least, left over chopped wheat straw (bhusa) in the manger either goes to the manure pit to make farmyard manure, or it is mixed it with dung to make dung cakes, a common fuel in many farm households.

FARMERS' PERCEPTIONS

Wheat straw is considered to be a major staple feed for all categories of ruminant animals, and it is fed throughout the year. It is also sold and purchased throughout Northern India. Regular wheat straw marketing can be seen in all small or big cities. In periods of feed scarcity the straw price goes up and due to this reason no farmer wants to waste it. Urban dairies depend on wheat straw for their roughage supply, because it can be stored even in the open, provided it is protected from rain. Farmers consider chopped wheat straw as a security fodder and is the only fibrous residue transported for distant places for marketing.

CONCLUSION

Wheat straw is often available throughout the year. It is fed to cattle, buffaloes, sheep and goats after suitable supplementation either with green fodder or concentrate, after treatment or after soaking. It is one of the most widely used staple energy feeds, sold and bought throughout Northern India.

SUGGESTED READING

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