5.1. RICE STRAW - ITS PRODUCTION AND UTILIZATION IN INDIA

R.B. Singh, R.C. Saha, Mahendra Singh, Dinesh Chandra, S.G. Shukla, T.K. Walli, P.K. Pradhan and H.P.P.Kessels

INTRODUCTION

Rice (*Oryza sativa*) is the most widely grown crop in India with 43 million cultivated hectares yielding 746 million tonnes of grain. India occupies the world's largest area under rice, grown under a wide range of agro-ecological conditions. Rice straw is a major feed for ruminant livestock in India. The production levels of rice straw depends on variety cultivated, level of fertilization,climatic conditions, holding size, irrigation facilities, soil type etc. This chapter will discuss rice and rice straw production and utilization of rice straw as livestock feed and for other uses.

PRODUCTION

Rice is grown in India mainly as rainfed upland (16%), rainfed lowland (42%) and irrigated land (42%). The average rice yield on rainfed upland is 0.6 MT/ha (1 MT = 1000 kg) while on rainfed and irrigated medium lands it is 1.3 and 1.7 MT/ha, respectively. Relatively high grain yields occur in

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coastal states near the Arabian sea and the Bay of Bengal, some Himalayan as well as sub-Himalayan areas, Punjab, Haryana and Western Uttar Pradesh. Lower yields are obtained in Rajasthan, most parts of Gujarat, Madhya Pradesh and Maharashtra.

The grain to straw ratio varies from 1:1.3 to 1:3. The percentage of rice in paddy varies from 65 to 72 and the percentage of bran in rice husk is 15 to 20%. The grain and straw yields depend on environmental and genetic factors like variety, season, location, plant-height, soil texture and fertility, plant density, available water,fertilizer, weeds and their control, harvesting stage and methods. A brief discussion on the effect of these factors on the yield of rice straw is given below.

Varieties

A good number of varieties of rice has been developed so far. With IR8, Jaya, Ananda and Ratna varieties it is possible to realise a grain yield of 2.5 MT/ha in rainfed uplands, 3-4 MT/ha in rainfed low lands and 5-8 MT/ha in irrigated lands. The rice straw yield can be enhanced even when the ratio of grain to straw is low. Different varieties have different grain:straw ratios ranging generally from 1:1.3 to 1:3. Semi-tall and tall varieties produce relatively more straw than the dwarf varieties. Short duration varieties of rice contain relatively more leaves than long duration varieties.

Location

The yield of grain and straw differs between locations because of variation in agroclimatic conditions, e.g. soil type and fertility, amount and frequency of rainfall and temperature during the growth of the crop.

Upland rice is sown by broadcast at the start of the monsoon. This system is followed in almost all rice growing states in India but, mainly confined to tracts which get either the South-West or North-East monsoon. The major portion of rice crops in India is grown under lowland conditions, that is under submerged conditions.

EFFECT ON STRAW QUALITY AND QUANTITY

Plant density

Proper plant spacing is one of the important factors to obtain a good rice yield, particularly in transplanted conditions. There is a progressive increase in grain and straw yield with increase in plant population up to an optimum level of approximately 15 x 20 cm, though this density depends on the variety used. Plant density beyond the optimum level reduces grain yield but, leads to higher straw yield and better straw production. Spacing is wider in the wet season as compared to the dry season.

Soil condition

Soil fertility, soil texture, salinity, acidity and alkalinity affect grain and straw yield as well as their chemical and physical conditions. Accumulation of certain nutrients (Selenium) in the straw up to toxic levels may take place under adverse soil conditions such as the accumulation of Selenium in some areas of Punjab and Haryana resulting "Degnala" disease of cattle.

Irrigation

Rice is a water loving plant and requires a minimum of 125 mm of standing water in the rice field for its growth. Frequency of irrigation is directly

affecting grain and straw yield. Rice cultivation in India is mainly rain based and only 4.3% of the total land area is under winter cultivation where assured irrigation is available. Irrigation if not done at the right time may lead to crop failure and the production of both grain and straw will be affected. The quality of straw will be better but, hardly any farmer will prefer that at the cost of grain production.

Fertilizer application

Fertilization with Nitrogen (N), Phosphorus (P) and Potassium (K) is necessary to maintain good yields of grain and straw.The standard recommended level of N. P, K fertilization is 120: 60: 60 kg/ha, respectively, for high yielding varieties of rice. In most areas in India, the recommended rates of fertilizer N for flooded tall *indica* rice have been limited to 30 to 60 kg/ha. Some trials have indicated that doses of up to 200 kg N/ha, 90 kg P/ha and up to 80/kg K/ha are required for good yield of grain and straw. With additional Nitrogen, plant growth will be higher but, grain production will be reduced. However, high levels of fertilizer use are capital intensive and unsuitable for resource poor farmers. Even resource poor farmers with sufficient water cannot grow high yielding varieties due to relatively high costs of inputs like fertilizer and pesticides. To avoid the risk of crop failure, these farmers prefer traditional varieties which produce relatively less grain and straw but can stand climatic hazards to a considerable extent. This implies a low input oriented farming practice in most situations where the high yielding varieties are not suitable. Farmers in different farming systems have different requirements of grains depending on family size and composition, cattle numbers and availability of inputs. The straw production varies accordingly in terms of quantity and quality.

Weeds and their control

Weeds compete with the main crop for nutrients, sunlight, water and space, thus reducing production of grain and straw resulting in reduced rice yields. Weed control is, therefore, essential for good production but it is labour intensive. Some weeds, however, can be used as cattle feed.

Harvesting

The method of harvesting influences quality and quantity of straw. Early harvest may provide good quality straw (some greenness of straw will remain) but grain quality and production will be negatively affected. Hardly any farmer will prefer to do that. The cutting height affects straw yield, as lower cutting increases straw yield. Harvesting of the plant is done at a certain height for two reasons: (1) The bottom most part is generally waterlogged, coarse and is not easily relished by cattle. (2) It is mixed with the soil to maintain soil texture and soil fertility. In waterlogged land, the plants are harvested at 20-25 cm height from the surface of the land and the plants thus left grow vegetatively, being either utilized as cattle feed or production of another rice crop known as ratoon crop. However, ratooning is not a common practice in rice cultivation and is mostly done in areas where other cropping is not possible.

Threshing

The method of threshing affects quality of straw. Bullock trodden threshing contaminates straw with soil and such straw is less relished by the animals. A hand-beating method or threshing by a Japanese paddle thresher provide good straw which is relished by cattle and easy to store in stacks.

Storage

The traditional method of storing of paddy straw in Indian villages is in circular or rectangular stacks built in open air over a platform (made of indigenous materials like bamboo, wood, jute-sticks, bricks etc.). Storage improves palatability of straw if done properly and if there is no fungal or mould growth. Stored straw is preferred by animals over freshly harvested straw. Wet straw is not stacked to avoid spoilage. Good stack structures avoids percolation of rain water inside the stack and only the outer layer of the stack is spoiled.

UTILIZATION OF RICE STRAW

Rice straw is used as feed for ruminants and for many other uses like manure, thatching, paper pulp, alcohol, mats, poultry litter and mushroom production. Besides the straw, rice also produces rice polish, rice bran and rice husk. On an average, there is 20% husks, 10% bran, 3% polishings, 1-17% broken rice and 50-66% polished rice.

Rice straw as feed

Rice straw is fed to cattle and buffaloes in India since ages. Though rice and wheat straw on average have a similar nutritive value according to laboratory analysis, in some parts of the country like Punjab, Haryana and Western Uttar Pradesh, wheat straw is preferred over rice straw. This is possibly due to "Degnala" disease which is a problem in those areas. Farmers in these areas mostly cultivate green fodder and mix it with wheat straw (which needs not be chaffed and is commonly available in that form) and feed it to the animals which is labour saving, while rice straw chaffing is labour

intensive. Rice straw is fed at home as basal diet in most areas where green fodder is scarce. Stubbles and ratoon left in fields after harvesting of rice are also grazed. Rice straw is a poor quality feed in terms of protein and mineral content. It is high in lignocellulose and insoluble ash. The chemical composition on a dry matter basis is presented in Table 1.

Table 1. Chemical composition of rice straw (% on dry matter basis)

Organic Matter	82
Crude Protein	4
Crude Fibre	37
Non Fatty Esthers	43
Total ash	18
Calcium	0.14
Phosphorus	0.05
Neutral Detergent Fibre	75
Acid Detergent Fibre	54
Cellulose	37
Lignin	8
Silica	8

Rice straw is poorly palatable and its intake by animals is low. However, the intake of straw depends on straw type (coarse, fine, long, dwarf, leafy, steamy, fresh, stored, hard, soft), animal species and breed, body weight of animals, other feed in the ration, physiological state, climatic stress etc. In general, fine (slender), soft, long, leafy and stored rice straw is preferred by animals. Dry matter intake and digestibility of rice straw free from dirt and water lodging, in different species is presented in Table 2. The DMI is highest in buffaloes followed by cattle, whereas sheep and goats have relatively low DMI's. However, DMD is similar in cattle, buffaloes and goats but, seems lower in sheep.

Table 2. Dry matter intake (DMI) and digestibility (DMD) of rice straw consumed by different animal species *)

	Cattle	Buffalo	Sheep	Goat
DMI ($g/kg^{0.75}$)	67 (46-87)	83 (60-105)	43 (25-60)	43 (40-46)
DMD (%)	48 (40-55)	47 (44-50)	42 (40-44)	48 (46-50)

*) Figures within parentheses indicate ranges (Prasad *et al.*, 1993)

Different parts of rice straw (node, internode and leaf blade) differ in chemical composition and digestibility as shown in Table 3. Unlike in most other straw types, in rice the stems are preferred over the leaves. Newer short straw varieties with less stem and, therefore, more leaf do always have a better straw than traditional tall straw varieties.

Table 3. Chemical composition (g/Kg DM) and digestibility (g/kg) of different parts in rice straw at 40 kg N/ha

Characteristic	Node	Internode	leaf blade	Whole plant
Crude protein	42	46	40	37
ADF	459	508	478	475
Cellulose	337	375	280	295
OM digestibility	495	418	584	501
NDF digestibility	428	398	522	430
ADF digestibility	380	364	493	400

(Source: Mahendra Singh, 1993)

Other uses of rice straw

Manuring/composting: This can be done in two ways. Either the stubbles are mixed with the soil to maintain soil fertility, a common practice in the rice growing areas of the country. Also unused and spoiled straw (either left by the animals, spoiled during storage or waterlogged and unfit for consumption) is generally kept in a place along with dung and allowed to form compost which is then used in fields for manuring.

Thatching: Rice straw is used for thatching everywhere in the villages in the rice growing areas, particularly in the Eastern Indian States.

Poultry litter: Chaffed rice straw is used for bedding material in deep litter poultry keeping in the Eastern Indian states.

Mushroom cultivation: Rice straw is used for mushroom culture.

Packing material: Rice straw either chaffed or unchaffed is used as packing material for transport of goods to avoid breakage/spoilage.

Industrial uses: Rice straw is industrially used to manufacture paper, straw-board, alcohol, hats and mats, ropes, baskets etc.

FEEDING SYSTEMS OF RICE STRAW

Feeding and use of rice straw vary between farming systems. Since rice straw is poor in nutrients, it is generally supplemented or occasionally treated for better utilization by animals, depending on level and type of animal production. In spite of its low nutritive value as measured in the

laboratory, it can also be valuable as an emergency feed to help animals survive a period of feed scarcity.

Supplementation

In low input farming systems, straw is the basic feed supplemented with field or roadside grazing, kitchen wastes, vegetable wastes, fruit wastes or whatever is available throughout the year. In a poor man's farming system (marginal or landless), rice straw is substituted by field grass as much as possible. Supplemental feeding of concentrates is more important with lactating and working animals. The associative effect of low levels of supplementation (field grass/concentrate) results in increased intake and efficient utilization of rice straw by animals (#4.3.).

In high input farming systems, rice straw is substituted by cultivated green fodder or high levels of concentrate. In some parts of the country where high quality green fodder is fed at high levels (Haryana and Punjab) some straw is fed as supplement to improve the consistency of animals faeces. In commercial dairy farms near the cities and towns, rice straw is used as supplement to provide some fibre in concentrate based rations to maintain normal rumen function (#4.3.).

Treatment

Many methods have been investigated of which most are technically sound but economically unattractive. The objectives constitute a mix of improved intake and digestibility of straw, as well as a correction of deficiency by

adding proteins and minerals. None of these treatment except for chopping and soaking (#4.6.2.) and to some extent urea treatment (#4.6.1.) has been successful under field conditions.

In low input farming systems of West Bengal, Bihar, Orissa and Assam, the bullock trodden rice straw is generally not chaffed. The texture is soft and such straw is fed as such to the animals. However, straw threshed by paddle thresher/hand beating is chaffed and soaked with water and fed to the animals in the Eastern Indian States. Chaffing reduces selective consumption and wastage by animals and it may improve intake if the particle size is very small. However, increased intake is followed by faster rate of passage and lowered digestibility. Soaking softens straw and possibly has some treatment effect if the water is acidic or alkaline (#4.6.2.). In high input systems rice straw is either fed as such or in chaffed form. Urea treated straw in such systems is not relevant because of high levels of concentrate feeding, high levels of milk production, and often a high price of straw on the urban market.

GENDER ISSUES

Women and children largely contribute in the production and processing of rice straw. However, there is a great degree of variation of women's role in aspects depending on socio-economic and cultural factors (#2.1.). Women in small holder farming systems do most of the physical work themselves, while women in higher caste or income levels also have access to hired labour. The work mostly carried out by women in rice straw production includes:

- transplanting of rice;
- threshing of straw (not always);
- chaffing, soaking and feeding of straw to the animals;
- cleaning of residual straw from the manger followed by composting;
- making of baskets, ropes (not always);
- harvesting (not always).

Work carried out mostly by men includes:

- cultivation of rice which includes land preparation and sowing;
- manuring, intercultural operations;
- harvesting, transporting and threshing;
- stacking and storing of straw.

CONCLUSION

The quantity of rice straw produced per hectare largely depends on the variety used and on the management practices adopted. In addition to these factors, quality of rice straw is mainly influenced by the method of storage. Traditionally, rice straw among its other uses has been a valuable source of feed for cattle and buffaloes in both low and high input farming systems. Other than in most other straws, in rice the leaves are not always better than the stems.

SUGGESTED READING

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Relevant addresses:

Central Rice Research Institute
ICAR, Cuttack, Orissa, India.

Directorate of Rice Research,
Rajendranagar, Hyderabad, India.