Feed and Fodder Production in Different Agro-Climatic Zones and its Utilization for the Livestock of Odisha

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Nutritional content of different feed and fodder resources in different agro-climatic zones of Odisha

Braja Swain[1], Habibar Rahman[1], Chris Jones[2], Nils Teufel[2] and Prasad KVSK[1]

1. International Livestock Research Institute, India
2. International Livestock Research Institute, Kenya

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Patron: Professor Peter C Doherty AC, FAA, FRS
Animal scientist, Nobel Prize Laureate for Physiology or Medicine–1996

Box 30709, Nairobi 00100
Kenya
Phone +254 20 422 3000
Fax +254 20 422 3001
Email ilri-kenya@cgiar.org

ilri.org
better lives through livestock

ILRI is a CGIAR research centre

Box 5689, Addis Ababa,
Ethiopia
Phone +251 11 617 2000
Fax +251 11 667 6923

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1. Introduction

Feed (nutrition) is an important component in livestock rearing and a major factor affecting the development of viable livestock industries in rural economies. With feed being the major input factor in all livestock production systems, the production/productivity of livestock is strongly linked to feed resource availability. Makkar (2016) argues that feed costs account for up to 70% of the total variable cost of livestock production and may reach 90% in more intensive farming systems. Therefore, the availability of, and access to, good-quality feed will improve ruminant livestock productivity, resulting in lower age at first calving and shorter inter-calving, thus increasing productive life and profitability (Linde et al. 2002). Thus, any attempt to enhance feed availability and minimize feed costs would result in high profit margin for the livestock owner (IGFRI 2013). However, at present India faces a net deficit of 32% green fodder, 23% dry fodder and 36% concentrate feed ingredients (Government of India 2016).

Adequate provision of feed is essential for livestock production and feed scarcity has been one of the major limiting factors for better animal productivity in Odisha (Swain et al. 2015).[1] In 2020, the International Livestock Research Institute (ILRI) observed that there is a 59% shortage of green fodder and 33% shortage of dry fodder in the state (Swain et al. 2020), with the use of combined harvesters expected to reduce the available dry fodder (rice straw) further (Panda and Swain 2021). Milch animals in Odisha are usually fed with locally available resources, especially crop residues and collected grass. This often leads to feeding of an imbalanced ration, which contain protein, energy, minerals and vitamins either in excess or deficit related to the nutrient requirements of the animals. The imbalanced feeding adversely impacts not only productivity, health and welfare of animals, but also the environment.

These lack of high-quality feed resources and imbalanced feeding mechanisms have resulted in the under exploitation of the genetic potential of dairy animals in Odisha. Although the state's daily milk production has increased, data shows that the average milk yield of cattle (both crossbreed and local) in Odisha is lower than the national average. The milk yield of crossbred and indigenous cattle is 6.52 and 1.43 kg/day, respectively, in Odisha, while all India's average is 7.95 and 3.01 kg/day (Government of India 2019).

To improve livestock production in Odisha, the deficit in feed and fodder has to be met either by increasing the utilization of untapped feed resources, or by increasing the area under green forage production (which may not possible due to pressure to grow food crops to feed a growing population). The use of different types of feed including industrial by-products, horticulture and vegetable waste, local grasses, tree leaves, weeds and other non-conventional feed resources should also be promoted. The availability of crop residues and concentrates is linked with food crop production, which has shown an increasing trend with a commensurate increase in the amount of crop residue and concentrate feed ingredients available in the state. However, crop diversification, seen in recent years with commercial crops replacing the traditional (coarse) cereal crops, is likely to reduce the availability of crop residues. In addition, the lack of knowledge among farmers on the nutritional composition of feeds means that

1 Animal husbandry is one of the key sectors which plays a vital role in employment and income opportunities for the rural inhabitants of Odisha. The livestock sector has the highest potential for generating rural self-employment at significantly low investment per unit. This sector contributes about 30% of total rural income (Government of Orissa 2002) and provides large-scale employment to women and workers belonging to the marginalized sectors of society. Livestock contributes about 24% to the gross value of the agricultural output of Odisha and 3.91% to the gross state domestic product (GSDP). The share of the livestock sector in gross value added (GVA) at the constant basic price has been increasing from 2.45% in 2011/12 to 3.91% in 2019/20. The average growth in this sector has stood at 17% at the current price over the years (Government of Odisha 2021).

the available feed resources are not used in the correct proportions to meet the dietary needs of different animals. Further, manufactured compound feeds produced by different agencies in Odisha don't often meet the specific composition and required level of nutrients to meet feed requirements of different animals based on species, breed, stage of lactation and physiological status and quality of basal roughages etc.

The adoptions of supplementary feeding can improve the productivity of livestock, dairy animals in particular. When planning a supplementary feeding program and choosing the feed types, it is important to know the nutritional composition of the feed and fodder that is fed to animals. Milk production and the productive life of dairy animals can be improved substantially if the available feed resources are utilized judiciously.

This report shares the results of an examination of the nutritional composition of different feed and fodder resources that are used as livestock feed in different regions of Odisha. It includes nutritional content estimates of these ingredients, which are provided to help farmers roughly calculate how to meet different animals feed requirements using locally available resources.

2. Data and methods

Data collection

The study assessed different types of fodder such as dry fodder and green fodder (natural grasses available in the open field, cultivated fodder and others) and concentrate feed samples in different blocks across 10 agro-climatic zones of Odisha. A total of 1,528 samples were collected for the study. Of these, 417 samples were concentrate-feed, 417 were dry fodder, and 939 were green fodder. A stratified random sampling strategy was used to identify the blocks and villages. First, the blocks and villages were selected where to collect the samples based on dairy population and milk production in consultation with the Chief District Veterinary Officers (CDVO) and the Block Veterinary Officer (BVO) or Additional VS, and the District Fodder Officer. After the selection of villages, the samples were collected randomly from the village in consultation with a local Livestock Inspector (LI) and farmers. The samples were collected in consultation with the BVO or Additional VS, district Fodder Officer and LI of the respective village. Among the agro-climatic zones, more samples were collected from the East & South-Eastern Coastal Plan (321 samples) followed by Northeastern Coastal Plain (284) and the least from the Southern-Eastern Ghat (37 samples) (Table 1).

Table 1: Samples collected from different agro-climatic zones of Odisha

Sl. No	Agro-climatic zone name	Concentrate	Dry fodder	Green fodder	Total
1	North-western Plateau	19	4	57	80 (5.24)
2	North-central Plateau	16	7	20	43 (2.81)
3	North-eastern Coastal Plain	74	33	177	284 (18.59)
4	East & South-eastern Coastal Plain	100	36	185	321 (21.01)
5	North-eastern Ghat	36	10	91	137 (8.97)
6	Eastern Ghat Highlands	29	15	55	99 (6.48)
7	South-eastern Ghat	4	6	27	37 (2.42)
8	Western Undulating Zone	19	10	47	76 (4.97)
9	West Central Table Land Zone	60	30	208	298 (19.50)
10	Mid Central Table Land	60	21	72	153 (10.01)
Total	Odisha	417 (27.29)	172 (11.26)	939 (61.45)	1,528 (100.00)

Note: () shows %

Methods

The accuracy and reliability of the feed analysis results are associated with the method of sample collection following the collection of feeds and feed materials (Barel 2013). Therefore, it is important to ensure sampling of feed ingredients and feeds is done in an area and in a way that makes the procedure easy and minimizes the risk of contamination and cross-contamination, making proper performance of the laboratory analysis possible. The study followed a very simple method in collection of samples. As the samples were collected from all over Odisha, it was

not possible to process them (by drying, grading and grinding) in the field, so logistic arrangements were made to ensure that the samples reach a central place (the project office at Bhubaneswar) without losing dry matter (DM) and other nutritional contents. Then after grading and drying at the Odisha project office, the samples were sent to the International Livestock Research Institute (ILRI) feed laboratory at Hyderabad for analysis.

Several standard laboratory methods have been developed over the years for the detection of both nutrients and contaminants in feed ingredients and feedstuffs. Feedstuffs can be analyzed using traditional wet chemistry techniques or near-infrared reflectance spectroscopy (NIRS) (Rasby and Martin 2022). The study used the NIRS method to analyze the samples.

The moisture content of feeds can vary greatly and so DM content can be the biggest reason for variation in feed composition on an 'as-fed' basis. Therefore, chemical constitutes, and biological attributes of feeds are presented in this report on a DM basis. The study has different indicators to examine nutritional content in different types of feed (Table 2).

Table 2: Nutrition indicators

Sl. No	Feed nutrition Indicators	Unit
1	Dry matter (DM)	%
2	Ash	%
3	Nitrogen on DM (NDM)	%
4	Neutral detergent fibre on DM (NDFDM)	%
5	Acid detergent fibre on DM (ADFDM)	%
6	Acid detergent lignin on DM (ADLDM)	%
7	Metabolizable energy (ME)	mega joules/kg DM
8	In vitro organic matter digestibility (IVOMD)	%
9	Crude protein (CP)	%

3. Cropping system in different agro-climatic zones of Odisha

Crop residues play an important role in livestock feeding, contributing more than more 70% of total feeding resources (Rao and Hall 2003; Panda et al. 2015). The availability of crop residues is closely related to the farming system, crop produced and the intensity of cultivation. The potential use of crop residues as livestock feed is of great importance in integrated crop-livestock farming systems. When crop and livestock production are segregated, most of the crop residues are wasted. Livestock feeding in coastal Odisha is dependent on rice straw while the zones closer to forest area are mostly rely on the use of forest wastes.

Odisha is characterized by complex and mixed agro-climatic situations, and wide variations exist within and between agro-climatic regions. The east and north-eastern parts of Odisha have more Kharif (rainy season crop) and Rabi (winter season crop) with pulse crops like black gram and green crop intercropped with paddy rice. Paddy rice is the major crop in this region. The western part has a mixture of paddy rice, maize, cotton and other cash crops. The details of the cropping systems in different agro-climatic zones are presented in Table 3.

Table 3: Major crops grown in different agro-climatic zones of Odisha

Zones and districts covered	Climate	Soil type	Cropping system
Zone 1: Northwestern Plateau Zone (Sundargarh, parts of Deogarh, Sambalpur and Jharsuguda)	Warm and humid	Red, mixed red and black, mixed red and yellow	Upland area: rice+ horse gram /mustard, niger, maize-mustard, rice-castor Medium land area: rice-mustard/linseed/ black gram Lowland area: rice-black gram/lentil/linseed
Zone 2: North Central Plateau Zone (Mayurbhanj, major parts of Keonjhar except Anandapur and Ghasipura block)	Warm and humid	Red, lateritic, black	Upland area: groundnut, maize-horse gram, groundnut-castor Medium land area: rice-mustard, rice-green gram/ black gram, rice-chickpea, rice-sunflower Lowland area: rice-black gram
Zone 3: Northeastern Coastal Plain Zone (Balasore, Bhadrak, parts of Jajpur and hatdihi, Ghasipura and Anandpur block of Keonjhar)	Hot and moist sub-humid	Red, mixed red and black, and black	The following are the principal cropping system in rainfed upland, medium and lowlands. Rainfed upland: rice-mung/pulses/black gram/ groundnut-jute Lowland area: jute-rice-pulses, rice-black gram/ mung.

Zone 4: East and Southeastern Coastal Zone (Kendrapara, Khurda, Jagatsinghpur, part of Cuttack, Puri, Nayagarh and part of Ganjam)	Hot and moist sub humid	Red and yellow, red and black, black, brown forest, lateritic	Cropping intensity of the zone is 168%. The cropping pattern of the zone is as follows: rice-rice, rice-pulse, rice-pulse/ groundnut, rice-potato-til, green gram, early rice-cauliflower, cabbage, okra, sugarcane
Zone 5: Northeastern Ghat Zone (Phulbani, Rayagada, Gajapati, part of Ganjam and small patches of Koraput)	Hot and moist sub- humid	Alluvial, red, lateritic, mixed red and black	Unirrigated upland area: rice-green gram/black gram/horse gram, finger millet Irrigated upland area: rice-potato-summer vegetable, rice-green gram/vegetable, summer vegetable
Zone 6: Eastern Ghat Highland Zone (10 blocks of Koraput, Nabarangpur)	Hot and moist sub- humid	Red, brown forest, red and yellow, mixed red and black	Upland area: ragi, rice, niger, horse gram, pearl millet, maize Medium land area: Vegetables, rice-maize, rice-ragi, maize-vegetables, rice-lentil, rice-wheat-black gram Low land area: rice (monocrop), rice-rice
Zone 7: Southeastern Ghat Zone (Koraput, Malkangiri and Similiguda)	Hot and moist sub humid	Lateritic, red and yellow, mixed red and black	Rice is the principal crop occupying 63% of the gross cropped area of the Zone. Other important crops that are widely cultivated are millet (20%), mesta (1.3%) and sesamum (37.08%). A number of fruit crops particularly mango, lime and guava are successfully grown in the zone.
Zone 8: Western Undulating Zone (Kalahandi and Nuapada)	Moist sub humid	Red, lateritic, deltaic alluvial, coastal alluvial and saline	Rain-fed mono cropped: rice, maize, groundnut, black gram, ragi, sesamum, horse gram, pigeon pea Rain-fed double cropped: rice-horse gram, groundnut-horse gram/mustard, maize-mustard/ niger/sesamum Irrigated area: rice-wheat, rice-rice, rice-vegetables, vegetables-sugarcane.
Zone 9: West Central Table Land Zone (Bargarh, Bolangir, Boudh, Sonepur, parts of Sambalpur and Jharsuguda)	Hot and humid, hot and moist sub humid	Saline, lateritic, alluvial, red and mixed red, and black	Cropping intensity is 154% in the zone. There are seven farming situations in the zone and the cropping system of each farming situation is different depending on rainfall and socio-economic conditions. Major cropping system: Double/triple crop Rice-vegetables, rice-black gram, groundnut-vegetables, rice-groundnut, rice-mustard, rice-green gram.
Zone 10: Mid Central Table Land Zone (Angul, Dhenkanal, parts of Cuttack and Jajpur)	Hot and moist sub humid	Brown forest, lateritic alluvial, red, mixed red and black	Rice is the principal crop in the area, comprising 53% of the gross cultivated area. Pulses comprising horse gram, green gram, black gram constitutes 15% of gross cropped area.

4. Results

It is well known that livestock in Odisha are fed with locally available feed (e.g., paddy straw, maize stover, local grass, tree leaves, rice bran etc.) with or without supplementation of compound feed and mineral mixture. These ingredients are used without knowing their quality and nutritional content. Therefore, a systematic analysis is needed to assess the nutritive values of different types of feed and fodder available in different agro-climatic zones of the state The following section discusses the nutritional content in concentrate feed, green and dry fodder of the samples collected across Odisha.

Concentrate feed

Concentrates are low-fibre, high-energy feeds when compared to forages (dry or green) but they vary considerably in nutritional content including crude protein (CP). There can be substantial variation in nutritional content in concentrate feed based on the feed ingredients. St-Pierre and Weiss (2015) found large variations in nutrient composition of common feeds and mixed diets on commercial dairy farms. Table 4 presents the nutritional content in concentrate feed across different agro-climatic zones of Odisha. The results show that the average value of dry matter content in concentrate feed is around 86.98% and varies from 9.87% to 98.5%. The average CP content in concentrate feed is around 16.84% and it varied from 3.18% to 57.45% (Figure 1). Dry mater content in the majority of concentrate feed (more than 70% of samples) ranged from 80 to 98% and CP content ranged from 10 to 30% (Figure 1). The nitrogen on dry matter (NDM), Neutral detergent fibre on dry matter (NDFDM) and Acid detergent fibre on dry matter (ADFDM) is around 2.70%, 44.93% and 25.88%, respectively. The metabolisable energy is around 8.72 mega joules/Kg DM.

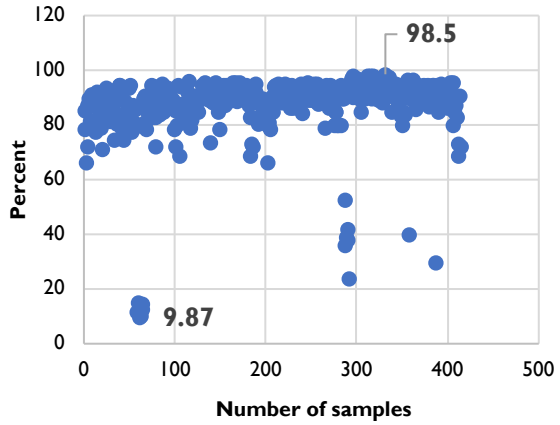
Table 4: Nutritional content in concentrate feeds in different agro-climatic zones of Odisha

Agro-climatic zone	DM	Ash	NDM	NDFDM	ADFDM	ADLDM	ME	IVOMD	CP
North-western Plateau	90.72 (4.05)	12.12 (4.69)	2.66 (0.94)	45.41 (10.87)	27.22 (15.05)	5.33 (2.02)	8.55 (1.55)	61.40 (9.65)	16.66 (5.90)
North-central Plateau	91.98 (2.30)	16.91 (6.48)	2.10 (0.92)	44.42 (8.51)	30.72 (13.86)	5.48 (2.66)	7.75 (1.75)	55.85 (10.78)	13.13 (5.73)
North-eastern Coastal Plain	81.43 (24.17)	9.60 (5.73)	2.93 (1.61)	44.75 (9.31)	22.59 (14.71)	5.23 (2.29)	9.25 (1.77)	65.49 (11.44)	18.33 (10.05)
East & South-eastern Coastal Plain	86.39 (6.08)	10.94 (5.09)	2.59 (1.21)	48.07 (12.86)	26.95 (13.81)	5.31 (2.06)	8.72 (1.59)	62.02 (10.41)	16.19 (7.57)
North-eastern Ghat	93.21 (3.65)	10.80 (4.74)	2.43 (1.04)	41.86 (14.73)	24.84 (14.68)	5.82 (1.82)	8.82 (1.48)	62.26 (9.34)	15.20 (6.49)
Eastern Ghat Highland	89.85 (3.52)	15.11 (6.18)	2.06 (0.97)	46.44 (7.71)	32.10 (11.80)	6.26 (2.03)	7.83 (1.53)	56.10 (9.64)	12.86 (6.05)
South-eastern Ghat	85.08 (7.60)	12.34 (6.33)	1.64 (0.52)	50.29 (5.66)	33.94 (17.53)	7.58 (2.84)	7.79 (2.16)	54.89 (12.94)	10.23 (3.27)
Western Undulating Zone	92.53 (3.20)	15.86 (4.79)	2.44 (0.98)	41.97 (8.06)	28.25 (11.20)	5.28 (1.94)	8.27 (1.40)	59.53 (8.92)	15.26 (6.15)
West Central Table Land Zone	88.02 (15.17)	14.80 (5.89)	2.55 (1.02)	44.35 (7.63)	29.10 (11.63)	5.46 (1.94)	8.06 (1.44)	58.29 (9.16)	15.95 (6.38)
Mid Central Table Land	87.40 (6.58)	8.50 (5.18)	3.49 (2.21)	42.24 (10.50)	19.67 (12.76)	5.13 (2.03)	9.58 (1.50)	68.24 (10.05)	21.83 (13.81)
Odisha	86.98 (13.47)	11.69 (5.94)	2.70 (1.44)	44.93 (10.80)	25.88 (13.83)	5.43 (2.09)	8.72 (1.66)	62.17 (10.76)	16.84 (9.02)

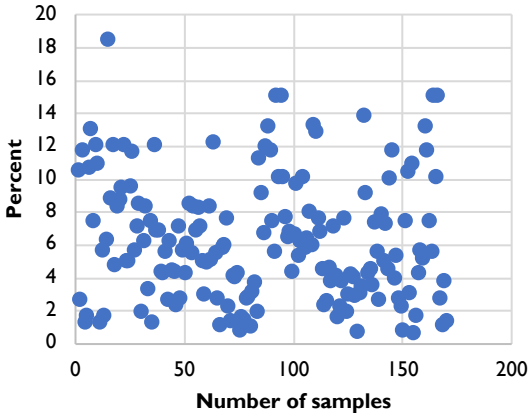
Note: () shows standard deviation

Dry matter content in concentrate feeds was low in the Northeastern Coastal Plain (81.43%) and high in the Northeastern Ghat (93.21%). A high crude protein content was observed in the Mid Central Table Land (21.82%) and it was low in Southeastern Ghat (10.23%).

Figure 1: DM and CP content in concentrate feeds.



% Dry matter (DM)



% Crude protein (CP)

An attempt was made to examine the nutritional content of different types of concentrate feed and the results are presented in Table 5. They indicated that there is considerable variation in dry matter (DM) and crude protein (CP) content not only among the types of concentrate feed but also the same type of concentrate feed. Higher variation in CP content is observed in the oil cake, followed by horse gram bran. High CP content is observed in oil cake (35.60%) and the lowest is observed in platen rice bran (7.55%). The average value of CP in the commercial concentrate feed is around 19.20% and it varied from 4.96% to 30.85%. The average CP content in concentrate feeds supplied by the Odisha State Cooperative Milk Producers Federation (OMFED) is 21.62% and it varied from 9.06% to 29.66%. Black gram bran contained 18.02% CP on average, and it varied from 7.28% to 25.93%. The different values of CP content indicates that there is no proper quality control of the feed available in the market. There is a large variation in the quality, which is hampering the milk yield of dairy animals.

Table 5: DM and CP content in concentrate feeds in Odisha

		DM%			CP%		
Name of concentrate feed	No. of Sample	Mean	Maximum	Minimum	Mean	Maximum	Minimum
Black gram bran	11	88.81 (5.57)	95.4	78.57	18.02 (6.09)	25.93	7.28
Broken rice	3	66.29 (44.28)	94.73	15.27	13.14 (3.94)	17.68	10.8
Chickpea bran	1	91.6 6 (0.00)	91.66	91.66	17.23 (0.00)	17.23	17.23
Chickpea powder	1	83.33 (0.00)	83.33	83.33	10.27 (0.00)	10.27	10.27
Commercial Concentrate feed	88	90.31 (4.98)	98.5	73.33	19.20 (6.07)	30.85	4.96
Finger millet bran	1	94.44 (0.00)	94.44	94.44	7.75 (0.00)	7.75	7.75
Flattened rice bran	1	12.04 (0.00)	12.04	12.04	17.15 (0.00)	17.15	17.15
Gram flour	1	89.47 (0.00)	89.47	89.47	16.28 (0.00)	16.28	16.28
Green gram bran	12	79.70 (21.05)	94.73	15.01	17.71 (5.24)	24.91	8.6

Horse gram bran	3	91.78 (2.35)	94.44	90	16.74 (8.48)	26.15	9.7
Local concentrate feed	35	87.36 (10.36)	97.1	39.23	18.57 (7.30)	33.01	5.49
Maize flour	35	85.18 (16.95)	97	9.87	13.96 (8.49)	45.44	7.9
Maize grain	1	78.94 (0.00)	78.94	78.94	12.18 (0.00)	12.18	12.18
Oil cake	25	86.28 (8.26)	95.8	68.75	35.60 (15.97)	57.45	8.71
OMFED concentrate feed	34	84.39 (19.74)	98.1	11.29	21.62 (4.95)	29.66	9.06
Paddy husk	1	95.83 (0.00)	95.83	95.83	11.68 (0.00)	11.68	11.68
Platen rice bran	1	95.23 (0.00)	95.23	95.23	7.55 (0.00)	7.55	7.55
Polished rice	5	93.05 (2.43)	95.83	90.1	15.65 (4.39)	18.24	7.86
Rice bran	108	87.12 (13.32)	98.3	13.11	10.20 (4.47)	27.65	3.18
Rice husk	2	92.75 (3.46)	95.2	90.3	15.83 (0.26)	16.01	15.64
Wheat bran	43	86.34 (12.77)	96	10.25	16.01 (3.68)	24.26	8.28
Wheat flour	1	87.50 (0.00)	87.5	87.5	13.49 (0.00)	13.49	13.49

Note: () Shows standard deviation

Green fodder

Green fodder is an economical source of nutrients for dairy animals. Green forages have a cooling effect on the animal's body since they are more palatable, easily digestible and, provide fresh and effective nutrients. Microorganisms present in green fodder help in improving digestibility of crop residues for animals maintained under a mixed feeding system. The feeding of concentrates gives higher milk yield per unit of feed intake, however, it may not be economically viable in states like Odisha, where grains and concentrates are costly and/or of inadequate supply. On the other hand, feeding only with concentrate will not be cost-effective and without fibre some benefits can be wasted. Animals yielding as high as eight litres of milk can easily be maintained by solely depending on green fodder without feeding any concentrate. However, farmers in Odisha hardly grow any green fodder in their fields. The population pressure of Odisha compels farmers to undertake agricultural activities on their land and the lack of proper irrigation facilities also does not encourage them to engage in fodder cultivation. They use different types of green grass from different sources such as the forest floor, roadsides and other areas that may have high nutrient content. Identifying these particular varieties and knowing their nutritional content will help in feed planning in the state.

Table 6 presents the nutritional content of green fodder available in the different agro-climatic zones of Odisha. The average value of dry matter content in green fodder was around 31.03% (Table 6) and it varied from 5.88% to 58.49% (Figure 2). The average crude protein (CP) content in green fodder is around 14.56% and it varied from 1.90% to 35%. Dry mater content in the majority of green fodder (more than 80% of samples) varied between 10 and 50% and CP content varied between 2 and 20% (Figure 2). The NDM, NDFDM and ADFDM is around 2.33%, 56.99% and 33.73%, respectively. The metabolic energy content is around 7.85 mega joules/KgDM (Table 6).

Table 6: Nutritional content in green fodder in different agro-climatic zones of Odisha

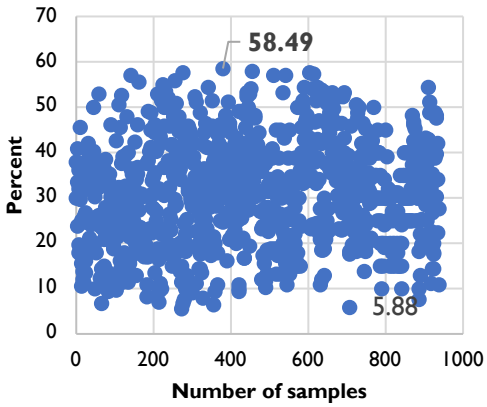
Agro-climatic zone	DM	Ash	NDM	NDFDM	ADFDM	ADLDM	ME	IVOMD	CP
North-western Plateau	27.91 (11.46)	13.63 (2.87)	2.32 (0.82)	56.71 (9.81)	33.01 (5.95)	3.97 (1.90)	7.91 (0.74)	57.36 (5.45)	14.50 (5.13)
Northcentral Plateau	32.35 (9.08)	17.43 (3.05)	2.33 (0.74)	54.28 (9.38)	34.12 (7.04)	4.78 (1.70)	7.07 (0.97)	51.97 (6.53)	14.55 (4.64)
North-eastern Coastal Plain	30.92 (12.28)	13.38 (3.38)	2.58 (0.95)	57.27 (8.58)	32.27 (6.44)	3.74 (1.51)	8.09 (0.72)	58.36 (5.36)	16.13 (5.91)
East & South-eastern Coastal Plain	26.89 (10.86)	12.45 (3.80)	2.30 (0.86)	54.65 (10.25)	32.49 (7.52)	4.82 (1.95)	8.15 (0.91)	58.34 (6.46)	14.41 (5.40)
North-eastern Ghat	32.49 (10.29)	13.47 (2.84)	2.39 (0.91)	57.26 (9.85)	32.70 (6.31)	4.18 (2.00)	7.97 (0.82)	57.63 (5.88)	14.95 (5.68)
Eastern Ghat Highland	34.92 (13.18)	17.91 (7.55)	2.28 (0.68)	54.44 (9.80)	37.13 (6.84)	5.35 (2.23)	7.31 (0.81)	53.79 (5.07)	14.28 (4.26)
South-eastern Ghat	35.19 (14.96)	13.58 (3.96)	2.57 (0.94)	55.23 (10.98)	30.47 (6.13)	4.40 (2.54)	8.10 (0.93)	58.44 (7.08)	16.09 (5.89)
Western Undulating Zone	32.05 (11.15)	17.13 (4.05)	2.21 (0.72)	57.60 (7.75)	37.47 (5.89)	4.86 (1.91)	7.09 (0.71)	52.10 (4.70)	13.81 (4.48)
West Central Table Land Zone	32.81 (10.44)	13.81 (3.87)	2.22 (0.79)	58.30 (8.83)	34.84 (5.28)	4.35 (1.73)	7.67 (0.65)	55.35 (4.60)	13.87 (4.95)
Mid Central Table Land	31.89 (10.82)	12.23 (3.15)	2.04 (1.08)	61.40 10.16)	35.25 (7.88)	4.04 (1.64)	7.82 (0.90)	55.86 (6.70)	12.77 (6.75)
Odisha	31.03 (11.52)	13.77 (4.17)	2.33 (0.88)	56.99 (9.58)	33.73 (6.72)	4.36 (1.89)	7.85 (0.84)	56.65 (5.94)	14.56 (5.49)

Note: () shows standard deviation

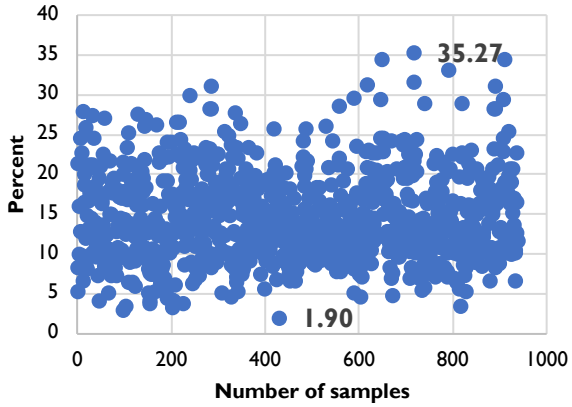
Dry matter content in green fodder is low in the East & Southeastern Coastal Plain (26.89%) and high in the Eastern Ghat Highland (34.92%). A low crude protein content is observed in the Mid Central Table Land (12.77%), and it is high in the Northeastern Coastal Plain (16.13%).

Dry matter content in green fodder is low in the East & Southeastern Coastal Plain (26.89%) and high in the Eastern Ghat Highland (34.92%). A low crude protein content is observed in the Mid Central Table Land (12.77%), and it is high in the Northeastern Coastal Plain (16.13%).

Figure 2: DM and CP content in green fodder.



% Dry matter (DM)



% Crude protein (CP)

Table 7 presents the dry matter and crude protein content in different types of green forges available in Odisha. The value of crude protein content indicated that Sesbania grandiflora (Agasti) has high CP content (31%) followed by Leucaena leucocephala (Subabool) (26%). Among all the samples collected for the analysis, sugarcane leaf had the lowest CP content (8.08%) even less than the local grass or tree leaves. The aquatic fern, Azolla has 17.56%, fodder sorghum (COFS-29) has 10.63% and a hybrid Napier grass has 11.17% CP. High variation in CP content is observed in the vegetable leaf samples, varying from 10.28% to 29.92%. Cowpea contained 16.76% CP and Congo signal grass had 10.34%.

Table 7: DM and CP content in different green forages in Odisha

Green grass name	No. of Sample	Mean	Maximum	Minimum	Mean	Maximum	Minimum
Azolla	4	8.90 (6.08)	18	5.47	17.56 (3.99)	23.37	14.95
Bajra grass	2	19.85 (14.82)	30.33	9.37	11.88 (0.82)	12.46	11.3
Berseem	3	28.94 (9.93)	39.45	19.71	19.29 (3.56)	22.27	15.35
Brachiaria mutica	19	26.23 (10.52)	46.96	14.28	15.27 (3.64)	20.74	10.15
Chickpea leaf	5	32.96 (11.68)	45.09	13.51	16.38 (4.07)	22.31	12.62
Congo signal	1	45.98 (0.00)	45.98	45.98	10.34 (0.00)	10.34	10.34
Cowpea	10	31.03 (12.99)	48.73	14.28	16.76 (4.35)	22.65	7.24
Green groundnut plant	2	18.50 (0.00)	18.5	18.5	20.00 (2.00)	22.78	18.57
Green maize tree	19	34.96 (12.19)	54.12	13.1	13.70 (3.64)	19.32	7.79
Guinea grass	2	23.16 (11.53)	31.31	15	12.75 (1.38)	13.73	11.78
Hedge lucerne	1	31.00 (0.00)	31	31	19.69 (0.00)	19.69	19.69
Hybrid Napier	65	27.28 (8.79)	49.18	11.67	11.17 (3.51)	23.58	5.5
Local grass	628	30.84 (11.33)	58.49	6.55	14.63 (5.43)	35.27	1.9
Maize leaf	1	26.57 (0.00)	26.57	26.57	9.07 (0.00)	9.07	9.07
Oat	1	19.07 (0.00)	19.07	19.07	21.75 (0.00)	21.75	21.75
Pigeon pea leaf	1	44.11 (0.00)	44.11	44.11	19.14 (0.00)	19.14	19.14
Sesbania grandiflora	1	23.72 (0.00)	23.72	23.72	31.61 (0.00)	31.61	31.61
Sorghum Sudan	8	44.11 (7.96)	54.47	32.92	12.70 (3.06)	17.12	9.11
Sorghum-29	69	32.38 (8.80)	57.89	15	10.63 (2.48)	15.86	3.42
Stylo grass	1	39.62 (0.00)	39.62	39.62	17.90 (0.00)	17.9	17.9
Subabool	10	34.83 (10.13)	44.28	10.95	26.99 (5.89)	34.56	19.01
Sugarcane leaf	3	36.10 (12.92)	50.68	26.05	8.08 (1.10)	8.76	6.81
Tree leaf	73	36.32 (11.10)	57.57	11.9	17.15 (4.80)	27.5	3.03
Vegetable leaf	11	12.07 (4.77)	23.33	6.77	22.21 (6.22)	29.92	10.28

Note: () show standard deviation

Dry fodder

Feed shortage is one of the main constraints to exploiting the full genetic potential of dairy animals. Due to inadequate availability of green fodder production, paddy rice straw is the main feed resource for dairy animals in Odisha. It is estimated that paddy rice straw contributes around 70% of total roughages available to large ruminants. In the foreseeable future, it is envisaged that if alternative feeds are not available in the state, farmers will continue to

depend on straw for feeding their animals. Due to other uses of paddy rice straw (i.e., packaging, use for mushroom cultivation and use of combine harvesters), there is likely to be scarcity of dry fodder for livestock feeding in the future. To mitigate this shortage, efforts should be made to explore other dry forages, which are being grown by the farmers but are underutilized or not even fed to the animals. Therefore, it is important to know the nutritional content of the dry fodder options available in Odisha.

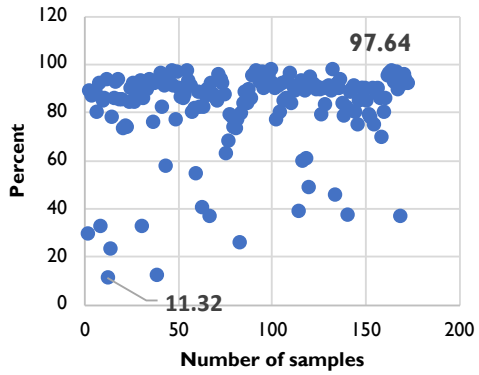
The average value of dry matter content in dry fodder was around 82.72% (Table 8) and varied from 11.32% to 97.64% (Figure 3). The average crude protein (CP) content in dry fodder is around 6.34% and it varied from 0.70% to 18.47%. Dry matter content in the majority of dry fodder (more than 80% of samples) varied between 80% and 98% and CP content varied between 1% and12% (Figure 3). The NDM, NDFDM and ADFDM content in dry fodder is around 1.01%, 62.21% and 45.01%, respectively. The metabolic energy content is around 6.97 mega joules/KgDM (Table 8).

Table 8: Nutritional content of dry fodder in different agro-climatic zones of Odisha

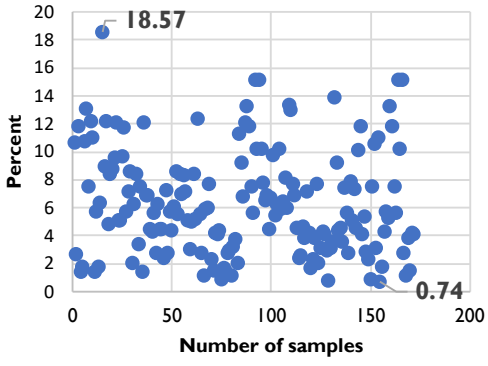
Agro-climatic zone	DM	Ash	NDM	NDFDM	ADFDM	ADLDM	ME	IVOMD	CP
North-western Plateau	78.89 (13.63)	17.72 (0.65)	0.92 (0.26)	66.97 (1.46)	49.14 (2.66)	4.63 (0.24)	6.30 (0.36)	44.90 (2.54)	5.78 (1.64)
North-central Plateau	88.96 (6.60)	18.74 (3.81)	1.20 (0.39)	62.04 (5.99)	46.81 (5.32)	5.93 (2.16)	6.50 (0.51)	46.95 (2.84)	7.46 (2.43)
North-eastern Coastal Plain	84.90 (13.97)	15.10 (4.01)	0.89 (0.57)	61.35 (14.16)	43.39 (12.41)	4.93 (1.77)	7.26 (1.06)	51.42 (7.47)	5.58 (3.59)
East & South-eastern Coastal Plain	74.81 (25.28)	13.15 (4.35)	1.08 (0.60)	58.45 (12.09)	40.62 (12.11)	5.81 (2.44)	7.38 (1.28)	52.36 (9.18)	6.72 (3.75)
North-eastern Ghat	87.51 (3.77)	19.41 (2.38)	0.56 (0.17)	68.36 (1.57)	52.13 (1.97)	4.15 (0.47)	6.68 (0.45)	47.75 (2.46)	3.47 (1.07)
Eastern Ghat Highland	84.54 (16.10)	13.73 (6.16)	1.14 (0.38)	65.89 (6.97)	46.73 (7.14)	6.50 (2.36)	6.90 (0.87)	48.68 (5.17)	7.11 (2.34)
South-eastern Ghat	87.93 (6.69)	12.90 (5.24)	0.93 (0.33)	66.96 (4.92)	47.99 (3.88)	6.55 (2.61)	7.19 (0.50)	50.18 (2.89)	5.82 (2.04)
Western Undulating Zone	87.73 (4.38)	19.01 (6.62)	1.44 (0.52)	57.38 (14.06)	44.13 (9.02)	5.61 (1.56)	6.81 (0.83)	49.34 (5.52)	9.01 (3.26)
West Central Table Land Zone	86.95 (16.81)	17.08 (4.74)	1.29 (0.64)	60.42 (9.05)	44.36 (9.53)	6.04 (2.56)	6.70 (0.79)	48.28 (4.69)	8.07 (4.01)
Mid Central Table Land	77.73 (17.84)	17.38 (2.55)	0.60 (0.50)	67.07 (8.98)	50.18 (6.06)	4.47 (1.50)	6.71 (0.51)	47.49 (3.82)	3.74 (3.11)
Odisha	82.72 (17.51)	15.82 (4.81)	1.01 (0.58)	62.21 (10.93)	45.09 (10.02)	5.47 (2.16)	6.97 (0.95)	49.62 (6.47)	6.34 (3.62)

Dry matter content in dry fodder is high in the Northwestern Plateau (88.96%) and low in the East and Southeastern Coastal Plain (74.81%). A low crude protein content is observed in Northeastern Ghat (3.47%) and it is high in the Western Undulating Zone (9.01%).

Figure 3: DM and CP content in dry fodder in Odisha.



% Dry matter (DM)



% Crude protein (CP)

Table 9 presents the dry matter and crude protein content in different types of dry fodder available in Odisha. The value of dry matter indicated that horse gram residue had high dry matter content (93.59%) followed by chickpea residue (93.19%), and it is lowest in sugarcane bagasse (32.84%). Paddy rice straw content 82.59% dry matter and maize stover has a little higher (86.76%). Pigeon pea had the highest CP content (13.85%) followed by red gram residue (12.36%). Among all the samples collected for analysis, paddy rice straw has the lowest CP content (4.18%) even less than finger millet residues. Bajra residue has 4.48%, maize stover has 6.65%, groundnut haulm had 10.59% and black gram had 9.64% crude protein.

Table 9: DM and CP content in dry fodder in Odisha

Type of dry fodder	No. of Sample	Mean	Maximum	Minimum	Mean	Maximum	Minimum
Bajra residue	1	90.00 (0.00)	90	90	4.58 (0.00)	4.58	4.58
Black gram residue	13	73.41 (24.14)	97.36	12.63	9.64 (1.74)	12.19	6.94
Chickpea dry residue	5	93.19 (5.47)	96.59	83.87	10.34 (2.81)	13.37	7.57
Finger millet residue	2	75.01 (28.53)	95.18	54.83	4.81 (2.45)	6.55	3.08
Grass pea residue	1	90.19 (0.00)	90.19	90.19	4.38 (0.00)	4.38	4.38
Green gram residue	15	81.92 (14.39)	95.18	37.5	10.12 (2.39)	13.13	5.25
Groundnut haulm	8	86.10 (10.23)	97.64	73.17	10.59 (2.25)	13.94	7.24
Horse gram residue	1	93.58 (0.00)	93.58	93.58	10.78 (0.00)	10.78	10.78
Horse gram residue	4	76.15 (20.72)	90.32	45.81	8.97 (1.27)	10.19	7.18
Long bean residue	1	93.33 (0.00)	93.33	93.33	6.99 (0.00)	6.99	6.99
Maize stover	3	86.76 (2.64)	89.09	83.89	6.65 (0.96)	7.47	5.59
Paddy straw	106	82.79 (17.34)	97.33	11.32	4.18 (2.02)	8.62	0.74
Pearl millet residue	1	91.37 (0.00)	91.37	91.37	8.38 (0.00)	8.38	8.38
Pigeon pea residue	9	92.42 (5.08)	96.66	85.8	13.85 (1.99)	15.13	9.79
Red gram residue	1	82.41 (0.00)	82.41	82.41	12.36 (0.00)	12.36	12.36
Small millet residue	1	97.82 (0.00)	97.82	97.82	4.47 (0.00)	4.47	4.47
Sugarcane bagasse	1	32.84 (0.00)	32.84	32.84	7.57 (0.00)	7.57	7.57

5. Conclusion

Adequate provision of feed is essential, and its scarcity is one of the major limiting factors that is hampering livestock productivity in Odisha. To meet the enhance the level of livestock production in the state, the deficit in feed and fodder has to be met either from increasing utilization of untapped feed resources or by increasing the area under green forage production. Most livestock keepers in the state use locally available feed resources such as paddy straw, local grass, tree leaves, rice bran etc. with or without supplementation of compound feed and mineral mixture. These ingredients are fed without knowing their quality and nutritional content. This study examined the nutritional content in different types of feeds in Odisha and provided estimates that could be used by actors in livestock sector including farmers in the state to improve livestock feeding, especially for dairy production.

The results showed that the average value of crude protein in available concentrate feed is approximately 17% and varies from 3.18% to 57.45%. The highest CP content was found in oil cake (35.60%) and the lowest in platen rice bran (7.55%). The average CP content in concentrate feed supplied by OMFED (Odisha State Cooperative Milk Producers Federation) is 21.62%. For green fodder, Agasti has the highest content of CP (31%) followed by Subabool (26%). Sugarcane leaf was found to have the lowest CP content (8.08%), which is less than that found in local grass or tree leaves. Azolla has 17.56%, COFS-29 (Perennial sorghum) has 10.63% and hybrid Napier has 11.17% CP. In the case of dry fodder, the results indicated that pigeon pea residue has high CP content (13.85%) followed by red gram residue (12.36%). Paddy straw had the lowest CP content (4.18%) even less than the finger millet residues. Pearl millet (Bajra) residue had 4.48%, maize stover had 6.65%, groundnut haulm had 10.59% and black gram residue had 9.64% crude protein.

These results indicated that nutritional content of available feed resources in Odisha varies significantly. Some concentrate feed quality is very poor compared to the green fodder. Therefore, the authorities and manufactures need to enhance quality control to ensure the commercial feed in the market is of a high standard and meets the nutritional requirements of animals. Some types of dry fodder available in the state have a higher CP content than paddy straw and need extension support to promote them alongside green fodder varieties, for use as livestock feed.

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