Working Group Report on Animal Nutrition Pertaining to Milk Cattle and Buffaloes in Haryana

aryana Kisan & Agricultural Costs and Prices Commission
(Government of Haryana)
Panchkula – 134116

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Working Group Report on "Animal Nutrition Pertaining to Milk Cattle and Buffaloes in Haryana"

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Copies printed: 300

Sh. Sanjeev Kaushal, IAS,
Additional Chief Secretary,
Government of Haryana and
Chairman, Haryana Kisan & Agricultural
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FOREWORD

Since ancient times, the beginning of agriculture, livestock rearing has remained its vital component. In Haryana females of cows and buffaloes, the principal farm animals of economic importance, are brought up exclusively for milk production and males for the draught purposes. The high milk yielding breeds Hariana and Sahiwal of cow and Murrah of buffaloes are quite popular in our state. Livelihood of about 20.5 million rural masses depends on livestock rearing. During the year 2018-19, the agriculture and allied sectors contributed about 17.5 per cent of the Gross State Value Added. For achieving more progress of farmers, the realization and improvement in the role of livestock is most essential.

Because of incentive based policies and programmes of state government, the livestock sector is growing at faster pace than the crop component of agriculture. Being the backbone of rural economy it is supplementing their income needs. Adopting modern technology, the total milk production in the state for the year 2017-18 has risen to 98.09 lakh tonnes. Now, per capita per day milk availability has also increased to 1005g; the second highest against the national average of 375g. In order to further revolutionize milk production the state government is setting up a Centre of Excellence on Livestock at Hisar costing Rs.14.98 crore.

The availability of adequate quantity and quality of feeds and fodder has greater impact on health and productivity of livestock in the state. The lactation and dry span of milk animals also depends on green or dry fodder, and feed is responsible for improving. However, with the demand of land for growing more food grains, oil seeds and pulses, due attention and share has not been given to production of fodder crops. The area under fodder cultivation, which is only 4% of the total cropping area, has remained static over a longer period. Although, in last decade availability of feed and fodder has improved, yet a lot remains to bridge the gap between demand and availability of fodder for sustaining the health of animals and milk production in the state.

In view of these facts, the present document brought out by the working group on ‘Animal Nutrition Pertaining to Milk Cattle and Buffaloes in Haryana’ to provide a roadmap for improvement in feed, fodder and the bovine production in Haryana is quite impressive. After several deliberations with stakeholder including feed and fodder industrialists, dairy farmers, animal husbandry, and veterinary services people and finally with the government officials the report addressed the issues identified in the notification of HKACPC. I appreciate the efforts and contribution of all the members of WG and the then Chairman, Member Secretary and other staff of HKACPC associated in bringing out this useful compilation. It contains appropriate suggestions and key recommendations for the benefit of farmers and other stakeholders in the state.

(Sh. Sanjeev Kaushal, IAS)
ACS and Chairman, HKACPC

Dr. N.N. Pathak
Former Director,
Central Institute for Research on Buffaloes, Hisar
Head, Animal Nutrition Division,
Indian Veterinary Research Institute, Izatnagar

PREFACE

Livestock plays an important role in rural economy. About 20.5 million people depend upon livestock for their livelihood. Agriculture and allied sectors contributed 17.5 per cent of the Gross State Value Added (GSVA) during the year 2018-19. Livestock sector, which provides livelihood for two third of the rural masses and supplements their income needs, due to incentive based policies and programs of state government, is growing faster than the crop component of agriculture. A decrease in livestock population has been noticed during 2007 to 2012 from 8.85 million to 8.81 million (excluding 0.18 million stray cattle) registering a negative growth of 0.44% of the total livestock population. However, with the implementation of National Program of 'Bovine Breeding & Dairy Development' for conservation, up-gradation and integrated development of indigenous breeds of cattle i.e. Hariana, Sahiwal, Tharparkar, Gir and Murrah buffalo, and efforts of farmers the total annual milk production in the State has reached to 98.09 lakh tones during 2017-18 and per capita per day availability of milk has increased to 1005g.

Available quantity and quality of feeds and fodder in the state has significant impact on productivity of livestock. Due to pressure on land for growing food grains, oil seeds and pulses, an adequate attention has not been placed on production of fodder crops. Coupled with this the grazing lands are also diminishing gradually. The area under fodder cultivation is only about 4% of the total cropping area, and very unlikely the area under fodder cultivation would increase substantially. Though availability of feed and fodder has improved in last decade, yet lot remains to be done to bridge the gap between demand and availability of fodder not only for sustaining the health of animals but also milk production in the state.

Looking into importance of livestock and the fodder production HKACPC formed a working group on 'Animal Nutrition Pertaining to Milk Cattle and Buffaloes in Haryana' to document a roadmap for improvement in feed/fodder and bovine production. The WG held five meetings at various places with stakeholder like feed and fodder industrialists, dairy farmers, animal husbandry, and veterinary services people and finally with the government officials before presentation of final document to the Commission. A final draft report was presented before the experts drawn from HKACPC, LUVAS, CIRB and Department of Animal Husbandry and Livestock Development, Haryana at Panchkula. WG addressed the issues identified and has come out with appropriate suggestions and key recommendations.

I thankfully acknowledge the support and cooperation extended by all members of WG and experts for their useful inputs in the preparation of report. I also place on record my sincere gratitude to Dr.R.K. Yadava, Chairman and Dr.R.S. Balyan, Member Secretary, HKACPC and all the secretariat staff at Panchkula for facilitating the visits and meetings. The WG takes immense pleasure in thanking Dr. Inderjeet Singh, the then Director, CIRB, Hisar for providing logistic support and sparing facilities for holding most of the meetings. Special mention goes to Dr. Ashok Balhara, Senior Scientist, Dr. Avijit Dey, Principal Scientist from CIRB, Hisar and Dr. Sajjan Sihag, Principal Scientist, LUVAS, Hisar for their help in compilation and editing of this report.

(**N.N. Pathak**)
Chairman Working Group

Sh. Vijay Singh Dahiya, IAS
Member Secretary, Haryana Kisan &
Agricultural Costs and Prices Commission
(Govt. of Haryana), Panchkula

ACKNOWLEDGEMENTS

Animal Husbandry as an integral part of agriculture provides livelihood to the rural masses in Haryana. The role of animal husbandry is very pivotal since its contribution has been highest to the Agricultural-GDP. Haryana, since its inception or even as part of erstwhile Punjab, ranks top position concerning the milk production per animal and milk consumption per capita. Further increasing milk productivity and production are essential to ensure the availability of required per capita milk in the state. The increase in milk production and consumption depends upon better nutrition feed fed to our animals. In this regard, proper nutritional quality & quantity of fodder and feed are required for healthy growth of animals. Therefore, fodder and feed shortages of milking and growing animals needed to be addressed to meet out the demand of milk in the state.

Haryana Kisan & Agricultural Costs and Prices Commission, through expert team of working groups having focus on the interests of all stakeholders, is striving its best efforts in promoting animal and farm sectors of the state. Commission extends apt suggestions to state government for making policy initiatives of new ventures, trainings and facilities for the benefit of farmers. The purpose of this working group on Animal Nutrition concerning milk Cattle and Buffaloes was to know their status and the fodder and feed needs in Haryana state. It was to catalyze policy changes needed to make this sector more vibrant by addressing the situation of fodder and concerns of less nutrition feeding of milk animals, their low productivity and training needs of farmers as well other promotional means.

It is a matter of immense pleasure for me to thank Dr. R.K. Yadava, Ex-Chairman; Dr. R.S. Dalal and Dr. R.S. Balyan Ex-Member Secretaries; Dr. Shyam Bhaskar, Member, HKACPC for their support and guidance throughout the functioning of the working group. My sincere thanks are to Prof. N.N. Pathak, former Director, CIRB, Hisar and all members of the WG, who after thorough study and interactions with stakeholders have brought out a valuable report along with practical recommendations. I also would like to thank Dr. Gajender Singh, Ex-Nodal officer, and Dr. Sanjay Yadav, Associate Nodal Officer of the Working Group. I express my thanks to Dr. Partap Singh, Consultant; Mrs. Vandna Bajala, Research Fellows, Mr. Pardeep Ahlawat, Computer Programmer and all other staff of the Commission for commendable efforts and support in preparing this useful report.

I am confident that present report will help the policy makers and provide guidance for improving feedings of milking cattle and buffaloes, and boost the milk production scenario of the state in long run. Also, I am thankful to the all stakeholders and farmers of the Haryana state who put forward their valuable suggestions in preparation of this report.

(Vijay Singh Dahiya, IAS)
Member Secretary, HKACPC

HARYANA KISAN AYOG
ANAJ MANDI, SECTOR-20, PANCHKULA

NOTIFICATION

The Chairman, Haryana Kisan Ayog is pleased to constitute the following Working Group on:

"Animal Nutrition Pertaining to Milk Cattle and Buffaloes in Haryana":

1.	Dr. N.N. Pathak, Ex. Director CIRB, Hisar	Chairman
2.	Dr. D.C. Sangwan, Ex-Professor & Head, Animal Nutrition, CCSHAU, Hisar	Member
3.	Dr. B.S. Jhorar, Ex-Head, Forage Section, CCSHAU, Hisar	Member
4.	Dr. S.S. Dahiya, Principal Scientist, Animal Nutrition & Feed Technology, CIRB Hisar	Member
5.	Dr. Nand Kishore, Head, Department of Animal Nutrition LUVAS Hisar	Member

TERMS OF REFERENCE

1. To analyze the present status of feed and fodder development in the State and suggest measures for further improvement in quality of feed and fodder with high nutritive value.
2. To review the current support and policies provided by the State Government for feed and fodder development in the State and recommend policies and programmes for strengthening the availability of feed and fodder in the State.
3. To examine the status of R&D efforts for development of fodder varieties with high yield, better nutritive value and low input requirement and suggest measures for filling the present research gaps.
4. To assess the status of fodder production in the State i.e. area under fodder crops and high yielding varieties and find out the ways for further improvement in fodder production, storage and transportation as per the need of the State.
5. To examine the availability and status of feed mixtures in respect of animal health and nutritive value pertaining to high milk yield and propose methods for further improvement in the situation.
6. To suggest most appropriate extension strategies for overall improvement in animal nutrition in respect of health and high milk yield in cattle.

OTHER TERMS AND CONDITIONS:

1. On submission of the report, the members will be entitled for a lump sum honorarium of Rs. 25000/- each, whereas the chairman will be paid an honorarium of Rs.50000/-.
2. Members of working group will be paid TA for attending meetings on actual basis and an honorarium of Rs. 2000/- for each meeting.
3. The Commission will bear the cost on typing, printing etc. and for conducting the meetings. In case if any meeting is to be held by the group elsewhere, the expenses will be paid on actual basis.
4. The working group should submit its report preferably in six months from the date of this notification.

Note: From Commission side, Dr. Gajender Singh, Research Fellow will be the nodal officer providing needed technical backstopping, whereas Dr. R.S. Dalal, Member-Secretary will extend required administrative support.

RSDalal

Member-Secretary
Haryana Kisan Ayog

Endst. No./HKA/WG/15/1654-1664 **Dated, Panchkula, 04.07.2016**

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EXECUTIVE SUMMARY

• The Bovine Production Scenario

Haryana has been the home of major draught, milch and dual-purpose breeds of cattle and the world famous Murrah breed of buffaloes. Haryana agriculture is endowed with the livestock production system which is complex. The growth rate of agriculture and allied sectors increased from 3.8 per cent in 2015-16 to 10.4 per cent in 2016-17, 5.5 per cent in 2017-18 and 5.5 per cent in 2018-19 (as per Advance Estimates). The entire feed and fodder requirement of livestock is met from crop residues and by-products; grasses, weeds and tree leaves gathered from cultivated and non-cultivated lands; and grazing on common lands and harvested fields. Due to ever increasing pressure of human population, it is highly unlikely that fodder production will get adequate attention & area under fodder production will increase.

As per Livestock Census-2012, livestock population of Haryana state was 89.98 lakh including 18.08 lakh cattle and 60.85 lakh buffaloes. The total annual milk production for the year 2017-18 has risen to 98.09 lakh tonnes in the state and per capita per day availability of milk has increased to 1005g, which is second highest in the country against 375g of national average. Cattle and buffaloes are the prime farm animals of Haryana. Number of exotic (*Bos taurus*) and crossbred (*Bos indicus* x *Bos taurus*) cattle are continuously increasing after the start of All India Coordinated Research Project on Cattle in 1968. Species wise animal production systems in the state have been discussed and presented in the report.

Traditional systems of bovine farming are prevalent in the state. It is likely that the demand of livestock products will increase and could be an excellent opportunity to the producers who are primarily small land holders. However, advent of large-scale integrated commercial companies will definitely add to the complexity of livestock value chains and thus, make it more difficult for small land holders and likely displacement of small-scale livestock farmers would magnify the rural poverty. In order to benefit the rural people and being the long awaited issue, a due attention and consent is desired from Haryana government to accord livestock farming and animal husbandry the status of a cottage industry.

• Existing Feeding Practices of Cattle and Buffaloes

Traditionally, intertwining of agriculture and livestock ensures sustainable livelihood to the large rural population. Livestock is also an important asset for providing employment to millions of rural people. The economic viability of livestock husbandry heavily depends on source(s) of feed and fodder as feeding cost account for about 65-70 per cent of the total cost of livestock farming.

About 78 per cent of the total milk production in the state is contributed by buffaloes only, thus making buffalo the animal of choice. In the irrigated areas of the state agriculture, largely the ruminants (cattle and buffaloes) are managed intensively hence the demand of feed and fodder is bound to increase, leading to a conflict in land resource use for grain production. Further, due to high intensity of cultivation and associated use of chemical fertilizers, the rapidly changing mineral profile of soil, fodders and other animal feed stuffs are resulting in mineral imbalances. Supplementation of such minerals through specific mineral salts is the only practical approach to alleviate these deficiencies. Balanced ration feeding will definitely improve the milk yield; milk constituents along with reduction in methane emissions, however, the inadequate supply and scarcity of feed/fodder resources is one of the major constraints.

Resource poor farmers are following the traditional feeding practices and are largely dependent on their 'own farm' produce for green fodder, dry roughage and some concentrate ingredients like wheat, bajra grains, cakes etc. Both quantitative and qualitative information's for feed and fodder resources of the state are required so that strategies to increase the production of feed and fodder or procurement/mobilization from the surplus areas can be visualized. Newer feed resources like fodder trees/bushes, by products of fruit and vegetable industry, hydroponics, aquatic feeds, feed supplement and some modern concepts like by pass and designer feeds are to be exploited. Supply of matching feed intake and nutrients is really a challenge for the high productivity animals.

• The Scenario of Feeds and Fodders

Due to ever increasing population pressure, there is little chance of having good quality arable land available for fodder production and the share has hardly ever exceeded 5% of the gross cropped area. To overcome adverse agro-climatic conditions in semi-arid zone where the soils are shallow, poor in texture, undulating, poor in drainage, low in water holding capacity and fertility, the alternate land use system can be for the adoption of various agro-forestry systems (agri-silvi-culture, alley cropping and boundary plantation, agro horticulture and silvi-pasture). With the establishment of Haryana Agricultural University, systematic research efforts for improvements in forage crops resulted in release of a number of high yielding varieties & suitable production technology for forage production.

R & D efforts for development of fodder varieties includes varietal improvement through forage breeding, basic and applied genetic research for quantity and quality traits, development of suitable forages for problematic conditions, seed production and seed technology research, development of agronomical package of practices for forage crops, identification of toxic constituents, forage pathology and entomology. Inadequacy of feed and fodder in the state may be attributed to disappearing pasture /grazing lands, lack of agency responsible for fodder seed production and lack of effective strategies of proper storage, transport and conservation (silage & hay) of surplus fodder available during favorable season. A lot is required to be done to bridge the gap between demand and availability of fodder in the state, particularly during lean periods and crisis situations. Increasing the area under fodder crops through incentives, promotional schemes, assured economic returns by ensuring MSP, creation of fodder banks and separate forage seed development agency should be on the agenda of Govt.

• Public Sector Programs and Policies

All the schemes for feed and fodder development to enhance livestock productivity has not been able to deliver the desired results. Since most of the schemes have common objectives but are working in isolation, therefore, convergence or merging of some scheme with other flagship schemes will certainly deliver the desired result.

• Extension Strategies for Fodder Production

The components of extension strategy can be motivation, education and creation of awareness among the farmers for on-farm evaluation of fodder production technologies, conservation of forages by ensiling and hay making to meet the demand in crisis at the time of fodder scarcity, plantation of shrubs and small trees (like *Gliricidia*, *Desmanthus*, *Leucaena*, *Sesbania* spp.) through intercropping between farm plots and Indigenous Technical Knowledge (ITKs). Modern means of communication like internet, TV, Radio, U-tube videos, face-book and other IT tools should be adopted. Pashu Gyan Kendras of LUVAS, KVKs are the effective tools and can serve as bridges between farmers and scientists working in the laboratories. Means of direct communication like telephone and internet will enhance the reach of scientists to the farmers in more effective way. The toll free telephone service of LUVAS and other institution should be available for seven days a week.

• Livestock Rearing vís-a-vís Climate Change

Livestock farmers are either not aware or they are least bothered about climate change and enteric methane emissions emanating from their enterprise. Imbalance feeding and the resultant high production of methane due to incomplete digestion lead to loss of energy causing lower milk production, poor fertility and poor health. Climate change and its impact on animal production system is discussed. Incidences of vector born diseases increase due to elevated temperature and humidity. Stubble burning in Haryana leads to non-availability of dry fodder for livestock besides environment pollution. Damage to beneficial insects/microbes in the soil and deterioration of general condition of the soil leads to low soil fertility leading to lower yield in subsequent crops.

• Recommendations

The salient recommendations are summarized with particular reference to Haryana. To ensure the livelihood of marginal/resource poor farmers in rural areas, we have to observe and implement the points given in this report in a systematic manner to augment the feed, fodder and ultimately dairy farming which are the lifeline for our people. All these when planned and implemented successfully, the feed and fodder scenario in Haryana will improve which subsequently improve the livestock productivity and subsistence level of majority of marginal/poor/landless rural community.

1. Livestock Sector of Haryana

Livestock production is the backbone of agriculture and also plays a key role in providing employment especially in rural areas. The Agriculture and Allied Sectors has always been an important contributor to the Gross State Domestic Product (GSDP). However, over the years, the contribution of the Agriculture and Allied Sectors at constant (2011-12) prices went down to only 17.5 per cent of the Gross State Value Added (GSVA) during the year 2018-19. Agriculture and Allied Sectors consists of agriculture (crop husbandry and dairy farming), forestry & logging and fishing sub-sectors. Agriculture including crop husbandry and dairy farming is the main component contributing about 93 per cent in GSVA of Agriculture and Allied Sectors. The growth rate of agriculture and allied sectors increased from 3.8 per cent in 2015-16 to 10.4 per cent in 2016-17, 5.5 per cent in 2017-18 and 5.5 per cent in 2018-19 (as per Advance Estimates). Over the years the decline in the contribution of agricultural and allied sector to the state GDP is the area of concern and does not commensurate well for the agrarian development model of the state.

In spite of the fact that livestock sector in Haryana, a significant contributor to agriculture (contribution of livestock has surpassed that of food grain), did not get the required attention from the policy makers. Due to incentive based policies and programmes of state government the growth of the livestock sector is faster than crop component for over a decade and has emerged as an important sector to supplement the income and employment of rural masses in the State. Haryana has been the home of major draught, milch and dual-purpose breeds of cattle and the world famous Murrah breed of buffalo. Haryana agriculture is endowed with the livestock production system which is complex and generally based on traditional and socio-economic considerations. Factors like cropping system, water resources, diversification of crops, intensification of agriculture, increasing use of mechanical power, transformation from sustenance farming to market oriented farming, changing food habits etc., have their impact on animal husbandry practices.

The entire feed and fodder requirement of the livestock is met from crop residues and by-products; grasses, weeds and tree leaves gathered from cultivated and uncultivated lands; and grazing on common lands and harvested fields. Due to ever increasing population pressure of human, the arable land is mainly used for food and cash crops, thus there is little chance of having good quality arable land available for fodder production and the share has hardly ever exceeded 5 per cent of the gross cropped area (GOI, 2009). The nutritive value of feed and fodder has a significant bearing on productivity of livestock. The major reasons for shortage of feed and fodder are, increasing pressure on land for growing food grains, oil seeds and pulses, adequate attention has not been given to the production of fodder crops. Further, on account of diversified use of agricultural residues, the grazing lands are gradually diminishing. The area under fodder cultivation is also limited. Majority of the grazing lands have either been degraded or encroached upon restricting their availability for livestock grazing.

1.1 Livestock population

The Animal Husbandry Department has undertaken ambitious programmes for genetic improvement of the livestock as well as keeping it disease free for optimum production. There was decrease in livestock population from 8.86 million to 8.81 million (excluding 0.18 million stray cattle) during 2007 to 2012 registering a negative growth of 0.44%. Among the total livestock, buffaloes contributed highest with 69% followed by Cattle 20.50%, Goats 4.19%, Sheep 4.11% and Pigs 1.44% besides marginal contribution is attributed by other livestock species such as Camel, Mules, Donkeys, Horses and Ponies (Table 1.1 and Fig.1.1).As per the Livestock Census-2012 Livestock, population of the State was

89.98 lakh including 18.08 lakh cattle and 60.85 lakh buffaloes. With the total outlay of 77.90 crore "National Programme for Bovine Breeding & Dairy Development" has been implemented for conservation, up-gradation and integrated development of indigenous breeds of cattle i.e. Hariana, Sahiwal, Tharparkar and Gir. The government of India approved the National Programme for Bovine Breeding for State to be implemented over a period of 3 years (22.90 crore were approved from NPBB and 55 crore for Rashtriya Gokul Gram).Under NPBB a Gokul Gram is to be established at Sector-1, Govt. Livestock Farm, Hisar. NDDB has sanctioned two sub projects for production of High Genetic Merit Bulls (Hariana-PS and Murrah–PT) and strengthening of Sperm Station, Hisar over a period of 5 years. The sub-project Hariana-PS is implemented in 4 districts namely: Bhiwani, Charkhi Dadri, Jhajjar and Rohtak. Likewise the sub- project Murrah-PT has been implemented in 7 districts namely Bhiwani, Charkhi Dadri, Jhajjar, Rohtak, Hisar, Jind and Sonepat. The district-wise livestock population in Haryana is shown in Table 1.2.

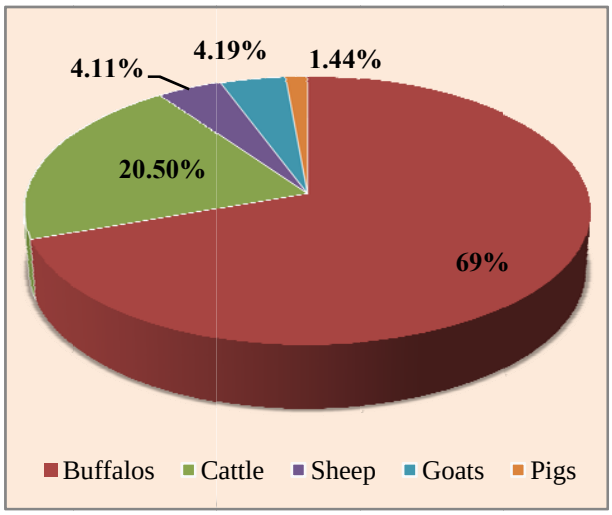

Fig. 1.1 Distribution of Livestock in Haryana

Table: 1.1: Total livestock population in Haryana during 2003, 2007 and 2012 (in millions)

CATEGORY	2003	2007	2012	% change (2007 to 2012)
Cattle	1.54	1.55	1.81	16.48
Buffalo	6.04	5.95	6.08	2.22
Bovines	7.58	7.50	7.89	5.17
Sheep	0.63	0.60	0.36	39.70
Goat	0.46	0.54	0.37	-31.43
Pigs	0.12	0.13	0.12	-4.93
Horses & Ponies	.025	.025	.036	41.89
Mules	.014	.010	.009	-15.01
Donkeys	.008	.005	.00	-40.0
Camels	.050	.038	.019	-51.19
Total Livestock	8.88	8.86	8.81	-0.44

Table 1.2: District wise livestock population ('000) in Haryana (Source: 2012 Animal Census)

District	Cattle	Buffalos	Sheep	Goats
Ambala	67.85	219.24	12.70	7.80
Bhiwani	130.34	524.86	50.27	50.91
Faridabad	35.30	121.33	2.87	11.70
Fatehabad	100.61	321.96	17.25	12.96
Gurugram	58.37	153.31	2.46	11.55
Hisar	161.67	509.54	49.04	21.96
Jhajjar	54.30	254.91	19.81	10.38
Jind	118.99	503.95	28.07	10.31
Kaithal	93.63	423.40	16.48	9.15
Karnal	149.98	357.62	15.09	11.59
Kurukshetra	93.20	223.26	10.04	4.76
Mohindergarh	50.45	260.82	24.38	54.69
Nuh	34.00	228.21	8.11	38.17
Palwal	38.76	286.29	11.62	9.35

Panchkula	24.08	68.94	3.47	8.20
Panipat	54.92	245.24	6.91	5.40
Rewari	44.38	208.79	8.68	23.24
Rohtak	61.49	263.44	16.12	6.48
Sirsa	214.28	343.55	41.89	41.72
Sonipat	104.14	348.46	7.42	8.64
Yamunanagar	117.38	218.16	9.91	10.15
Total	1808.12	6085.28	362.59	369.11

Table 1.2: Contd……..

District	Horses	Muels	Donkeys	Camels	Pigs	Total livestock	Poultry
Ambala	11.54	0.19	0.03	0	5.23	335.00	2554.38
Bhiwani	1.93	1.05	0.37	5.40	8.51	788.86	2826.64
Faridabad	0.26	0.07	0.11	0	4.22	184.49	42.87
Fatehabad	1.54	0.28	0.12	1.84	4.99	471.05	293.33
Gurugram	1.11	0.31	0.33	0.09	5.54	256.51	501.06
Hisar	1.60	0.66	0.15	1.62	8.97	765.22	3615.53
Jhajjar	0.69	0.92	0.19	0.11	7.80	356.84	224.84
Jind	2.06	0.65	0.11	0.10	10.93	678.98	6940.93
Kaithal	2.44	0.42	0.12	0	10.80	563.42	1592.21
Karnal	2.96	0.27	0.25	0.09	9.07	557.26	6561.14
Kurukshetra	1.41	0.15	0.01	0	3.52	343.18	3627.39
Mohindergarh	0.81	0.41	0.06	3.60	1.50	404.37	947.86
Nuh	0.28	0.12	0.11	0.13	3.45	313.32	46.09
Palwal	0.45	0.23	0.13	0.01	4.31	352.99	8.43
Panchkula	0.21	0.25	0.12	0.05	1.40	111.00	6193.34
Panipat	1.51	0.13	0.03	0	5.95	323.08	2286.96
Rewari	0.54	0.84	0.10	1.00	2.69	296.56	739.73
Rohtak	1.02	0.55	0.10	0.01	10.90	365.22	694.36
Sirsa	1.32	0.80	0.32	4.77	1.45	652.25	553.38
Sonipat	1.59	0.50	0.11	0	11.16	489.44	1564.39
Yamunanagar	1.38	0.20	0.00	0	4.54	369.66	1006.47
Total	36.65	9.00	2.87	18.82	126.93	8978.7	42821.33

Source: Haryana Annual Admin Report 2017-18

1.2 Milk Production

In order to improve the genetic merit of livestock, special attention is being paid towards conservation, multiplication and improvement of indigenous germplasm such as Murrah breed of buffaloes and Hariana and Sahiwal breeds of cows. Under this programme, animals of superior germplasm are being identified with an ultimate objective of establishing a 'gene pool' of these unique breeds for future breeding. To make the best use of modern and best technology, an agreement has been signed with Government of Israel in 2015 to set up a Centre of Excellence at Hisar with a cost of Rs.1,498 lakh. This will lead to a new revolution in the field of milk production in the State. Process for setting of this centre has been initiated. The total annual milk production for the year 2017-18 has reached to 98.09 lakh tonnes in the State (Table 1.3) and per capita per day availability of milk has increased to 1005g, which is second highest in the country against 375g of National average. For encouraging the farmers to rear good quality high yielding indigenous cattle of Hariana and Sahiwal breeds, performance recording for these breeds has been started (Table 1.4) and for that incentive money ranging from Rs.10,000 to 20,000 on the basis of milk yield is being provided to the owners of indigenous cows. During this year (2018), performance of 481 Hariana, 136 Sahiwal and 2 Belahi cows has been recorded till now.

Table 1.3: Milk production in Haryana in comparison with India and World (million tonnes)

Year	Estimated milk production in Haryana	Estimated milk production in India	Estimated milk production in World
1966-67	1.1	21.0	298.0
1999-2k	4.7	78.3	578.8
2000-01	4.8	80.6	589.5
2001-02	5.0	84.4	604.3
2002-03	5.1	86.2	614.9
2003-04	5.2	88.1	627.5
2004-05	5.2	92.5	646.9
2005-06	5.3	97.1	665.8
2006-07	5.4	102.9	679.2
2007-08	5.5	107.9	694.2
2008-09	5.7	112.2	696.6
2009-10	6.0	116.4	721.0
2010-11	6.3	121.8	704.0
2011-12	6.7	127.9	750.0
2012-13	7.0	132.4	769.0
2013-14	7.4	137.7	792.0
2014-15	7.9	146.3	817.0
2015-16	8.4	155.5	842.0
2016-17	8.9	165.4	824.8
2017-18	9.8	176.3	843.0
2018-19	10.7	187.8	856.2

Source: Animal Husbandry; Dairy & Fisheries Department, Ministry of Agri. & Farmers Welfare, GOI Statistics

Table 1.4: Estimated species wise milk production in Haryana during 2016-17 and 2017-18

Category	Number of Animals in milk ('000)		Average milk production (kg/animal/day)		Annual milk production ('000 metric tonnes)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Cattle						
Exotic	40.94	43.57	10.70	10.86	159.92	172.71
Crossbred	383.05	400.88	8.00	8.41	1118.80	1230.15
Indigenous	133.34	141.47	5.67	5.92	275.46	305.81
Non-Descript	55.92	59.62	5.04	5.14	102.90	111.78
Buffalo						
True to Breed	2000.88	2095.09	8.61	8.95	6287.56	6841.46
Non-Descript	372.63	394.06	7.21	7.64	981.35	1098.34
Goat	133.39	131.85	1.00	1.01	48.98	48.73
Annual milk production (000 metric tonnes)					8974.75	9809.00
Daily milk production (000 metric tonnes)					24.59	26.87
Per capita per day availability of milk (g)					**930**	**1005**

Source: Annual Admin Report 2017-18

1.3 Meat Production

With the change of food habits the demand for quality meat production has increased in the state. The estimated species-wise meat production in Haryana is depicted in Table 1.5. The adjoining market of Punjab, UP and National Capital Region is also added advantage to the state livestock owners. Buffalo meat from male calves (other than breeding bulls) reared on high energy and high protein diets which is lean, low in fat and have other blending qualities possesses great potential for high end export market. For effective and complete ban on cow slaughter in the State, the meat sector (specially buffalo meat) need to be strengthen in the state by sequestering surplus male buffalo calves which can be reared under feedlot system. Hygienic slaughtering facility and state of the art slaughter houses with cold storage facilities is the need of the hour to exploit the huge potential of buffalo meat besides mutton, chevron and poultry meat.

Table 1.5: Estimated species wise meat production in Haryana during 2016-17; 2017-18)

Category	Number of animals slaughtered (lakh)		Average meat production (kg/animal)		Annual meat production (lakh kg)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Buffalo	-	2.55	-	142.75	-	3.64
Sheep	3.63	8.43	14.57	17.17	6.440	12.83
Goat	3.59	3.83	14.57	13.91	6.43	6.81
Pig	1.51	1.49	41.07	41.05	6.86	6.76
Poultry	3185.83	3407.50	1.28	1.29	407.75	440.32
Total	**3194.56**	**3423.80**	**-**	**-**	**427.48**	**470.38**

Source: Annual Admin Report 2017-18

2. Livestock Production systems of state and expected changes

Animal production system in Haryana state differs with the species of farm animals and livestock is the backbone of rural economy as 95% of livestock is reared in rural areas. Cattle and buffaloes are the principal farm animals of Haryana. Number of exotic (*Bos turus*) and crossbred (*Bos indicus* x *Bos taurus*) cattle are continuously increasing after the start of All India Coordinated Research Project on Cattle in 1968. Species wise animal production systems in the state have been presented.

2.1 Cattle and buffalo production systems

Cattle and buffaloes are the principal animals of economic importance. Females are reared exclusively for milk production and males are draught animals. No female bovine is used for draught even after they are infertile and sterile. Normally traditional systems of bovine farming are prevalent in the state.

- **Animal–Crop production system**–This is most common practice known from generations. Number of animals and ratio of male: female animals vary with the land holding and working hand in the family.
- **Cattle herd on grazing and scavenging -** This system is practised in Peri-urban area by landless and small land holding farmers. Mostly indigenous cattle form the herd. Cows are let loose for grazing and scavenging. Calves are retained at home for the return of dams. These animals are fed some fodder and concentrates. This system is decreasing at a faster rate due to decreased demand of draught bullocks. These cattle are also menace in the towns.
- **Urban and Peri-urban cattle farms –** This system of cattle farming is limited because buffalo milk is preferred over cow milk. Some small holder dairy cattle farms can be seen around the big cities. At these farms small number of lactating cows with nursing calves is maintained.
- **Cattle- buffalo – crop production system –** In this system, though buffalo as main dairy animal, one or two lactating cows are kept for in house use of milk. They are let loose for grazing and fed fodders as well.

2.2 Buffaloes production system

Murrah buffalo is the main dairy bovine of the state. *Nili-Ravi* and its crosses with *Murrah* are found along the Punjab border. Female buffaloes are used for milk production and males for draught. The two most common buffalo production systems prevailing in Haryana are:

- **Buffalo- crop production system –** Farmers keep buffaloes on the basis of available fodder in the form of straws, *kadbi* and green. Number of lactating buffaloes ranges from one to ten or even more. Milk is either collected by vendors from the home or given on the collection centre.
- **Urban buffalo dairy farms –** There are commercial milk production farms in urban and *peri*-urban areas for the sale of fluid milk. Prime focus of these dairy owners is on lactating buffaloes only and dry buffaloes and weaned calves are sold without considerable delay. Calves of these farms are mostly weak and stunted due to under feeding. In spite of hygiene and health issues number of urban families continues to collect fresh fluid milk from these farms.

2.3 Types of modern dairy farms expected

We could expect a paradigm shift from crop livestock mixed farming system to large scale commercial dairy units in urban or *peri*-urban areas. It is likely that the demand of livestock products will increase and could be more than double in coming years which would be an excellent opportunity to the producers who are primarily smallholders. However, the factors like increasing urbanization and incomes, the quality and safety standards demanded in livestock markets and intensification and commercialization of livestock production systems with the advent of large-scale integrated commercial companies, as happened in poultry sector, will definitely add to the complexity of livestock value chains and thus, make it more difficult for smallholders and would likely displace small-scale livestock farmers and aggravate rural poverty. It is here that Haryana government should step in and give due attention to livestock farming and animal husbandry and recognise it as a cottage industry a long overdue credit to it. Following types of dairy farms are likely to develop in the state.

- **Independent dairy farm in animal –crop system -** Such farm is started normally by land owners for fodder production. The size of dairy farms will be affected by:

  (a) Size of land holding,

  (b) Availability of market or milk processing plant for bulk supply,

  (c) Distance of chilling plant of milk cooperative,

  (d) Regularity of payment at short interval and

  (e) Facility of finance by banks on easy terms for repayment.

- **Dairy farming by landless farmers -** This category will depend on purchased animal feeds. Such farmers may cultivate fodder on rented land for short duration of three months. Farmers of this category will prefer cultivation of maize or sorghum for ensiling in *kharif* season. Rabi crops can be oats or barley for hay making or ensiling. Some farmers can also use rented land for 6 months (October to March) for green forage for fresh feeding. Preferred crop is *barseem* with small quantity of succulent mustard variety. Oats can be also used for higher harvesting during first and second cut.

2.4 Sheep production system

Sheep production is family oriented and mostly under extensive and seasonal nomadic system. Sheep are reared for coarse carpet wool because fine wool breeds cannot survive in the hot climate of Haryana. Continuous increased demand of mutton has compelled farmers for supplemental feeding for early finishing of lambs for marketing. Scope of commercial sheep farming is increasing at a faster rate not only for domestic market but also for export. Sheep farmers restrict movement nearer to home tract during the rainy season. In other seasons specially summer sheep farmers in group of 3 or more flocks move away from the home for grazing sheep on scrubs, wastelands, canal bunds and harvested fields. Sheep droppings (faces and urine) are believed to increase crop production by supplying nutrients as organic manure. Degradation of faecal pellets of sheep is slower than the bovine dung which causes slow release of nutrients for crops and low escape in environment. That is why shepherds flock their sheep in agricultural fields against payment in the form of food grains and some money. Scope of intensive lambs fattening is increasing due to increased demand in the local market and also for export. It can be more remunerative in dual system of rearing: adults on grazing and fattening of weaned lambs in intensive system.

2.5 Goat production system

Goats are reared for chevron (meat) and milk mostly by landless, small and marginal farmers. Goat breeds of Haryana are mostly medium and large breeds. These breeds mostly produce 2 to 3 kids annually. Traditional goat farming includes browsing and grazing on waste lands and forests. Demand

of goat meat and milk is increasing. Importance of goat milk is increasing due to efficient digestibility of smaller fat globules and medicinal value for increasing platelets and immunity. Goat meat (chevon) is preferred by greater proportion of meat eater of Indian subcontinent. Big markets of fattened goats have come up along the borders of Haryana adjoining Punjab and Delhi. Goat is an animal of semi-arid zone and Haryana is suitable for goat farming. In addition to traditional goat farming in extensive system, there is scope of goat farming in semi-intensive and intensive system. Goat farming in semi-intensive system will be most appropriate in low rain fall area with little or no irrigation facility. Intensive goat farming is tagged with suppliers of Delhi, UP and Punjab.

2.6 Camel production system

There appears to be lack of scope of camel rearing due to continuous fall in utility. Population of camels in Haryana is small. In present situation it will be more appropriate to develop camels in homes for milk and meat.

2.7 Pig production System

North east states are the main consumers of pork and local production is inadequate to meet demand. Two systems of pig farming can be remunerative.

- **Pig fattening on scavenging with supplemental feeding –** In most of the towns plenty organic wastes are disposed daily. These organic wastes provide 50 to 70 percent nutritional requirements of scavenging animals including pigs. Scavenging pigs generally need protein-energy supplements. This can be sustainable pig farming for low income group with pig farming background.

- **Intensive pig production –** Either total production system or phased production system.
  a) In total production system breeding to fattening is done on farm, and fattened pigs are marketed.
  b) In phased production system following sequence can be followed.
     (i) Breeding and sale of weaned piglets
     (ii) Fattening and marketing of finished pigs
     (iii) Marketing of fattened pigs

2.8 Poultry production System

- **Commercial poultry production -** It is now are established farming business and there is little scope of breakthrough. Commercial poultry breeders, compounded poultry feed manufactures and producers are now mostly independent but complementary to each other in business. There are also other supporting industries associated with egg and chicken production, processing, packaging, storage, transportation and marketing.

- **Backyard poultry farming -** This has great scope and is convenient for supplementary income rearing 10 to 50 layers which provides 8-9 to 40-45 eggs daily. For such farmers small scale poultry feed industry can be another avenue of employment.

2.9 Phases of life cycle of bovine for feeding

- **Animals of Haryana**

Animals of Haryana are cattle, buffaloes, goats, sheep, camel, equines and poultry. Poultry is an established commercial enterprise and there is little scope of substitution of high energy grains and high protein oilseed cakes from the compounded complete feeds of poultry. Livestock of Haryana can be divided into the following groups and placed as follow descending order of priority.

1. First group – Dairy bovines
2. Second group – Goats and Sheep
3. Third group – Equines
4. Fourth group – Camels
5. Fifth group – Pigs

Haryana is home tract of famous dairy breeds *Murrah*, however, sporadic presence of *Nili-Ravi* is not uncommon along Punjab border. Sahiwal cattle are the dairy breed and Hariana is the dual purpose breed. There is considerable number of exotic dairy cattle (*Bos taurus*) and cross bred cattle (*Bos indicus* x *Bos taurus*). Crossbred cattle are the crosses of Hariana breed with Holstein Frisian, Jersey and Brown Swiss. In addition there is also considerable number of exotic dairy cattle. For optimum dairy performance these animals require management conditions comprising of feeding, housing, hygiene and health management. This requires scientific management during all phases of life cycle from birth to termination of active production life (see Tables 2.1, 2.2 and 2.3).

2.10 Objective of rearing cattle and buffaloes

➢ Cattle

Earlier cattle were reared for milk production and draught. Females were dairy animals and males were draught animals. Due to continuous increase in the use of fuel oil and electric operated agricultural operations utility of male cattle has decreased and continuously decreasing. There is no other route of utilization of male cattle in Haryana state. Therefore, surplus and non-serviceable cattle feeding and management is the responsibility of state and public. Although there are several of *goshala* but number of stray cattle is also quite large. In towns the menace of stray cattle is also due to intentional straying of cattle by many owners. The calves are detained at home and dams are let loose for feeding by straying. These cows are well trained to return at home for their calves. The life cycle of dairy cattle can be divided into the following phases (Table 2.1) for the purpose of feed selection, ration formulation and feeding.

Table 2.1: Phases of life cycle of cattle for feeding

S. No	Phases	Duration
1	New born calf	0-13 weeks
2	Growing phase, early, late	3-15 months
3	First breeding phase	15-18 months
4	Early pregnancy	18-22 months
5	Late half of pregnancy	22-26 months
6	Early lactating	3 months
7	Lactation & pregnancy	6 months
8	Pregnancy & flushing	6 months
9	7,8 & 9 to continual subsequent pregnancy	3 months
10	Breeding bulls	Regular
11	Retired dairy cows, sterile females and genetic	Survival diet only

➢ Buffaloes

Buffaloes are not let loose for straying. They do not need care after retirement. Life cycle of buffaloes for feeding can be divided into the following phases (Table 2.2).

Table 2.2: Phases of life cycle of buffaloes for feeding

S. No.	Phases	Duration
1	Calf	3 months/13 weeks
2	Growing male /female	6, 9, 12, 15 , 18 and 21months
3	First pregnancy	24 to 34 months
4	First lactation	34 to 44 months
5	First lactation & pregnancy	37 to 47 months
6	Lactation rest	47 – 50 months
7	Second lactation	50 – 60 months
8	Second lactation & pregnancy	63 – 73 months
9	Spent females and retired males	2 to 3 months

2.11 *Critical periods of life cycle of bovines*

Certain periods of life cycle of cattle and buffaloes require special care for feed selection and feeding for the maintenance of good health and optimum production. Care of animals during critical periods (Table 2.3) of life cycle has conspicuous effect on health, production and economics of production.

Table 2.3: Critical periods of life cycle for feed selection and feeding

S. No.	Critical period	Feeds and Feeding
1	New born calf	Colostrums feeding preferably within 3 hrs/ up to 8 hours
2	Last trimester of gestation period (a) Last month (b) Last week	Flushing with high energy feeds Calcium supplement is withdrawn Diet should be laxative
3	Lactation- cum gestation	High energy – high protein and free choice minerals lick
4	Retired cattle	Maintenance/survival diet
5	Non serviceable cows	Recuperative diet for improving condition

3. Existing Feeding Practices of Cattle & Buffaloes

Based on the agro-climatic conditions the 21 districts of Haryana state are divided into two North East and South West zones. Traditionally, agriculture and livestock are intertwined in a manner that ensures sustainable livelihood to a large proportion of rural population in the state. Livestock is also an important asset that provides employment to millions of such people. Total milk production in the state is 9.8 million tons of which 78% is contributed by buffaloes and 20% by cattle. Thus, buffalo is the primary dairy animal of the state. High fat content of milk and the ability of the species to convert roughage feeds into milk and meat more efficiently than cattle and less susceptibility to various diseases make buffaloes as the animal of choice.

In spite of large population of livestock, the productivity of milk and other livestock product per animal is very low compared to many other countries in the world. Traditionally, cattle grazed on the pastures and *gauchar* (grazing) lands and supported by feeding crop residues or straw of *jowar, bajra,* wheat, maize, paddy etc. either in the form of straw or a *bhusa* supplemented with some green fodder. The economic viability of livestock husbandry heavily depends on source(s) of feed and fodder as feeding cost account for about 65-70 per cent of the total cost of livestock farming. The feed given to cattle comprises of dry fodder, green fodder and concentrates. The inadequate supply and scarcity of feed/fodder resources is a one of the major constraints for livestock production. Therefore, it is important to put more emphasis on fodder development programmes for augmenting fodder/feed supply, while formulation of livestock development strategy.

High yielding animals are disappearing from the state due to various socio-economic reasons. Increased cost of feed inputs (cakes etc.) has affected the nutritional status of animals. Further, due to high intensity of cultivation and associated use of chemical fertilizers, the mineral profiles of soil, fodders and other animal feed stuffs are changing rapidly causing mineral imbalances. Meeting the nutrients requirement of animals for optimum health and production has caught the attention of scientists & now being looked into at national as well as state level.

3.1 Sources of animal feed in Haryana

For the preparation of standard diets and feeding schedule of farm animals in a state, it is basic requirement t0 find out the sources of feedstuffs in the state. Both quantitative and qualitative information's are required. All farm animals except pigs are herbivores animals by evolution. In natural habitats of various species the herbivore animals feed at different levels of the herbage cover. Herbivores farm animals of Haryana are dominantly graze like buffaloes, cattle, sheep and equines. Goats and camels prefer browsing but also graze in absence of adequate browse.

In changing situation these farm animals will be gradually shifted to exclusive stall feeding. Therefore, it is important to have information on the sources of feed stuffs in the state. This will help in the assessment of status of different feed ingredients in the state in comparison to requirements. On the basis of these data strategies to increase the production of feed and fodder or procurement/mobilization from the surplus areas can be visualised. Animal feeds are placed in the following four major categories.

Roughages: The herbaceous parts of the plants include the whole plant and fibrous crop residue after the extraction of food grains like cereals, pulses and oilseeds. Roughages are further classified as:

(A) Dry roughages **(B) Green roughages**

Each is further classified into: (1) Conventional roughages and (2) Non-conventional roughages. However, conventional and non-conventional classification is not universal but area specific, *viz.* tree fodder is non-conventional in most parts of plain but conventional on hills and some parts of the dry areas.

➢ Conventional dry roughages in Haryana

Dry cereal crop residues- these are poor quality feeds containing 2 to 5 % crude protein (CP) and 40 to 45% total digestible nutrients (TDN) on dry matter (DM) basis. Dry cereal crop residues available in the state are wheat *bhusa, barlay bhusa, jowar kadbi, bajra kadbi* and maize stalk.

Dry crop residues of pulses and oilseeds except straw of peas and cowpea only- a mixture of empty pods and dry leaves of more pulses and oilseed crops are fed to animals.

Conserved conventional dry roughages in Haryana- Leaves of *Khejari* (*Prosopis cineraria*) and Pala (*Zyziphus* spp.) lopped in with fine twigs during winter season are collected, dried and stored for feeding during scarcity of fodder in summer season. These are generally collected for ages and stored by goats and sheep farmers. *Khejari* and *pala* in Rajasthan and Haryana are conventional fodder known to farmers for generations.

➢ Non-conventional dry roughage in Haryana

Main source of non-conventional dry roughage is sugarcane trash and nature grasses on waste lands. Fibrous crop residues available after the extraction of ripe seeds and fibre are mustard stalk, guar stalk and cotton stalk. All these crop residues are coarse and palatability is very poor. These residues are eaten only when no other soft dry roughage is available. Round the year, different varieties of crops are grown in the state. The major crops grown during the *Rabi* season are wheat, barley, gram, mustard and sugarcane, while during *Kharif* season paddy, *jowar, bajra* cotton and maize. The total residue generated from all the major and minor crops was reported to be 24.697 million tonnes per annum (Table 3.1). Of this, the major agro residues are of wheat and paddy in the form of stalk and grain husk, contributing to about 80% of the total residue. The remaining amount was contributed by the residues of cotton (7.78%) and mustard (3.66%) among other crops.

Sirsa, Hisar, Jind and Fatehabad are reported as major crop residue potential districts within the state, which is due to the large agricultural area, higher crop yield, better irrigation facilities, more irrigated area, higher cropping intensity and introduction of high yielding varieties of crop seeds in these districts. Among the least crop residues producing districts are Panchkula, Yamunanagar, Rewari, Rohtak and Mahendergarh.

Table 3.1: Agricultural Residue Production in Haryana State

District	Crop Residues ('000 tonnes/year)					
	Paddy Straw	Paddy Husk	Maize Stalk	Maize Cobs	Wheat Stalk	Wheat Spike
Ambala	325.50	43.40	18.30	3.50	294.00	140.30
Bhiwani	30.00	4.00	0.00	0.00	568.80	232.30
Faridabad	116.00	16.00	0.00	0.00	646.80	242.60
Fatehabad	318.40	39.80	0.00	0.00	797.00	386.10
Gurugram	28.70	4.00	0.00	0.00	596.40	216.50
Hisar	88.20	12.60	0.00	0.00	1020.10	416.90
Jhajjar	38.10	5.00	0.00	0.00	482.40	188.90

Jind	288.60	44.40	0.00	0.00	1113.60	401.00
Kaithal	488.80	78.20	0.00	0.00	791.20	337.10
Karnal	599.40	88.80	0.00	0.00	884.20	346.10
Kurukshetra	520.20	71.40	0.00	0.00	607.20	227.70
Mahendergarh	0.00	0.00	0.00	0.00	241.70	76.40
Panchkula	24.30	3.60	28.80	5.60	55.40	19.80
Panipat	259.90	37.40	0.00	0.00	410.60	191.60
Rewari	0.00	0.00	0.00	0.00	262.20	102.60
Rohtak	50.40	7.20	0.00	0.00	383.70	172.50
Sirsa	155.40	22.20	0.00	0.00	1053.80	456.70
Sonepat	190.40	27.60	0.00	0.00	613.80	251.10
Yamunanagar	223.60	32.80	0.00	0.00	276.00	103.50
Total	3745.90	538.40	47.10	9.10	11098.9	4509.70
% of Total	(15.17)	(2.18)	(0.19)	(0.04)	(44.94)	(18.26)

Table 3.1 Continued……..

District	**Crop Residues (kilo tonnes/year)**						
	Sugarcane		***Bajra***		**Cotton Stalk**	**Gram Stalk**	**Mustard Stalk**
	Tops	**Trash**	**Stalk**	**Ears**			
Ambala	14.60	14.60	0.00	0.00	0.00	0.00	0.00
Bhiwani	0.00	0.00	312.00	25.00	166.30	54.60	158.40
Faridabad	4.70	4.70	34.60	3.00	0.00	0.00	0.00
Fatehabad	0.00	0.00	26.60	2.20	377.00	0.00	23.40
Gurugram	0.00	0.00	148.60	12.50	0.00	0.00	74.40
Hisar	0.00	0.00	139.90	11.80	496.70	0.00	87.40
Jhajjar	0.00	0.00	64.70	5.00	0.00	0.00	49.80
Jind	0.00	0.00	134.20	10.20	136.20	0.00	0.00
Kaithal	0.00	0.00	9.00	0.80	0.00	0.00	0.00
Karnal	6.20	6.20	0.00	0.00	0.00	0.00	0.00
Kurukshetra	9.40	9.40	0.00	0.00	0.00	0.00	0.00
Mahendergarh	0.00	0.00	228.10	17.60	0.00	10.90	118.40
Panchkula	0.50	0.50	0.00	0.00	0.00	1.20	1.40
Panipat	2.90	2.90	0.00	0.00	0.00	0.00	0.00
Rewari	0.00	0.00	118.00	9.40	0.00	0.00	131.00
Rohtak	6.80	6.80	56.70	4.30	44.80	0.00	18.90
Sirsa	0.00	0.00	0.00	0.00	699.70	0.00	68.90
Sonepat	3.80	3.80	21.60	1.90	0.00	0.00	5.40
Yamunanagar	27.00	27.0	0.00	0.00	0.00	0.00	0.00
Total	75.90	75.90	1,294.0	103.70	1,920.7	66.70	737.40
% of Total	**(0.31)**	**(0.31)**	**(5.24)**	**(0.42)**	**(7.78)**	**(0.27)**	**(2.99)**

➢ Green roughages/fodder

These are natural and cultivated fodder. Natural herbages are generally seasonal and include grasses, creepers, bushes and trees. Sheep, goats and camels are extensively fed on natural herbages.

➢ Natural grasses:

These grow on waste lands, road sides, along rail route, and forests orchards. Cattle, buffaloes, sheep, goats and draught equines are grazed on natural grasses.

➢ Fodder bushes and trees

In dry zone *Jharberi/*pala (*Ziziphus nummularia*) growing naturally on waste lands is an important bush browsed by goats. *Khejari* (*Prosopis cineraria*) is loped for all animals and conserved after drying for feeding during scarcity period of summer.

Babool (*Acacia nylotica*) is browsed by camels and pods are lopped for cattle, buffaloes and goats. *Neem* (*Azadirachta indica*) is browsed fed by camels and lopped for the feeding of goats.

Other trees for fodder are *Shisham* (*Dalbergia sisso*) and *Siris* (*Albizia lebbeck*), *Ardu* (*Alianthus sp*.) is nutritious and palatable fodder tree.

In hilly terrain of Haryana important fodder trees which are commonly used by the farmers are:

1. Biul (*Grewia optiva*)
2. Khirak (*Celtis australis*)
3. Kachnar (*Bauhinia variegata*)

The leaves of these trees are quite palatable to animals and form an excellent source of protein and minerals. These trees have high ability for coppicing and can be maintained as fodder hedges across the slopes. The hedges serve as fodder bank apart from checking the soil erosion.

In the arid and semi-arid parts of Haryana the following trees form an important source of fodder. Their leaves and pods are liked by the animals.

1. Khejri/Jandi (*Prosopis cineraria*)
2. Kikar (*Acacia nilotica*)

The leaves and pods of these trees are rich with minerals including copper and zinc and can be included in value added products for animals such as silage, feed and cakes, etc. and can be used as supplements.

Drum stick or *Sehjan (Moringa oilefera)* is a medicinal tree suitable for growing in Haryana and it is already growing but needs attention of the farmers to grow on commercial scale by choosing quality germplasm. Its leaves are rich with protein and minerals. It is excellent for human consumption and can also be incorporated in animal feed or silage.

An exotic species popularly known as *Vilayti Kikar (Prosopis juliflora)* is a potential source of fuel and fodder in Haryana. This tree species has been found growing on abandoned lands including in the areas having water logging and semi-arid conditions. The pods are an excellent source of fodder for sheep and goats in arid and semi-arid parts. The pods can be processed to make nutritive feeding cakes for animals. In some countries of South America this preparation of animal cakes from the pods of *Prosopis juliflora* is in general practice today. The potential of this waste land and wildly growing tree can be exploited for its suitable management and utilization for the benefit of animals in the state on larger scale since its regeneration and bearing after wood cutting is very fast.

Figure 3.1 shows % households in Haryana feeding green fodder and concentrates to their animals.

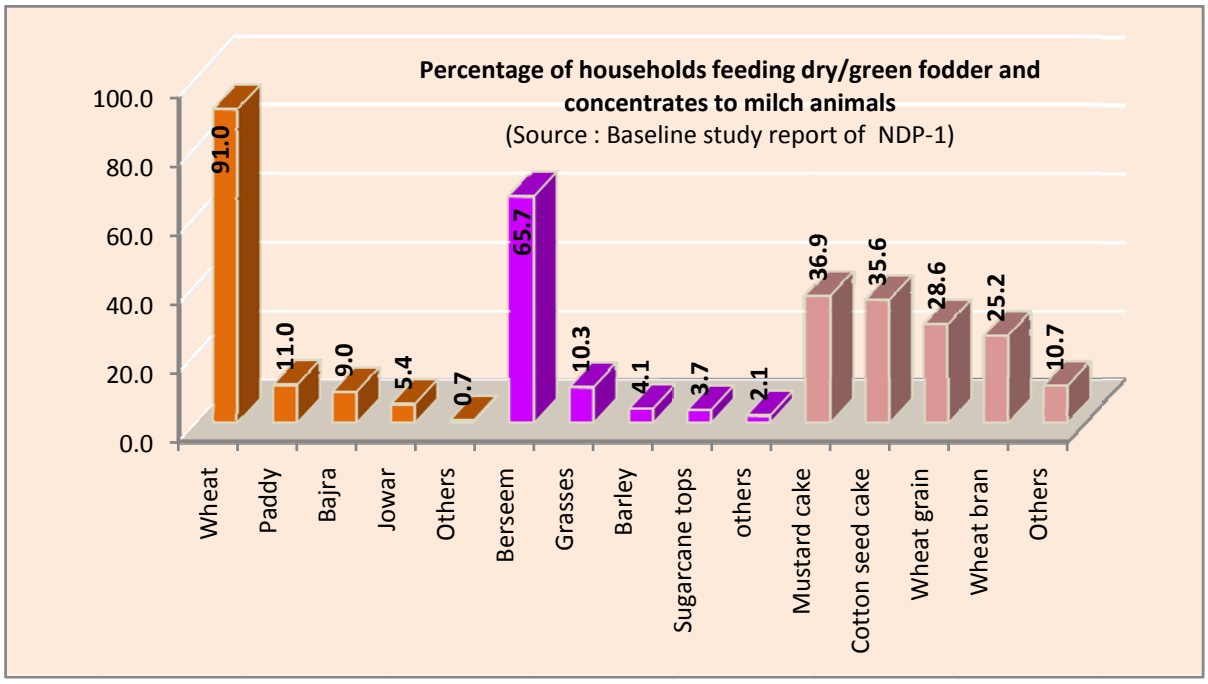

Fig 3.1: % households feeding top 5 dry/green fodders and concentrates to animals in Haryana

➢ Newer sources of green fodder

Consumption of green pea (*Pisum sativum*) and baby corn (*Zea mays*) in human diets is increasing extensively not only in urban but also in rural areas. Harvesting management of these two crops and presentation of immature pea grains can be sources of palatable and nutritious fodder. Baby com ears are removed from milk to dough stage of maturity. Residual plants available after the removal of green ears are still palatable and nutritious containing about 6-8% *crude protein* (CP) and 55-60 % *total digestible nutrients* (TDN) on *dry matter* (DM) basis, since baby com ears are removed at one time and succulent green plants are left residue.

The residual crop is a good green fodder for one week. If quantity is large, the crop can be harvested in bulk and ensiled at one time for feeding later as per requirement. Now immature green pea has become an all season vegetable. Pea is a winter pulse crop of high protein content and palatability. Green plants and empty pods are equally palatable and nutritious for the farm animals. On bulk availability these can be conserved after hay making. Green pea plants and empty pods containing about 85 % moisture can also be ensiled with wheat *bhusa*. A premix of 20 kg wheat *bhusa*, 79 kg chaffed green pea and empty pods and 1 kg molasses or starch will yield good quality palatable silage in 3-4 weeks. This improves voluntary intake and nutritive value of wheat *bhusa*. This silage alone can meet the maintenance requirement of cattle and buffaloes.

➢ Fruit and vegetable processing by-products

Haryana and adjoining states has made a remarkable development in production of vegetables and fruits, respectively of which only 2-3 % is processed

- **Apple processing waste:** Apple pomace is a residual material available from processing of apples for juice. It contains pulp, peel and cores. 25 to 35 % of the total weight processed is recovered as pomace. Dried apple pomace can serve as a rich source of energy for animals. Digestibility of its energy is very high (85%). Apple pomace can replace up to 40 of energy sources like maize in the rations without adversely affecting the feed intake, nutrients digestibility and milk production.

- **Citrus waste:** After processing oranges, lemons or grape fruit for juice, the left over that accounts 40-60 % of the fruits processed. Cattle can be fed up to 40 kg fresh citrus waste without any harmful effects. Citrus pulp is a rich source of soluble carbohydrates and can replace cereals in the diets of ruminants.
- **Tomato pomace:** It is available after extraction of juice and consists of skin pulp and seeds. After drying and grinding it becomes a good feed ingredient of concentrate mixture. Tomato pomace can be included up to 40 % in the diets of growing animals.
- **Sugar beet pulp:** After extraction of sugar, pulp is left which is a valuable feedstuff for ruminants. About 5 kg pulp is obtained per 100 kg sugar beet.
- **Cabbage and cauliflower waste:** After harvesting, the left over material in the field can serve as a good source of animal feed.

Many by-products have substantial potential value as animal feedstuffs and can replace cereals and green fodders. However, these residues decay rapidly as a result of fast microbial growth. There is a dire need to develop methods to preserve these residues for longer time so that they can be fed to livestock during lean seasons when green fodders are not available in sufficient quantities. Spoilage can be prevented by freezing, heat treatment, drying or chemical treatment with formic acid, propionic acid, urea and urea salt combinations. Several by-products are characterized by the presence of anti-nutritive factors like trypsin, lectins, glucosinolates. Feeding dairy cows with excessive amounts of sugar beet by-products can give a fishy taint to milk. Vegetables belonging to family *Chenopodiacea* contain large amounts of oxalates as well nitrates. The chemical composition of some fruits and vegetables waste material being fed to animals is presented in Table 3.2.

Table 3.2: Chemical composition of by-products of fruits and vegetables fed to the animals

Ingredient	CP	EE	CF	NFE
Citrus pulp	6.5	4.7	13.4	68.5
Citrus peel	7.2	4.1	30.0	55.3
Cabbage Waste	7.0-14.0	14.4-20.3	1.5	15.0
Cauliflower waste	22-25	3.6-7.1	11.9-13.7	3.0
Pea pods (dry/green shells)	16.1	5.8	23.8	53.9-57.7
Carrot waste(Tops & cut roots)	7.4-12.7	2.9	8.4-16.3	67.2-74.5

CP=Crude protein, EE= Energy efficiency, CF= Crude fibre and NFE= Net feed efficiency

Green fodder hydroponics

Green fodder hydroponics is the science of growing green fodder without using soil inside special machines. The physiological requirement of green fodder is met without the use of soil. Plants are rooted in an inert medium and nutrition is provided by water soluble mineral elements. The production cost of each kilogram of green fodder comes to Rs 5.00 approximately. The machine runs with the help of electric power and dimensions are around 2m long, 2m wide and 4m high. Fodder is grown on trays placed in several layers. Around 1,000 kg of hydroponics fodder requires an area of 300 sq ft as compared to the 2,700 sq ft area required for conventional fodder. Production of 1kg of fodder requires 3 litres of water against 80 litres per kg for producing conventional fodder. Hydroponics green fodder can be harvested on every seventh day in comparison to harvesting conventional green fodder every 30-45 days. The fodder is grown in an aseptic condition while conventional fodder is affected by several pest and diseases. It can be harvested throughout the year while green fodder is available only for few months.

➢ Aquatic feeds

There is great potential for production of large quantities of some of the aquatic weeds. About 800 kg dry matter of water hyacinth/ha/d can be harvested. Similarly duckweed can produce up to 30 tons DM per ha containing up to 43 % protein. Azolla is an aquatic fern and is a good source of protein (24-30 %) and NFE. Azolla either fresh or sun dried can be incorporated up to 35 % in the rations of ruminants.

3.2 Compound feeds

Compound feeds are mixture of two or more feed ingredients for feeding of farm animals. These are feed supplements or total mixed ration (TMR). A single feed ingredient of known nutritional value or a mixture of feed ingredients containing known content of nutrients is called as feed supplement. It is used for making of deficient nutrient(s) in the basal feed. Use of 2 types of feed supplements is quite common in the diets of farm animals.

3.3 Feed supplement

➢ Protein supplements

Without consideration of essential amino acids content are used for the feeding of ruminants and other herbivorous animals. These animals are capable of synthesizing essential amino acids to meet their requirements of most animals after the establishment of microbial digestion in the rumino –reticulum of ruminants and pseudo ruminants and specific segments of large intestine in the non-ruminant herbivorous animals. Feeding of small amount of sulphur is required for the microbial synthesis of sulphur containing amino acids.

➢ Minerals supplement

Most feeds of herbivorous animals are deficient in several minerals and to meet their requirements animals on extensive feeding are forced to eat soils (preferably different kind of clay) for the supply of minerals. In intensive and semi-intensive system composite mineral mixtures are supplemented. Use of area specific minerals mixture needs high precision and seasonal monitoring of the cropping lands used cultivation and minerals load in the irrigation water. Minerals level in land depends on the minerals extraction ability of fodder crops. Minerals concentration of irrigation water depends on the source which is canal water and ground water.

Besides concentration of minerals in soil and irrigation water some crops have more affinity for specific minerals. Some of the important crop minerals affinity affecting the health and production of livestock are as follows-

- **Paddy – silica affinity:** Paddy has also affinity for silica, which accumulates in the rice hull probably for the protection of rice Kernel from insects and other damaging factors.
- **Paddy – selenium affinity:** Paddy has high affinity for selenium which is selectively absorbed from the cropping land. Selenium is stored in the herbivorous part of the crop.
- ***Lathyrus* pea – flourine affinity:** *Lathyrus* pea sp. selectively absorbs fluorine from the field, which perfectly concentrates in the seeds and produces skeletal disorders on continuous consumption for long duration.
- **Sugarcane (*Saccharum officinarum*) – silica affinity:** All species of sugarcane selectively absorb silica from the soil, which accumulates on the edges of leaves making them sharp.

3.4 Bypass feed

Bypass protein feed contains a large percentage of solvent extracted protein meals in treated form. The special feature of the formulation is that more than 70 per cent of the total protein in the feed is rumen non-degradable protein. Bypass protein feed is a new generation cattle feed in India and is manufactured by a special chemical treatment, developed by the National Dairy Development Board (NDDB). This is used for high producing animals to meet the nutrient requirement.

Bypass fat is also used in the diet of high producing animals. This is manufactured by binding the fatty acids with Ca salt. Concentrate feeding to farm bovines is an age old practice. Earlier concentrate mixture of bovines in most part of Haryana use to be a cooked mixture of crushed wheat, crushed barley, crushed gram, crushed guar and crushed cotton seed for lactating animals. Mustard cake was fed to bullocks and yang stock.

Nowadays use of commercial concentrate mixture has increased, which is generally inferior to the traditional one. However, the traditional concentrate mixtures also have some limitations:

i) Nutrients density is not considered due to lack of knowledge and
ii) Ratio of ingredients is highly variable resulting in deficit or excess supply of energy or protein.

3.5 Compound cattle feed manufacturers

Feed industry came into existence in India in 1961 with the establishment of a feed plant in Ludhiana, India. Compound Livestock Feed Manufacturers Association (*CLFMA*) was formed. It is the sole, national, representative body of compound animal feed manufactures in India (Table 3.3). It has about 115 members in the public, private and cooperative sectors with about 150 small, medium and large scale feed mills al l over the country producing, nearly three million tonnes of compound feed per annum. The installed capacity of CLFMA members put together is around 6 million tones and capacity utilization is about 50 %. Compound feed also produced by other feed manufactures (Non-members of CLFMA) and farmers directly and this comes to around four million tonnes.

Table 3.3: Information regarding Manufacturers/Dealers' registered under Haryana Regulation of Compound Cattle Feed, Concentrates and Mineral Mixture Order, 1999

Year	Manufacturer	Dealer	Total
2001-02	119	679	798
2002-03	37	72	109
2003-04	7	68	75
2004-05	64	229	293
2005-06	39	137	176
2006-07	30	244	274
2007-08	37	158	195
2008-09	31	77	108
2009-10	30	139	169
2010-11	26	111	137
2011-12	46	127	173
2012-13	106	181	287
2013-14	52	106	158
2014-15	61	145	206
2015-16	68	273	341

Source: Animal Husbandry Department, Haryana

Small scale cattle feed manufacturing agencies can provide better concentrate mixture at compatible price. These will also provide employment to local people but the equipment requirement is limited to grinder, mixer and weighing scale. Production cost of concentrates mixture may be also less due to availability of food ingredients in local area. Common ingredients of a good quality dairy mixture include cereal grains viz. maize, wheat, barley, *jowar* and *bajra* can be included 30-40% of cereal grains. Protein sources are mustard cake, soya bean cake, cotton seed cake, groundnut cake and sesame cake. Third source is wheat bran or rice polish.

- **Small scale minerals mixture compounding companies**

Calcium phosphorus, magnesium, copper, zinc and iron are the common components. Incorporation of iodine and cobalt will depend on the status of these trace elements in local feeds and drinking water sources. Marble dust is a cheap source of calcium. Commercial magnesium sulphate, copper sulphate, iron sulphate and zinc salts are normally suitable for the mineral mixture of mammalian species due to wide tolerance level.

3.6 Feeding practices of Cattle and Buffaloes

Balanced ration programme and ration balancing is the process to balance the level of various nutrients of an animal, from the available feed resources, to meet its nutrient requirements for growth, body maintenance, pregnancy and milk production. The aim is to educate the farmers on optimum feeding of animals to optimize milk production by efficient utilization of locally available feed resources at the possible least cost. Balanced ration resulted in improvement of fats; milk yield and reduction in methane emissions. Farmers are following the traditional feeding practices and are largely dependent on their 'own farm' produce for green fodder, dry roughage and some concentrate ingredients like wheat, *bajra* grains etc. They are feeding three types of rations depending upon the status as under.

One of the notable characteristic of India's milk economy is that its almost entire feed requirement is met from crop residue and by-products; green grasses, weeds and tree leaves gathered from cultivated and uncultivated land; and grazing on common land and harvested fields. Land allocation to cultivation of green fodder crops is limited and hardly ever exceeds over 5 per cent of the gross cropped area.

- **Category-I:** In this category are mostly landless labourers (15-20% in each village) keeping 1-2 buffaloes/ indigenous cow yielding up to 5 litre milk per day. It is difficult to ascertain the nutritional status of these animals as they are let loose for grazing for most part of the day. Each animal is given 2-3 kg straw plus half a kg of wheat flour (mixed together) in a manner. The deficiency of nutrients apparently is more serious in animals of this category, as most of these animals are ancestorous, which could be due to under nutrition and/or imbalanced nutrition.

- **Category II:** This category comprised of small and marginal farmers including some dairy owners, animals produce 5-8 litre milk per day (Table). Cotton seed cake (CSC) is the cake of choice fed in the name of concentrate mixture in cotton growing belt i.e districts in South West zone (Hisar, Fatehabad and Sirsa). Feeding of CSC (besides serving as a protein source) has the additional advantage that it contains 6-8 % oil and serves as a good source of energy when supply of green fodder is limited and wheat straw forms bulk of the ration supply of these animals.

  Therefore, feeding of cotton seeds and cotton seed cake to milch animals is the right approach to match the ruminant production system with available source of energy in this cotton growing area of the state. CSC and mustard cake fed in the south west zone of Haryana was soaked in water

for 3-4 hrs and then mixed with straw (*Sani*) before feeding to milch animals. This helps to increase the overall intake of straw and also improves the utilization of nutrients due to associative effects. Heifers and dry animals, however, were not fed any concentrate mixture and are being maintained mainly on green fodders like the *berseem (Trifolium alexandrinum)*, *jowar* (5-10 kg), wheat straw and local grasses.

Category-III: Mostly medium and well to do farmers having animals yielding 10-14 litres of milk per day. The farmers in this category have the capacity and are well aware of formulating better/balanced rations with the inclusion of 30-40% of concentrate ingredients with wheat, *bajra* or cotton seeds. These grains are crushed and boiled/cooked sufficiently on low heat for 3-4 hrs to make gruel and fed before milking. Cooking of the feed in this manner is said to improve its digestibility. A few decades ago it was a common practice to feed boiled cotton seeds to all high yielding animals. *Bajra*, guar and gram *churi* as concentrate ingredients are more common in Mohindergarh and Rewari districts.

Feeding of sufficient *berseem* along with mustard cake to milch buffaloes by small and marginal farmers is a common practice in some parts of Haryana, which might cause excess nitrogen intake vis a vis excess dietary nitrogen excretion and result in low conception rates as also indicated in literature. Accordingly farmers can be advised to supplement wheat bran or rice bran instead of cakes with *berseem* fodder to reduce nitrogen stress. Moreover, the bran is rich in phosphorus can reduce the load of Ca/P imbalance arising out of excess *berseem* feeding.

3.7 Feed intake and nutrient supply

The nutritional status of a buffaloes (n=36) average weight 500 kg and av. Milk yield around 9.0 kg is depicted in Table 3.4. Example illustrated indicated that nutrient requirements (DCP & TDN) of the animals can be met following the traditional method of feeding prevailing in the state. However, with the decrease in green fodder to 5-10 kg/h/d and often substituted by local grass during lean periods; there may decline in daily milk production of these buffaloes. A wide variation existed in the availability of green due to economic strata of the farmers. However, *ad lib* feeding of wheat straw (say7-8 kg/h/d), 20-25 kg of *berseem* plus 1-2 kg mustard cake/CSC to milch animals yielding 6-8 kg of milk daily is a common dietary regime for majority of the buffaloes.

3.8 Feeding of various categories of buffaloes

Buffaloes are being suggested as the future species to meet the increasing demands for quality meat and milk. India is native for world famous high producing buffalo breeds such as *Murrah, Nili-Ravi, Jaffarabadi, Pandharpuri, Mehsana, Surti* etc. Buffalo milk and meat are popular throughout the world because of their high in the essential fatty acids, excellent ratio of Omega-3 to Omega-6 fatty acids, rich in minerals especially iron and low in cholesterol. However, the growth rate in milk and meat production remains low. Scientific feeding practices hold the key for increasing the production performance as feeding accounts for 60-70% of total rearing cost. Meeting requirements of critical plane of nutrition at each stage of life cycle has comportment on performance at subsequent stages and thus on lifetime production. Hence, proper scientific feeding should be followed at all stages of lifecycle for sustaining productivity. The example of nutrients supply to lactating buffaloes during Rabi season is given in Table 3.4

Table 3.4: Supply of Nutrients to Lactating Buffaloes during Rabi Season (example)

Body Wt/Milk yield/d	Feeds offered	Quantity		Nutrients supplied/required						
		Fresh Basis	DM basis	CP (g)	TDN (kg)	Ca (g)	P (g)	Zn (mg)	Mn (mg)	Cu (mg)
500 kg body weight; 8.4 kg av. Milk yield; (6.0-15.0) kg milk yield range	**Cotton seed cake**	2 (1-3)	1.80	270	1.44	4.25	10.26	59.99	30.10	21.06
	Wheat floor	0.53(0-1)	0.46	46	0.31	0.33	1.57	8.32	7.95	3.05
	Bajra grains	0.70(0-2)	0.63	63	0.50	0.11	1.69	18.87	4.02	3.85
	Wheat straw	7.8(7-10)	7.02	-	2.81	16.15	6.04	113.2	127.9	24.78
	Berseem	12.8(15-20)	2.56	410	1.41	30.28	5.81	105.1	169.2	33.69
	Nutrients Supplied	-	12.46	788	6.47	51.12	25.37	305.5	339.3	86.43
	Nutrients required	-	12.50	820	7.30	46.00	42.00	997	498	125
	% shortage	-	-	**3.9**	**11.36**	-	**39.60**	**69.35**	**31.93**	**30.6**

DM= Dry matter, CP= Crude protein, TDN= Total digestible nutrients

➢ Feeding of buffalo calves

➢ Feeding during early days (1-90 days)

Buffalo calves should be fed colostrum, the first milk of the mother secreted immediately after the birth of a new born as early as possible and positively within 30 minutes of birth and should be continued up to 4 days of age @ 3-4 litre/ day. The colostrum is rich in protein, fat, vitamin A and minerals. It also contains antibodies, which provide passive immune protection to the calf from many diseases and has laxative properties which help in expelling muconium. In case of non-availability of dam's colostrum, two eggs and 30ml of castor oil should be fed orally and serum of the dam should be administered intravenously for 2-3 days for providing the immunity to calves. After 4 days when colostrum feeding is over, calf should be continued to feed whole milk @1/10th of body weight i.e. around 2.5 kg per day up to the age of 7 days. From 8th day, calf should be allowed to take calf starter and green grass along with the whole milk to boost up the rumen development in the following manner.

Calf starter should be prepared with good quality, easily digestible feed ingredients (Crushed maize, 38 kg; crushed barley/ oats/ bajra, 14 kg; Groundnut cake, 35 kg; wheat bran, 10 kg; mineral mixture, 2 kg; salt, 1 kg; Vit A, B2, D3; 10 g per quintal so that the feed contains 22% CP and 70% TDN .

➢ Feeding during 3-6 months

At the age of 3 months, calves attain around 60 kg body weight and microbial digestion in rumen become functional. Calves are not allowed to suck milk from their mother and fed a complete diet (7.5 kg non- leguminous fodder, 2.5 kg leguminous fodder, 1 kg concentrate mixture and wheat straw *ad lib.*) which contains 13% CP and 62% TDN to support at least 500- 600 kg average daily weight gain.

➢ Feeding during 6 months to adult

Calves can be reared on straw based diet with minimum amount of concentrates (Table 3.5). Generally ration contains 12% CP and 60% TDN (10 kg green fodder, *ad lib* (unprepared) straw and standard concentrate mixture containing 20% CP and 70% TDN (Crushed maize, 20 kg; Crushed oats/*bajra*/wheat, 15 kg; Groundnut cake, 10 kg; Mustard cake, 20 kg; Cotton seed cake, 10 kg; wheat

bran, 22 kg; mineral mix, 2 kg; salt, 1 kg per 100 kg). The concentrate mixture should be fed @ 1.5, 2.0, 2.5 and 3.0 kg per day for 100, 150, 200, 250 kg BW for ensuring an average daily gain of at least 500 g. With proper feeding, buffalo heifers attain puberty at the age of 17-21 months with a body weight of 270-300 kg. For adult non-producing buffalo 6 h grazing with *ad lib* feeding of straw or 7 kg straw + 10 kg *berseem* for stall fed buffalo will meet the requirement. When green fodder is not available, additional 1 kg concentrate mixture should be fed as a replacement of 10 kg green fodder.

Table 3.5: Feeding of buffalo calves up to 90 days

Calf age (days)	Whole milk (kg)	Calf starter* (kg)	Green grass (kg)
1-7	2.50	-	-
8-14	2.50	0.050	0.250
15-21	3.00	0.100	0.350
22-30	3.50	0.300	0.500
30-45	3.00	0.600	0.600
46-60	2.00	0.900	0.900
61-75	1.25	1.250	1.200
75-90	0.75	1.500	1.800

**Composition of calf starter (*22% CP and 70% TDN)

➢ Feeding of Pregnant Buffaloes

Adult buffaloes should be fed on maintenance level of feeding in early pregnancy. In last 3 months of pregnancy, dry buffaloes should be fed with 30kg green fodder; 2 kg concentrate mixture (20% CP and 70% TDN) and *ad lib* wheat straw. Additional 1-1.5kg concentrates mixture for last 2 weeks of pregnancy till birth of new born. Pregnant immature buffaloes need be fed additional 0.5- 1kg mixture in early pregnancy to support maternal growth.

➢ Feeding of Lactating Buffaloes

Dietary energy is most limiting factor in milk production. Lactating buffaloes should be fed sufficient nutrients for their milk production and maintenance. For a buffalo of 450kg producing 10kg milk; 5.0kg concentrate mixture, 7kg straw and 20kg legume fodder/40kg cereal fodder per day should be fed depending on the availability. For every 50kg increase or decrease in BW, 350g concentrate mixture + 1 kg straw+3kg *berseem*+2.5kg cereal fodder is to be added or reduced, accordingly. For buffaloes in their 1^{st}or2^{nd} lactation, should be fed additional 0.5- 1.0kg concentrate mixture to support the maternal growth. High yielding buffaloes (> 15 kg milk/d) may be fed bypass fat (cracked un decorticated cotton seed, soybean and mustard seeds @ 1-3 kg per buffalo per day depending on milk production), starch (rice polishings), protein or amino acids (methionine hydroxyl analogue @ 20-30g per day per animal), rumen protected amino acids (a mixture of 7g RP Methionine + 15g RP Lysine +50g RP Choline per animal per day), probiotics (yeast culture, 10g) or vitamin B complex (5-10g niacin) to support high rate of production.

➢ Feeding of working buffalo Bullocks

Feeding of working bullocks depend on the duration, speed and load carried during work. For light work (4h/d), 700 kg buffalo bullock should be fed 2.0 kg concentrate, 10.0 kg *berseem*, 8 kg straw and 1.0 kg mustard/groundnut cake. For heavy work (8h/d), bullock should be offered 3.0 kg concentrate, 14 kg *berseem* and 8 kg straw.

➢ Feeding of breeding buffalo Bulls

Breeding bulls should be fed good quality balanced ration for proper development of testicular tissue and improved semen quality. Care should be taken to avoid overfeeding as fatness lead to reduced libido and reproductive performance. For a 700 kg buffalo bull, 2.0 kg concentrate, 8 kg straw, 2 kg green fodder and

1 kg mustard/GN cake should be fed. Special care should be taken to prevent deficiency of Vit. A and Zn as they delay puberty, reduce libido and integrity of testicular tissue.

➢ **Some common tips of feeding buffaloes**

- Mineral mixture (BIS type II or area specific) and salt may be added in the concentrate mixture or fed separately @ 0.6% and 0.3% of total DMI, respectively that is around 20g mineral mixture for young calves and 60-80g for lactating and adult buffaloes depending on BW and milk production.
- Daily feeding of 2-3kg green fodder is necessary to meet the requirement of Vitamin-A. Milch buffaloes should be supplemented with 20,000-40,000 IU Vitamin-A per day, when no green fodder is available.
- High yielding lactating buffaloes should be fed at regular interval (4 times daily) to maintain continuous fermentation in rumen. Forage should be chaffed and may be mixed with required quantity of concentrate mixture to make total mixed ration for better utilization of feeds.

3.9 *Feeding of various categories of Cattle*

India has largest livestock population in the world with a native of number of good quality breeds like *Sahiwal, Gir, Red Sindhi, Deoni, Hariana, Tharparker, Rathi, Kankrej* etc. As feeding accounts for 60-70% of total rearing cost of animals, meeting requirements of critical plane of nutrition at each stage of life cycle has demeanour on performance at subsequent stages and thus on lifetime production. Hence, proper scientific feeding of all stages of life holds the key of increasing lifetime productivity.

➢ **Feeding of calves (cow)**

➢ **Feeding during early days (1-90 d)**

At birth, the first of the four compartments of the compound stomach, i.e. the rumen is under developed, while the fourth compartment i.e. abomasums, is active and makes up to 70% of the total volume. The most critical period of life of a calf is the initial 2-3 weeks, during which the digestive system is not mature enough but it is developing rapidly with regard to digestive secretions and enzymatic activities. Calves should be fed *colostrum*, the first milk of the mother secreted immediately after the birth of a new born as early as possible and positively within 30 minutes of birth and should be continued up to 4 days of age @ 1/10th of body weight i.e. 3-4 litre/ day (Table 3.6).

Table 3.6: Feeding of calves up to 90 days

Calf Age (days)	Whole milk (kg)	Milk replacer* (kg)	Calf starter** (kg)
1-10	2.50	-	-
11-14	2.50	0.050	-
15-21	3.00	0.100	-
22-30	3.00	0.150	-
31-45	2.00	0.400	-
46-60	1.00	0.600	-
61-75	1.00	-	1.200
76-90	0.75	-	1.500

Composition of milk replacer:

Milk replacer should be prepared with good quality ingredients with high biological value (skim milk powder, 30 kg; linseed oil, 15 kg; wheat/soybean flour, 25 kg; whey powder/concentrate, 21 kg; mineral mixture, 3 kg; molasses, 5 kg; citric acid, 1kg). Milk replacer is diluted with lukewarm water and mixed thoroughly to bring it to the consistency of milk during feeding to calves.

***Composition of calf starter (*22% CP and 70-75% TDN):

Calf starter should be prepared with good quality, easily digestible feed ingredients (Crushed maize, 38 kg; crushed barley/ oats/ bajra, 14 kg; Groundnut cake, 35 kg; wheat bran, 10 kg; mineral mixture, 2 kg; salt, 1 kg; Vit A, B2, D3; 10 g per quintal so that the feed contains 22% CP and 70-75% TDN.

The *colostrum* is rich in all the nutrients (20% more protein, 10-100 times more vitamin A, and 3 times more vitamin D than normal milk). It also contains antibodies, which provide passive immune protection to the calf from many diseases and has laxative properties which help in expelling accumulated faeces in the intestine. After 4 days when *colostrum* feeding is over, calf should be continued to feed normal milk @1/10th of body weight i.e. around 2.5-3.0 kg per day up to the age of 10 days. From 11th day, calf should be allowed to take milk replacer with gradual decrease of milk up to the age of 45 days. Thereafter, calf starter should be introduced and green grass to be fed 2-3 kg per day in addition to whole milk to boost up the rumen development in the following manner.

➢ Feeding during 3-6 months

At the age of 3 months, calves attain body weight around 50 kg and microbial digestion in rumen become functional. Calves are not allowed to suck milk from their mother and fed a complete diet [10.0 kg green fodder (7.5 kg oats/ maize fodder + 2.5 kg *berseem*/ lucerne (*Medicago sativa*) fodder, 1 kg concentrate mixture and wheat straw *ad lib*, which contains about 12% CP and 62% TDN to support about 500 g average daily weight gain.

➢ Feeding during 6 months to adult

Calves can be reared on straw based diet with minimum amount of concentrates. Generally ration contains 12% CP and 60% TDN (10 kg green fodder, *ad lib* straw and standard concentrate mixture containing 20% CP and 70% TDN (crushed maize, 20 kg; crushed oats/*bajra*/wheat, 15 kg; groundnut cake, 10 kg; mustard cake, 20 kg; cotton seed cake, 10 kg; wheat bran, 22 kg; mineral mix, 2 kg; salt, 1 kg per 100 kg body weight). The concentrate mixture should be fed @ 1% of body weight for ensuring an average daily gain of 500 g. With proper feeding, heifers attain puberty at the age of 18-24 months and body weight of about 250 kg.

➢ Feeding of pregnant cows

Pregnant adult cows should be fed on maintenance level of feeding in early pregnancy. In last 3 months of pregnancy, cows should be fed with 20 kg green fodder; 1.5 kg concentrate mixture (20% CP and 70% TDN) and *ad libitum* wheat straw. Additional 0.8- 1.0 kg concentrate mixture is to be fed for last one month of pregnancy till birth of the new born to support rapid growth of foetus.

➢ Feeding of lactating cows

Dietary energy is the most limiting factor in milk production. Dry matter intake reduces around 15-20% after parturition, while nutrient requirement for milk synthesis continues to increase up to 6-7 weeks post-parturition, resulting negative energy balance. The requirement for energy and protein depend on milk yield and fat content. The maintenance requirement of lactating cows for energy is higher by 10% than dry cows. Lactating cows should be fed sufficient nutrients for their milk production and

maintenance. The fibre (NDF) content of diets of lactating cows should be 25-33% out of which 15-19% should come from forage to maintain milk production and fat content. For a cow of 400 kg producing 10 kg milk; 4.0 kg concentrate mixture, 5 kg straw and 15 kg legume fodder/30 kg cereal fodder per day should be fed depending on the availability.

For every 50 kg increase or decrease in BW, 300 g concentrate mixture + 0.8 kg straw+ 2 kg *berseem*+ 2 kg cereal fodder has to be added or reduced, accordingly. For cows in their 1st or 2nd lactation, should be fed additional 0.5- 1.0 kg concentrate mixture to support the maternal growth (additional 10-20% of maintenance energy). High yielding cows (>15 kg milk/d) may be fed bypass fat (cracked un decorticated cotton seed, soybean seeds and mustard seeds @ 1-2 kg per day depending on milk production), starch (rice polishing), protein or amino acids (methionine hydroxyl analogue @ 10-20 g per day per animal), rumen protected protein and amino acids, pro-biotic (yeast culture, 5-10 g) or vitamin B complex (5-10 g niacin) to support high rate of production.

➢ Feeding of breeding bulls

Breeding bulls should be fed good quality balanced ration for proper development of testicular tissue and improved semen quality. Care should be taken to avoid overfeeding as fatness lead to reduced libido and reproductive performance, while underfeeding reduces the growth rate and delays sexual maturity. For a 600 kg cattle bull, 2.0 kg concentrate, 7 kg straw, 2 kg green fodder and 1 kg mustard/GN cake should be fed. Special care should be taken to prevent deficiency of Vit. A and Zn as they delay puberty, reduce libido and integrity of testicular tissue. A good quality of green fodder should be fed after 10-12 months of age for better nourishment to attain early puberty. Care should be taken for supplementation of bypass protein and fat especially during summer months to provide sufficient nutrients under reduced feed intake.

3.10 Mineral supply through feeds

In India, Haryana is the second most important state contributing to the central food grain pool, and contribution towards milk production is equally impressive. But due to deficiency of certain essential micronutrient (minerals) in feed and fodders, performance of the livestock is not optimum. Incidences of reproductive and health problems like anoestrus, delayed puberty, repeat breeding, post-parturient haemoglobin urea, arched back condition, pica, etc. are largely encountered. These are attributed to deficiency of macro- and micro-minerals in diets of animals. Also the sub-clinical deficiency of minerals cannot be ruled out.

Mineral composition of majority of feeds and fodders also revealed deficiency of essential mineral except iron. But iron deficiency has been found in some area. Here, an effort has been made to consolidate the information generated from survey works in different districts of Haryana and based on that the recommendations have been made for efficient supply of minerals matching to the requirements at low cost. Calcium contents in majority of the green fodders (see annexure-1) ranging from 0.32% in *jowar* to 1.32% in *berseem*, sufficient to meet the requirements of milch animals. However, when animals are fed with concentrates on a straw based ration, supplementation from external source is required. Although *berseem* contains sufficient amount of Ca to meet the production requirements of milch animals but its supply is limited to *rabi* season. Similarly, P is adequate in most of green fodders, but mixing it with dry roughages (under field conditions) would again dilute the P content in ration.

Zinc, Mn and Cu are the other major limiting nutrients (minerals) which affect the productivity of the animals and are responsible for anestrous conditions (including heifers) under field conditions. Zn content ranging from 24-38 ppm in green fodders, 15-42 ppm in concentrates and 18-23 ppm in dry roughages cannot meet the requirement of Zn for milch animals. Similarly, Mn is fairly sufficient in leguminous green fodders like *berseem*, lucerne, cowpea and beans, but supply of green fodders is not round the year. However, brans can be used/fed round the year. The mean value of Cu i.e. around 3-10 ppm in most of the common feeds and fodders creates its deficiency in comparison to its standard requirement of 10 ppm.

Iron content in various feeds and fodders as elucidated in the Annexure-1 is sufficiently high and does not need to be supplemented in the ration. Rather its present status may be causing antagonism to the availability of other essential minerals as evident from the literature. Similarly Mg – wherever estimated, appears to be sufficient in feeds and fodders, and we need to be cautious here too for its external supplementation as suggested by BIS. Survey conducted by LUVAS revealed the mineral status in different districts of Haryana.

➢ Strategies for mineral supplementation to improve productivity

The major deficiency is of calcium, phosphorus, zinc, manganese and copper as elucidated from feeds and fodder, biological samples or from data of feed intake, as reported in literature. These feeds/fodders can be exploited judiciously to overcome short supply of minerals to some extent. For example in certain districts – Sonepat, Panipat, Karnal, Kurukshetra, Ambala, large number of animals are offered leguminous fodders alone in sufficient quantities with some oil cakes. This is not a good practice. Although all forage diet is superior for milch animals, but these fodders may not be available round the year and secondly there can be chances of excess protein load/stress to the animal. Therefore, supplementation of deficient minerals through specific mineral salts is the only practical approach to alleviate these deficiencies.

➢ Area Specific Mineral Mixture

Area specific mineral mixture was developed/formulated taking into account the minerals which are deficient in the traditional ration being fed by Haryana farmers (Table 3.7). The readymade mineral mixture at nominal rates is available to the farmers at LUVAS, Hisar and ICAR-CIRB, Hisar, ICAR-NDRI, Karnal and Haryana Dairy Development Dept. at nominal rates.

Table 3.7: Deficiency of minerals in animals of different districts

Districts	Deficiency of minerals	Recommended supplements
Ambala	P, and Zinc	Sodium orthophosphate and Zinc sulphate
Bhiwani	Ca, Cu, Zn and Mn	Calcium carbonate, Copper sulphate, Zinc sulphate and Manganese dioxide
Faridabad	Ca, Mn and Zn	Calcium carbonate, Manganese dioxide and Zinc sulphate
Fatehabad	Ca, P, Cu and Zn	Di-calcium phosphate, Copper sulphate and Zinc sulphate
Gurugram	Ca, P, Cu and Zn	Di-calcium phosphate, Copper sulphate and Zinc sulphate
Hisar	Ca, P, Cu ,Zn and Mn	Di-calcium phosphate, Copper sulphate, Zinc sulphate and Manganese dioxide
Jhajjar	Ca, P and Zn	Di-calcium phosphate and Zinc sulphate
Jind	Ca, Cu, Zn and Mn	Calcium carbonate, Copper sulphate, Manganese dioxide and Zinc sulphate

Kaithal	P, Cu, Zn and Mn	Sodium orthophosphate, Copper sulphate, Manganese dioxide and Zinc sulphate
Karnal	Ca, P, Cu and Zn	Di-calcium phosphate, Copper sulphate and Zinc sulphate
Kurukshetra	Ca, P, Cu and Zn	Di-calcium phosphate, Copper sulphate and Zinc sulphate
Mahendergarh	Ca, P, Cu and Zn	Di-calcium phosphate, Copper Sulphate and Zinc sulphate
Nuh	Ca, P, Cu and Zn	Di-calcium phosphate, Copper Sulphate and Zinc sulphate
Panchkula	P, Cu, Zn and Mn	Sodium orthophosphate, Copper sulphate, Manganese dioxide and Zinc sulphate
Panipat	Ca, P and Zn	Di-calcium phosphate and Zinc sulphate
Rewari	Ca, P, Cu, ,Zn and Mn	Di-calcium phosphate, Copper sulphate, Zinc sulphate and Manganese dioxide
Rohtak	Ca, Cu, Zn and Mn	Calcium carbonate, Copper sulphate, Zinc sulphate and Manganese dioxide
Sirsa	Ca, P, Cu and Zn	Di-calcium phosphate, Copper Sulphate and Zinc Sulphate
Sonepat	Ca, P and Zn	Di-calcium phosphate and Zinc sulphate
Yamunanagar	Ca, P and Zn	Di-calcium phosphate and Zinc sulphate

3.11 *Important information regarding dairy bovines*

The dairy animal farmers of Haryana state are well versed with the traditional feeding and management of the cows and buffaloes. Some farmers may not be aware with few scientific developments in animal feeding. Therefore, it is important to list the findings for the information of the farmers.

- Animals sipping urine require more protein rich feeds like oilseed cake, *berseem*, lucerne and cowpea. In deficiency of common salt/minerals they start sipping urine or licking walls and clay. Minerals mixture should be fed free choice to cows and buffaloes licking the walls and eating clay type soil or ash.
- Minerals mixture containing calcium compounds should not be fed to cows and buffaloes during last month of pregnancy. This practice provides protection from the milk fever, which occurs within 4-6 weeks after calving. Calcium containing mineral mixture feeding should be started again after the birth of calf.
- For the cows and buffaloes yielding more than 15 kg milk daily, a common salt containing minerals mixture should be provided in separate container for licking as per desire. Such minerals mixtures are available in the shape of a brick or block with a hole at one end. Such brick can be hanged by toeing in a rope at a place in reach of the cows and buffaloes.
- Calf should be allowed sucking immediately after birth and should not be delayed more than 3 hours. Suckling has no relationship with the expulsion of placenta and *lochia*. Calf should not be allowed to lick placenta and *lochia* or soiled ground.
- Milk feeding has no advantage after 6-8 weeks of age. Therefore, suckling should be allowed only for letdown of milk. In case of the calves weaned at birth after colostrum feeding, milk feeding should be gradually and stopped discontinued, in the 9^{th} week in case of cow calves.

- Buffalo calves generally take some longer time in learning to eat calf starter and fodder. Thus, milk feeding should be discontinued in the 13th week. Since weaning at birth is not fully successful in most breeds of buffaloes, suckling should be allowed only for let-down of milk from 14th week of calving.
- In case of first calving the cow/buffaloes should be fed 20% more energy and protein. This requires feeding of additional concentrates mixture. In second calving additional 10%concentrate mixture is fed.
- Concentrates mixtures for dairy cattle and buffaloes should contain 18% CP and 70% TDN for feeding with non-leguminous roughages. With feeding of plenty amount of leguminous forages the concentrates mixture may contain about 10-12%CP and 68-70% TDN.
- The cows yielding more than 25kg and buffaloes yielding more than 20kg milk daily require changed feeding for supplying required quantity of nutrients in the following order. The animals should gain additional 80 to 100 kg body weight of this about half is delivered as calf, membranes and fluids, and remaining half is utilized for the synthesis of milk during first 1 to 2 months of the lactation period.
- Post-partum breeding interval may be extended by 30 to 45 days. The quantity of straw or chaffed hay of oats/grass should be only 2-3 kg daily. Half of the straw/hay should be fed first before offering green roughages and concentrates mixture. This practice can provide protection from the occurrence of acidity and other feed related disorders. The proportion of concentrates mixture can be 40 to 60% of the total feed intake.
- In case of cows yielding more than 30 kg and buffaloes yielding more than 25kg milk daily, the animals should be given freedom to choose the feeds. After feeding 1-2 kg straw or hay, they should be offered concentrates mixture and green fodder simultaneously for feeding.
- The high milk yielding cows and buffaloes require more observations for body condition and health. Imbalance in the voluntary intake of roughages and concentrates mixture can cause digestive disorders.
- Minerals mixture should be available to all high milk yielding cows and buffaloes. Both cows and buffaloes need plenty of drinking water. Veterinary doctor should be called without any delay.
- Bathing, preferably wallowing is essential for the health and production of the buffaloes. Exotic and crossbreed cows also require daily washing. Indigenous cows have tolerance for high ambient temperature.
- All pregnant animals should be de-wormed and vaccinated during pregnancy. Naval cord should be painted with tincture of iodine after cutting or breaking. In absence of antiseptic lotion the free and of naval cord can be burnt with a red hot iron. The teats should be infused with drug and sealed at the end of lactation. This provides protection from infection.
- Calves may require de-worming against round worm and treatment of *coccidiosis*. Vaccinations are required after 5-6 months of age.
- Dry *kachcha* -no mud plastered and clean floor is comfortable than the *pucca* floor-brick lined or cemented. The *Pucca* floor should not be slippery. Bedding is required for providing protection to full developed udder and teats. Bedding should not be moist and soiled. It should be sun dried daily and on cloudy day it should be changed. Ash is satisfactory bedding on *kacha* flour due to high moisture absorption capacity.
- Animal houses should be well ventilated but direct cold wind must be prevented with the use of heavy curtains or by other means. Animals should not be let loose for grazing before 2-3 hours exposure of herbs by sun rays.

4. Fodder Scenario in Haryana

The entire feed and fodder requirement of the livestock is met from crop residues and by-products; grasses, weeds and tree leaves gathered from cultivated and uncultivated lands; and grazing on common lands and harvested fields. Due to ever increasing population pressure of human, arable land is mainly used for food and cash crops, thus there is little chance of having good quality arable land available for fodder production and the share has hardly ever exceeded 5 per cent of the gross cropped area (GOI, 2009). Area under permanent pasture and cultivable wasteland in the State was 26000 ha and 18000 ha in 2013-14 (National Action Plan for Dairy Development, Vision-2022). The nutritive value of feed and fodder has a significant bearing on productivity of livestock. The major reasons for shortage of feed and fodder are, increasing pressure on land for growing food grains, oil seeds and pulses, adequate attention has not been given to the production of fodder crops.

Further, on account of diversified use of agricultural residues, the grazing lands are gradually diminishing. Majority of the grazing lands have either been degraded or encroached upon restricting their availability for livestock grazing. The area under fodder cultivation is also limited. It is only about 4% of the cropping area, and it has remained static for a long period of time. Owing to the importance of food crops and other cash crops, it is very unlikely that the area under fodder cultivation would increase substantially. Though the availability of feed and fodder has improved in the last decade, still a lot is required to be done to bridge the gap between the demand and availability of fodder in the county, particularly during the lean periods and crisis situations (see Figure 4.1). To overcome the shortage of feed and fodder and to improve the nutritive value, the Department of animal Husbandry and fisheries, GOI has included a Sub-Mission on Fodder and Feed Development in the National Livestock Mission from 2014-15 onwards.

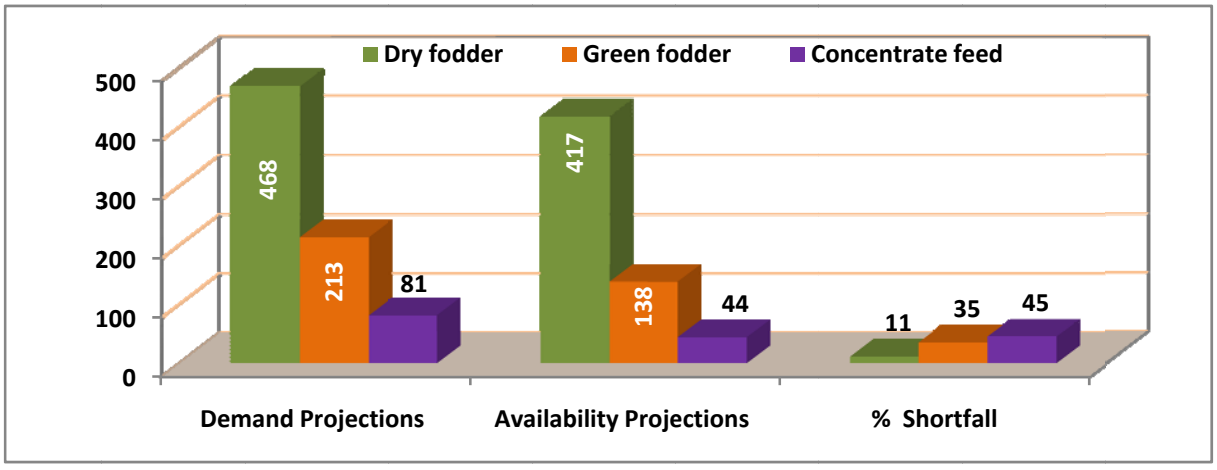

Fig. 4.1 Projected demand and availability of fodder in India ((million MT) during 2020

Source: CLFMA Annual Survey 2013-14

4.1 Importance of Feed and Fodder

Green fodder is a vital source of nutrients, especially vitamins, for livestock. Green fodder is primarily obtained through cultivation. Livestock rearing in India is changing fast and there has been a rise in demand of milk cattle as compared to dual or draught breeds and to realize the productivity potential

and to improve reproductive efficiency of our dairy animals, feed and fodder supply is essential Feed and fodder cost constitute about 60-70% of cost of milk production thus cultivated fodder has an important role in meeting requirement of various nutrients and roughage to produce milk most economically as compared to concentrates. Feeding not only meets nutrient requirement but also fills the rumen to satisfy the animals. Feed has to meet requirement of cattle maintenance, production and requirement of microbes to promote digestion. Because of the peculiarity of digestive system, ruminants need feeds and fodder, which not only meet their nutritional requirements but also fill the rumen and satisfy the animal. The green fodder is a good source of nutrients i.e. energy (cereal crops like Maize, Sorghum and Oats) and protein (leguminous crops like Lucerne, *Berseem* and Cowpea) and also of critical elements like major and micro minerals and vitamins. Feeding dairy animals with green fodder, known to be cheaper source of nutrients as compared to concentrates can reduce the cost of feeding and thus an economical alternative. In case surplus fodder is available in some season it can be stored in form of silage or hay for lean season. Looking into the land constraints, efforts needed to:

(i) Enhance fodder production from available land and

(ii) Increase availability of fodder by minimizing wastage.

4.2 Availability and Future Requirement

There is tremendous pressure of livestock on available feed and fodder, as land available for fodder production has been decreasing. The scenario of feed and fodder availability till 2025 has been shown below in Table 4.1. It is obvious from table that deficit in green and dry fodder is increasing every year, while for concentrates, the gap is almost static. However, this gap is critical and is going to determine the type of animals and husbandry practices to be followed. Scarcity of feed and fodder resources (both quantity and quality), low production potential of animals, non-availability of critical inputs or services in time along with access to capital and markets, are primary reasons for low productivity of dairy animals.

Table 4.1: Scenario of feed and fodder availability and future requirement (in million MT)

Year	Supply (million tonnes)		Demand (million tonnes)		Deficit as % of demand (actual demand)	
	Green	Dry	Green	Dry	Green	Dry
1995	379.3	421	947	526	59.95 (568)	19.95 (105)
2000	384.5	428	988	549	61.10 (604)	21.93 (121)
2005	389.9	443	1025	569	61.96 (635)	22.08 (126)
2010	395.2	451	1061	589	62.76 (666)	23.46 (138)
2015	400.6	466	1097	609	63.50 (696)	23.56 (143)
2020	405.9	473	1134	630	64.21 (728)	24.81 (157)
2025	411.3	488	1170	650	64.87 (759)	24.92 (162)

4.3 Assessment of fodder production status in the state

Forage crops are the lifeline of the agrarians particularly marginal/poor rural mosses in stress prone areas, where cultivation of major cereals is subjected to a variety of constraints and the rural people thrive mainly on mixed farming of both agriculture and animal husbandry. In India, total area under cultivated fodder of about 8.4million ha (2%) has remained almost static since last 3-4 decades and

animal population is 17% of the world's livestock population. During this period, forage research has contributed in the development of more than 300 forage crops varieties of cultivated species, range grasses and legumes (see Table 4.2).

Table 4.2: Varieties of grasses and their yield per acre

Sr. No.	Name of grass (local/desi also)	Yield per ha (q/year)	
		Improved strain	Local strain
For summer and rainy/*kharif* season grasses			
1	Bara Dhaullu	250	238
2	Chhotta Dhaullu	266	249
3	Lamb	298	225
4	Dariaii	339	261
5	Sunehra Bara	409	323
6	Kodri	347	306
7	Lunji	390	328
8	Chhotta Baru	335	295
Winter/Evergreen (perennial)			
1	*Flarus tuberose*	302	-
2	*Lolium perenne*	282	-
3	*Fastira prertus*	306	-
Annual grasses			
1	*Nolium rigidium*	332	-
2	*Nolium tenulatum*	202	-
3	*Flasser minor*	167	-
4	Barom deshi	155	-

India is basically on agricultural country and livelihood of 65-70 per cent of its village people is dependent mainly on agriculture and animal husbandry. Although, India has the highest livestock population in the world, yet the production of milk and other livestock products is lowest. One of the main seasons for poor performance of our livestock is their malnutrition, under-nutrition or both besides the low genetic potential of the animals. As forage crops provide nutritional base to livestock, they are most important for the economy of our nation. Forage crops have never been given importance in agriculture as they did not find place in the crop rotations followed by the farmers mainly due to their small holdings and more emphasis on grain/cash crops are grown in separate area except in some areas of northern states where some land is devoted for fodder production.

The area under forage crops cannot be increased and the solution to the problem is to raise the fodder production per unit area and time. When we talk of fodder production, in our state, HAU has always emphasize to conduct research for improvement of forage crops and a number of high yielding varieties and suitable production technology for forage production has been achieved and thus, Haryana state has recovered the deficiency in forage production. In Haryana, state total area under green fodder production was 3.0 lakh ha till the end of twentieth century but now it has reached at 4.0 lakh ha. In our state, the area at varietal level is not available, however, area under different fodder

crops (both irrigated and un-irrigated) in Haryana has been shown in Table 4.3. On the country level, with the passage of time and adoption of mechanization in agriculture and also development of input responsive, high yielding cultivars of food grains, the pace for fodder production has decreased. There is inadequate feed and fodder available to the rural poor due to disappearing community postures/grazing lands. Coupled with this, there is no Govt. Agency owing responsibility for fodder seed production.

Table 4.3: Scheme to obtain green fodder round the year

Period	Crop	Variety	Sowing time	Yield (q/ha)	Cutting
January	Berseem	Mescavi	1st week of Oct.	200	2nd cut
	Japan rape	Light leaves	1st week of Nov.	500	-
February	Berseem	-	-	250	3rd cut
	Oat	Weston11, Brunker 10	15 Oct.	450	-
	Lucerne	T 9	Oct. – Nov.	100	1st cut
March	Berseem	-	-	300	4th cut
	Oat	FOS 1/29	15 Oct.	400	-
	Lucerne	-	-	150	2nd cut
April	Berseem	-	-	100	5th cut
	Oat	Algerian	15 Oct.	350	-
	Lucerne	-	-	150	3rd cut
May	Sudan grass	SSG59-3	End of March	300	1st cut
	Maize	African tall	-do-	250	-
	Lucerne	T 9	Oct. –Nov.	150	4th cut
	Pearlmillet	-	Start of April	200	-
June	Sudan grass	-	-	300	2nd cut
	Teosinte	Improved Teosinte	1st week of April	300	-
	Lucerne	-	-	100	5th cut
July	Sorghum	JS20, JS263	1st week of may	450	-
	Teosinte	-	-do-	400	-
	Sudan grass	-	-	200	2nd cut
August	Sorghum	JS 20, JS 263	3rd week of May	500	-
	Sorghum	-do-	June	450	-
	Sudan grass	SSG 59-3	March-April	100	3rd cut
September	Sorghum	JS 20, JS 263	1st week of July	500	-
	Mixture of Sorghum-Guar	- / No 2	-do-	450	-
	Lucerne	T 9	Oct. – Nov.	50	6th cut
October	Teosinte	-	Start of Aug.	250	-
	Sorghum	JS 29/1	1st week of Aug	500	-
	Sudan grass	SSG 59-3	March-April	50	4th cut
November	Teosinte	-	Start of Aug.	250	-
	Sorghum	JS 29/1	1st week of Aug.	500	-
	Lucerne	T 9	Last year crop	80	7th cut
December	Berseem/Japan rape mixture	Mescavi Light leaf	1st week of Oct.	150	1st cut
	Lucerne	T 9	Last year crop	100	8th cut
	Sorghum	JS 29/1	1st week of Aug.	450	-

Also, there is lack of effective feed and fodder development strategy for the state. Fragmentation of the land holdings since independence added with competition for food/cash crops, our fodder production has decreased. At national level, the shortage of green fodder (40%), dry matter (35%) and concentrate (55%) exists, although a rise in milk and other animal products has been there in 3-4 decades. Growing green fodder round the year for commercial sale has become more profitable than grain production. Increase in feed grain demand as against fodder food grain demand due to growth of size and demand of livestock sector.

4.4 *Future strategies and action plan for fodder production, storage and transportation*

Haryana is an agriculture state and the contribution of agriculture sector to total GDP of the state is around 15% whereas the livestock sector is contributing to the tune of around 39% of agriculture GDP. In the progress of dairy industry, the main component is adequate supply of nutritious feed and fodders the year round. Good piece of work has been done in our state with regard to development of fodder varieties with high yield potential, better nutritive value coupled with low input requirement. Development and production of fodder resources can be judged from the fact that during 2012-13, milk production (132.43 tonnes) surpassed to that of rice (92 tonnes) and wheat (75 tonnes) crops and thus in India, milk is the number one crop. For enhancing fodder production, the state should launch a special programme (Table 4.4), incentive policy, technology support and special provision of quality seed production and research and also human resource development.

A special drive for R&D for feed and fodder resource inventory and development need to be taken on priority by the state government involving private sector for evolving location specific better varieties/cultivars of forage crops, production and availability of quality fodder seeds in sufficient quality and capacity building for testing the quality of fodder seeds. Location specific cluster based strategies for feed and fodder should be developed for each agro ecological zone of the state. All these programmes should be undertaken in PPP (public–private) mode to reduce the financial burden on the Govt.

Table 4.4: Area under green fodder crops in Haryana

Sr. No.	Fodder Crop	Fodder cropped area (in ha)		Total (A+B)
		Irrigated (A)	Un-irrigated (B)	
1	Sorghum Chari	62960	10156	73116
2	Maize Chara	363	-	363
3	Pearlmillet Chara	28	-	28
4	Dhencha	2539	2028	4627
5	Methi Chara	1209	27	1236
6	Oats	4138	52	4190
7	Berseem Chara	50879	394	51273
8	Lucerne Chara	9771	-	9771
9	Other fodders	179703	66501	246204
Total		**311590**	**79218**	**390808**

Source: Revenue & Disaster Management Department (Haryana) 2011-12

Increasing the area under fodder crops through incentives, promotional schemes, assured economic returns by ensuring MSP should be on the agenda of Govt. Fodder seeds of good quality may be distributed free to poor/marginal/small farmers. Latest technologies and necessary knowhow will result in higher production of green fodder. The Panchayat or common lands in and around villages may be exclusively reserved for cultivation of fodder crops and pasture development. In case of fodder seeds production, *it is no body's baby* and also fodder seeds are a low priority area for HSDC. That is

why fodder seeds have not entered into seed production chain in the state till today. In the arid and semi-arid zone of southern Haryana, we have loamy-sandy soils with alkaline pH. Tube wells are the main source of irrigation but the underlain water level is deep and brackish in quality. The fodder requirement of this area, in future, can be met by exploiting trees and shrubs for fodder.

Agro-forestry systems are widely known due to their productive role as 5 Fs. These five 'Fs' are food and feed, fodder, fuel, fruit and fertilizer. In the recent past, Indian agriculture has been passing a difficult time in view of shrinking of land due to various reasons, primarily being urbanization and over exploitation. Agro-forestry systems, besides producing a wide range of products from the same unit of land can also play a vital role in restoration of degraded lands, soil and moisture conservation etc. It can also generate self-employment for family and build its economy. To overcome adverse agro-climatic conditions in semi-arid zone where the soils are shallow, poor in texture, undulating, poor in drainage, low in water holding capacity and fertility, the alternate land use system can be for the adoption of various agro-forestry systems (agri-silviculture, alley cropping and boundary plantation, agro-horticulture and slivi-pasture).

Nitrogen fixing trees foliage is highly nutritious and can replace/supplement the feeds for the livestock. The productivity and production of most of the forage cereals and legumes has been low and static because of their cultivation under marginal and sub marginal lands, left over pieces of land, rain fed areas, mixed cropping, poor or negligible management with non-specified seeds and inadequate adoption of plant protection measures. Very few farmers use barley as fodder; however it is poor man's dual purpose crop for rain fed area and can be grown for fodder and grain as well. From barley crop, farmer can take one cut for fodder and then grain without much loss of grain yield. Our extension machinery has to be activated to teach the farmers about adopting new technologies and diversification of farming which is need of the hour.

We can take note of National Dairy Development Board (NDDB), Anand (Gujarat) model which is working successfully since last about 3-4 decades. The salient features of the integrated fodder seed production and cooperative dairy development programme are summarized as:

- HRD for seed production and fodder development is essentially required.
- Under silvi-pasture system green fodder and fuel wood can be produced by the farmers.
- Varietal demonstration programs (VDP): Under the scheme, the certified fodder seeds can be given free of cost to the milk produces.
- Demonstration of urea treatment of straw to improve its nutritive value is of great use for farmers.
- Popularization of chaff cutters by providing financial support to the milk producers.
- An approach to achieve self-sufficiency in improved varieties of fodder seeds, dairy cooperative and farmers started fodder seed production in 1983. NDDB makes available breeder seed to various milk unions according to the seed production plan from the ministry of agriculture/ICAR. The State Dairy Federations/District Milk Unions have conveyed multiplication of 373.9 tonnes of improved fodder seed through farmers' participation.
- Establishment of fodder seed processing plants: Dairy cooperatives /Animal Husbandry Department may establish seed processing plants to provide certified quality seed to the farmers. Unfortunately Haryana state does not have a single seed processing plant devoted to fodder seed production.
- Quality control: The seed producing agencies take care of the quality control measures starting from fresh seed for sowing for seed production, adoption of suitable agronomic

practices, drying of seed, cleaning and grading of seeds, sampling and testing of seeds for germination, moisture and seed health status to seed packing after processing and then stacking in the store.

4.5 Storage and transport

Although, there is scarcity of green fodder in the state, but still in most places surplus green fodder is available during the monsoon. A major part of this surplus green fodder goes waste or is improperly stored, reducing its nutritional value. The farmers may be trained in the techniques like making silage or hay at household level. Densification of the bulky dry fodder can reduce the requirement of storage space and also reduce the transport cost. The dry fodder can be handled by installation of low capacity Fodder Block making units and provision of low cost fodder harvesters cum bailers at each Primary Milk Cooperative/ Panchayat level.

Tractor mounted fodder block making units are now available, which can be operated in the fields to store surplus fodder / dry fodder. Agricultural refuge can be densified with or without mixing it with easily available material like urea, molasses, butter milk, etc., for easy storage and use during the lean period. Use of nonconventional by-product of food industry (tomato and apple pomace) and other agricultural wastes / by products as animal feed must be encouraged. Green topping of sugarcane and other crops should be used as fodder.

➢ Bailing and densification

The transport of dry grass occupies voluminous space and takes lot of time to transport resulting into higher costs. Bailing and densification of dry grass helps in reducing the volume and could be transported from excess producing areas to deficit areas economically and efficiently. Densified block of wheat straw, molasses and urea could be developed through high density bailing machine.

➢ Production of complete feed blocks

Complete feed blocks could also be prepared by densifying machine. Nutritive value of forage is enhanced through mixing with molasses and blending with leguminous fodder, concentrate mixture, minerals and vitamin additives.

➢ Fodder Bank

Milk Cooperatives and Panchayats may be assisted for keeping surplus fodder in **fodder banks** for use during crisis periods. *Gaushala* may be encouraged and trained to popularize high-yielding fodder and forage crops and supported for creating fodder banks through silage or fodder blocks and enrichment of crop residues, etc. Places/districts with surplus dry fodder may indicate the quantity and type of fodder available with them, so that necessary arrangements for supply to scarcity area can be made.

➢ Storage of hay and dry fodder

Hay requires protection from fire and storm which are quite common in Haryana. Hence, godowns are required for the storage of hay. A hay barn of brick walls and roof of corrugated galvanized iron sheet can be suitable. Dry roughages are highly inflammable. Therefore, storage of hay and straw should be away from the housing of animals and residence. There should be water pipe line for forced water supply in emergency. Dry fodder store should be well connected with a road connecting the animal sheds/barns/paddocks having mangers for feeding. Despite drying of forage in hot sun for several days the presence of some microorganisms and spores of microorganism should not be ignored. Although these microorganisms are mostly non-pathogenic but can cause other kind of harms. Presence of less dried bundle(s) of hay crop stalled in the hay barn can be the cause of spontaneous fire in the hay.

If, there is 18% water in hay the facultative microorganisms turn active and start multiplication. This results in the generation heat inside the hay stack. In case of limited reaction in small area only browning, i.e. incomplete burning of hay occurs. When microbial fermentation occurs on large area, more heat is generated due to which browning (partial anaerobic burning) of hay takes place. The exposure of this portion of hay by any reason, results in spontaneous fire due to the sudden flow of air (oxygen) across the fermenting portion of the hay. In the curing of very large quantity of green forage for hay making chances of incompletely cured hay containing more than 18% water is high. Therefore, it can be safer to increase the curing duration for a day or two for bringing down moisture content of the hay below 16 per cent. Hay can be stored (i) in the form of long hay or (ii) chaffed in 2-3 cm length by a chaff cutter. Both forms of hay has advantages and disadvantages

➢ Conservation and storage of fodder as Silage

Silage is a succulent fodder prepared by acidic fermentation of green forages in anaerobic conditions. Crops are ensiled at 33 to 40 per cent dry matter content for the preparation of palatable and nutritious silage of low pH (3.4 to 4.0) and long self-life. Haylage – Ensiling of mature crops of 40-45% dry matter content is called haylage. Its pH range is 4.5 to 5.0 and self-life is short. Haylage of oats and barley is superior to the haylage of maize, sorghum and pearlmillet.

Maize (*Zea mays*) is universally known as the silage crop. Milk to dough stage of maturity is preferred for the preparation of high quality silage. Oats (*Avena sativa*) is also ensiled at milk to start of dough stage of maturity for the preparation of good quality silage. Baby corn, a variety of maize contains adequate fermentable sugar essential for the production of optimum level of organic acids (preferably acetic and lactic acid) needed for the production of high quality silage.

Trench Silo (place and structure used for the ensiling of green forages). is most suitable for the Haryana state. Filling and packing of forage for ensiling and removal of silage for feeding are convenient and economical in trench silo as compared to pit silo and tower silo. Effluent of the silage can be absorbed in a layer (4-5 cm thick) of wheat straw spread on the surface of trench silo before packing the green forage for ensiling.

➢ Purpose of silage making

- Green crops continue to grow progressively towards maturing. This affects the chemical composition and nutritive value of the forage crops, particularly the single cut cereal forage crops. The nutritive value of green fodder is stabilized in an almost non-significant narrow range of chemical composition and feeding value.
- Number of landless dairy farmers is increasing due to almost assured marketing of milk and milk products. Such landless dairy farmers procure land for housing of dairy animals and space for the storage of feeds, farm appliances and milk processing. They cultivate land on annual rent for fodder production. On such hired land maize is cultivated 2-3 times during warm months of summer & rainy season. Oats or barley and leguminous crop (preferably *berseem*) are cultivated in winter season. Farmers can harvest the entire crop at proper stage of nutritive value in a single go to prepare the field for cultivation of the second crop in time.

5. Research efforts & fodder varietal development

5.1 The March- A Way Forward

After the emergence of Haryana State on 1st November, 1966, the state felt the need to ameliorate its agricultural research and education and on 2nd February, 1970, the Hisar campus of PAU was elevated into full-fledged University and thus Haryana Agricultural University came into existence. Keeping in view the importance of forage crops in Haryana and to intensify research work for the improvement of these crops, the Fodder Research Section was elevated as Department of Forage Research, HAU in the year 1975. Since then the research work for over-all improvement and management of forage crops is being undertaken at main campus of the Haryana Agricultural University, Hisar.

The University reorganized the Department of Plant Breeding in 1980 for cohesiveness and proper implementation of various teaching and research programmes and the Department of Forage Research was merged in the Department of Plant Breeding and since then it exists as one of the biggest sections of the department of Plant Breeding called "Forage Research Section". From 1970 to 1977-78, Forage Section was biggest among all the sections of the department of Plant Breeding in terms of staff positions, number of research schemes in operation, budget and other infrastructure facilities.

Till 1985, there were two teams of forage research scientists engaged for the overall improvement of forages at Haryana Agricultural University. These teams had outstanding achievements to their credit as the scientists of Forage Section have brought laurels by winning two prestigious ICAR awards, under the capable guidance of Dr. R.S. Paroda, namely, "Rafi Ahmed Kidwai Award" and "ICAR Award for Team Research in Agriculture for the biennium 1982-83 and 1983-84", respectively. A substantial amount of good information/work has been obtained on all aspects like Breeding, Agronomy, Nutritional Quality, Pathology, Entomology and Biochemistry of forage crops through sustained research and team work. To strengthen research work on different forage crops after the formation of CCS HAU in 1970, seven different research schemes were sanctioned in Forage Research Section & a brief account of those schemes along with their main objectives is given below:

- ***State Schemes***

- **C (a) PB-12 NP Agri.--** 'Strengthening of the Research Facilities for Improvement of Fodder Crops for Yield and Disease Resistance': (i) To develop high yielding and better quality varieties of various fodder crops for normal and problematic soils and (ii) To find out suitable production technology of fodder crops for various agro-climate zones and soil conditions.

- **C (a) PB-18 NP Agri.--** 'Strengthening of Research Work on Fodder Crops': (i). To evolve high fodder yielding and nutritionally superior varieties of grasses, legumes and fodder shrubs suited to dry land areas. (ii). To work out suitable agronomic practices for successful raising of grasses, legumes and fodder shrubs in dry land areas. (iii). To work on insect-pests and disease of sorghum, cowpea and lucerne prevalent in Haryana and to find out their control measures.

- **C (a) PB-19 N P Agri.--** 'Investigations on Seed Production of Fodder Crops': (i) To produce sufficient quantities of nucleus and breeder seed of all forage crops varieties; (ii) To know the causes of low seed setting in *berseem*, lucerne and Sudan grass and (iii) To work on seed production and seed technological aspects of fodder crops.

- **C (a) PB-2 Plan Agri.—**'Strengthening of Research facilities for Improvement of Few Important Fodder Crops for Yield and Disease Resistance': (i) To identify work on lucerne and berseem crops at Hisar and (ii) To strengthen research on silvi-pasture at Bawal.

- *ICAR Schemes*

- **C (b) Forage-1—'**All India Coordinated Research Project on Sorghum Improvement': (i) Development of high yielding fodder varieties as well as hybrids of sorghum; (ii) Improvement in the nutritional quality of hybrids & varieties of sorghum and (iii) To work out ideal agronomic practices for cultivation of sorghum.

- **C (b) Forage-2--** 'All India Coordinated Research Project on Forage Crops': (i) To study and evolve high yielding varieties of forage crops and (ii) To study agronomical requirements of different maturing categories of forage crops.

- **C (b) Forage-4--** 'Guar Improvement Project': (i) To develop short duration, quick growing, determinate and high yielding varieties of fodder, grain and vegetable purposes; (ii) Development of photo and thermo- insensitive varieties for year round production; (iii) To develop and identify plant types for inter and mixed cropping systems of crop production; (iv) Development of production technology of guar for fodder, grain and vegetable purposes, and (v) Evaluation of plant protection technology involving pest and pathogen management.

Since the days of combined Punjab and after the bifurcation of Punjab i.e. during the last 50 years, Haryana is well known for its cattle and buffalo wealth in the country. Considerable emphasis was given by the Government and all other concerned organizations to further increase the milk yield of livestock in this state. At that time, there was shortage of both green fodder and good nutritional quality dry fodder. Therefore, systematic work in this direction was started only after the formation of HAU in 1970.

Keeping in view the cultivation trend, distribution and suitability of various fodder crops in various parts, the state was divided mainly in two zones, the drier zone (Sirsa, Fatehabad, Hisar, parts of Jind and Rohtak, Bhiwani, Mohinergarh, Jhajjar, Gurugram and Faridabad) and the humid zone (Sonepat, Panipat, Karnal, Kurukshetra, Kaithal, Ambala, Yamunanagar and Punchkula). In drier zone, the crops like guar, jowar, bajra, oats, grasses and some pasture legumes were preferred for fodder production due to their less water requirement. Whereas in humid zone more water requiring crops like maize, cowpea, makchari , berseem, lucerne and few perennial grasses were grown. However, some overlapping in the distribution of these crops exists depending upon the availability of irrigation facilities and preference of farmers for a particular crop.

Considering the importance of forage crops, the research work on was undertaken at various research stations of Haryana Agricultural University for their improvement with broad objectives given below:

a) Breeding of improved varieties of forages having high fodder yield, better quality, good seed productivity, wider adaptability and resistance to disease and insect-pests.
b) Development of suitable agronomic practices for economical production of forage crops under varying agro climatic conditions, soil types and cropping patterns.
c) To identify diseases and insect-pests of forage crops to evolve their economical control measures.
d) Production of nucleus/ breeder seeds and to undertake research on seed technology aspects of forages.
e) Determination of various biochemical parameters and nutritional quality of forage crops for identification of nutritionally superior varieties.
f) To devise ways and means for conservation and improvement in nutritional quality of forages.

5.2 Forage crops and fodder trees - A list to mention

List of some forage crops and fodder trees that serve the source of animal fodder.

A.	Kharif Forage		
(i)	Jowar (*Sorghum bicolor*)	(iv)	Teosinte (*Euchlaena mexicana*)
(ii)	Bajra (*Pennisetum typhoides*)	(v)	Guar (*Cyamopsis tetragonoloba*)
(iii)	Cowpea (*Vigna unguiculata*)		
B.	**Winter Forages**		
(i)	Berseem (*Trifolium alexandrinum*)	(iv)	Metha (*Trigonella foenum-graecum*)
(ii)	Senji (*Melilotus parviflora & M.alba*)	(v)	Chinese cabbage (*Brassica chinensis*)
(iii)	Oat (*Avena sativa*)		
C.	**Perennial Forages**		
(i)	Lucerne (*Medicago sativa*)	(vi)	Dhaman grass (*Cenchrus setigerus*)
(ii)	Napier grass (*Pennisetum purpureum*)	(vii)	Lablab bean (*Dolichos lablab*)
(iii)	Rhodes grass (*Chloris gayana*)	(viii)	Butterfly pea (*Clitoria ternatea*)
(iv)	Guinea grass (*Panicum maximum*)	(ix)	Khejri (*Prosopis cineraria*)
(v)	Buffel grass (*Cenchrus ciliaris*)	(x)	Subabool *(Lucaena leucocephala*)

5.3 Research Achievements

Major work on cultivated forages was being done at Hisar main research station. The work on improvement of grasses, pasture legumes, fodder shrubs & trees was being undertaken at Dry Farming Research Station, Bawal. Testing of promising lines of some fodder crops was also done at research sub-stations of the University at Sirsa and Ambala. The establishment of the main and research sub-stations has been quite useful for undertaking multi location testing of forage crops for different agro-climatic regions of the state. Voluminous work has been done at CCS HAU, Hisar in 70s and 80s and as a result more than fifty varieties with high yield, nutritious, resistance to biotic and abiotic stresses characteristics coupled with multicut, long duration and multipurpose traits were developed and released. Besides breeding other aspects like forage agronomy, pathology, entomology, animal nutrition and biochemistry etc. were also covered with special emphasis on important forage crops like sorghum, oat and berseem.

➢ Forage breeding

❖ Varietal improvement

Many good varieties of various fodder crops have been developed and released for general cultivation from time to time and the important ones of some main crops are listed in Table 5.1. Under varietal improvement programme discussed in the preceding pages, important *kharif* (sorghum, cowpea and guar) and *rabi* (berseem and oats) forage crops are developed and also the varieties released are given with their salient features. In case of remaining forage/dual purpose crops, not much headway was achieved with regards to release of varieties except one or two fodder varieties in crops like lucerne, Chinese cabbage, maize, bajra, senji or Indian sweet clover (*Melilotus indica*) and metha (*Trigonella foenum-graecum*) etc. This was due to the fact that since beginning, there were full-fledged separate crop sections in case of maize, teosinte (*Euchlaena maxicana*), bajra, oil seeds and dry land agriculture and forestry which were working mainly for grain purpose (maize, pearl-millet and

oilseeds and on other important cash crops) and trees in case of dry land agriculture and forestry. Thus crops like lucerne, Chinese cabbage, senji and metha did not get much needed attention in research at that time including few important grasses and legumes. However, in the beginning, a lot of work has been done in terms of germplasm, collection and evolution, basic and applied research, suitable forages for problematic areas/conditions, seed production and seed technology, forage agronomy, forage quality and forage pathology etc. Also during that time of 70s and 80s, Haryana along with Punjab has achieved a position of "Food Grain Bowl" of India and thus the fodder crops lost their significance as compared to other cash/ commercial crops like wheat, rice, cotton, sugarcane, fruits and vegetable crops.

Table 5.1: Varieties of important fodder crops released after 1970

S. No.	Crop	Variety	Year of Release	Green Fodder Yield (q/ha)
1	**Sorghum (*Sorghum bicolor*)**	Haryana Cheri (JS 73/53)	1975	300
		SSG 59-3	1977	750
		Haryana Cheri 136 (HC136)	1981	500
		HC 171	1987	400
		HC 260	1987	380
		HC 308	1996	530
		HC 513	2010	500-525
		HC 541	2014	525-550
2	**Oat (*Avena sativa*)**	Haryana Javi 114 (HFO 114)	1974	550
		OS 6	1981	500
		OS 7	1981	530
		HJ 8	1998	600-650
		OS 346	2010	525-570
		OS 377	2015	540-570
3	**Berseem (*Trifolium alexandrinum*)**	Mescavi	1975	600-725
		HB 1	2006	675-725
		HB 2	2014	750-825
4	**Cowpea (*Vigna unguiculata*)**	HFC 42-1	1975	320
		CS 88	1995	350-375
		HC 46	2009	350-365 (10-12*)
5	**Guar (*Cyamopsis tetragonoloba*)**	FS 277	1974	280
		HFG 119	1981	230
		HFG 156	1981	325-350
		HG 75	1981	18-20*
		HG 182	1981	15-18*
		HG 258	1987	18-20*
		HG 365	1998	17-19*
		HG 563	2004	18-20*
		HG 870	2010	20-22*
		HG 884	2010	20-22*
		HG 2-20	2010	21-23*

*Grain yield (q/ha)

➢ Germplasm collection, evaluation and categorization

Since 1971, a large number of entries have been introduced in the germplasm pool of different forage crops at this centre. The germplasm so collected was both from exotic and indigenous sources. The detail of germplasm lines available for different fodder crops of this centre (Forage Section, HAU,

Hisar) has been given in Table 5.2. The collected germplasm had been evaluated for fodder yield and quality characters including resistance etc. The variability observed for different traits in various crops is presented in Table 4. Through the germplasm evaluation of all the crops, a number of lines most promising for different traits have been identified and developed for the important fodder crops.

Table 5.2: Germplasm lines in various fodder crops

Crop	Number of Germplasm Lines		Crop	Number of Germplasm Lines	
	Before 1970	At present		Before 1970	At present
Sorghum	568	3000	**Shaftal**	-	40
Cowpea	131	450	**Marvel Grass**	06	-
Guar	50	3500	**Dhaman Grass**	04	10
Oats	183	645	**Buffel Grass**	20	26
Berseem	01	560	**Blue Panicum**	10	40
Lucerne	69	395	**Lablab bean**	-	48
Metha	215	328	**Butterfly pea**	04	40
Senji	61	180	**Subabool**	-	50
Moth	70	-			

The variations in germplasm lines of forage crops evaluated for different plant characteristics concerning fodder yield and quality have been mentioned in Table 5.4.

➢ Sorghum (*Sorghum bicolor*)

In sorghum, considerable variability was observed for many characters. The large number of male sterile lines of sorghum along with their maintainers and restorers are being maintained. So far more than 10000 lines of sorghum have been evaluated for different yield characters, toxic constituents, quality and resistance to diseases, insect-pests and birds. The most promising lines identified in the germplasm for various characters are:

1. Early vigour	**:**	MP Chari, JS 20, SSG 59-3, S 259, 260, 171, IS 2309, 4776 & 12308
2. Early flowering	**:**	S 260, JS 20, MP Chari, IS Nos 677, 2305, 13100, S 250 and S 241
3. Plant height	**:**	IS 18580, S 285, S308, HC 136 and S 286
4. Leaf characters	**:**	HC 136, PJ7R, S 171, IS 1044, SPV 8 and V 60-1
5. Dry matter yield	**:**	IS 1044, HC 260, HC 136, PS 14413 and S 308
6. Low toxic constituent	**:**	*Sorghum roxburghii*, HC 136, IS 4776, PJ7R and IS 3214
7. Disease resistant	**:**	G 40, G 52, IS 3380, HC 171, HC 260, S 308 and *S. roxburghii*
8. Stem borer resistant	**:**	IS 1054, 2123, 5469, 5260, 5171 and PS 14454
9. Bird resistant	**:**	IS 14346, 1807 and 1020
10. Better in quality	**:**	HC 136, JS 4770 and HFS 566

Table 5.3: Range of variation for different characters in various fodder crops

Characters	Sorghum	Guar	Cowpea	Oats	Berseem
Days to flower	38-150	30-89	56-76	86-136	166-178
Plant height (cm)	63-473	55-165	98-167	84-160	50-93
Tillers or branches/plant	1-15	0-13	3-5	9-19	5-37
No. of leaves/plant	5-20	18-56	43-118	6-10	40-628
Leaf length (cm)	35-110	-	9-12	23-65	3.8-7.3
Leaf breadth (cm)	2-10-	-	8-9	1.5-5.0	1.0-2.6
Stem girth (cm)	8-9	-	5-6	1.5-4.5	0.5-3.6
Leaf weight/plant (g)	61-430	17-55	98-267	35.7-126.6	5-200
Leaf/stem ratio	0.17-0.39	0.61-0.96	-	0.15-0.40	0.25-0.40
Green fodder yield/plant (g)	63-1500	40-123	226-708	174-478	25-765
Dry matter yield/plant (g)	25-300	10-35	25-79	34-94	3-80

Table 5.3 Continued.....

Characters	Lucerne	Buffel Grass	Dhaman Grass	Lablab bean
Plant height (cm)	393-94.4	43-95	43-72	51-103
Tillers or branches/plant	3.3-38.7	6.7-24.0	4.6-9.2	3.1-14.3
No of leaves/plant	74.3-853.3	6.5-22.0	6.7-10.2	20.7-95.5
Leaf length (cm)	1.7-4.0	-	-	5.1-7.5
Leaf breadth (cm)	0.7-2.4	-	-	5.2-8.5
Leaf weight/plant (g)	3.3-33.3	56.6-251.6	48-147	130-444
Stem weight/plant (g)	3.3-66.7	88.3-301.0	48-110	160-503
Leaf/stem ratio	-	0.7-2.5	0.7-1.7	1.0-1.8
Green fodder yield/plant (g)	6.6-96.7	177.5-713.7	98-588	309-2560
Dry matter yield/plant (g)	0.92-29.01	65.0-239.1	39-175	92-807

➢ Guar (*Cyamopsis tetragonolobus*)

In guar about 3500 germplasm accessions are being maintained out of which about 1000 lines were collected from NBPGR, New Delhi and rest are collection from different guar growing regions of the country including some exotic collections. Some very good genetic lines have been identified after evaluation for various traits.

High seed yield and early maturity	: IC Nos. 51148, 40682, 51188, 40781, 51236, 51147, 41378 and 51273
Number of clusters and pods/plant	: IC Nos. 9777, 11425, 10308, 10317 and 10345
High seed weight	: IC Nos. 9032, 8932, 42P1, 9054 and 2383
Early maturing	: IC Nos. 40P1, 9032, 2383 and 5496, PLG 276.
High gum content	: HFG 458, 469, 612, 678, 776,937,942 and 1052
High green fodder	: HGS Nos. 280, 281, 282, 283, 284 and 285
Dry matter yield	: HG 2-20, HGS 204, and 206

➢ Cowpea (*Vigna unguiculata*):

In cowpea, 450 germplasm lines have been evaluated extensively and the same are being maintained. Following promising lines for different traits have been identified from germplasm:

Early maturity	: FS 68, IC 1551 and HFC 42-1
Broad leaves	: C 28, FOS 1, and CS 5
High fodder yield	: CS Nos. 24, 40, 44 and 45
Mosaic resistant	: EC 1022P, 20614, 20645, 20664 and 20445 & FOS 1.

➢ Lucerne (*Medicago sativa*):

HAU centre has highest number of germplasm lines (395) of Lucerne in the country. These were being maintained, evaluated and characterized. Wide range of genetic variability was observed in these lines. Following are the most promising genetic stocks identified for different traits in this crop:

Higher fodder yield	: Nos. 77, 79, 84, 90, 91, 461, 514 and NC 83 – 1 – 19.
Disease resistance	: No. 1 and London
Early flowering	: No 26, EC Nos. 95828, 101247, 95616
Broad leaves	: Nos. 91, 85, 82, 432 and 428.
More tillers/plant	: Nos. 25, 26 and 31; Victoria 71, 94 and 513 and EC 95829.
Good seed setting	: NOS. 81, 4321, 45711, 498 and 513.
Salt tolerant lines	: EC 83-1-91 and Igronis

➢ Other forage crops:

The germplasm of grasses, posture legumes, fodder shrubs and fodder trees was increased many fold and evaluated and maintained under dryland conditions at HAU Regional Research Station, Bawal (Rewari) in order to find out more suitable and productive genotypes there for semi-arid areas of the state. Promising genotypes identified out of the germplasm in oats, berseem and metha (at Hisar) and grasses, posture legumes and fodder trees (at Bawal) are given below:

Oats	: HFO55, 114, 181, 239, 240 & 245, OS6, 7, 9, 96, 108, 121, 129, 134, 143, 145, 146 and 152.
Berseem	: Line No. 502, 516, 491, 489, 543, 434, 112, 540, 523, 529, 530, 522, 91, 114, 476 and 485.
Metha	: EC Nos. 26175 and 18737, HFM Nos. 65 and 65-2, NLM IC 326 and PLME-46
Buffel grass	: CC Nos. 120, 1114 and 581
Dhaman grass	: CS Nos. 175 and 415.
Lablab bean	: Nos. 1649-III, 19288 and 16862
Butterfly pea	: Nos. 1442, 173-1, 468 and 10
Subabool	: Peru, Hawaiian Giant and Cunningham.

Among the various species of oats evaluated so far, Avena strigosa, Avena abyssinia, Avena fatua and Avena byzantine apparel to be most premising for various fodder yield attributes and these need to be exploited extensively in future breeding programmes.

➢ *Basic and Applied Genetic Research*

➢ Genetics of fodder yield and quality traits in different forage crops

Studies on genetics of fodder yield and quality attributes using different mating designs, extent of heterosis, correlation and path coefficient analysis and phenotypic stability were undertaken in different forage crops in order to have information on various genetical parameters for subsequent use for the genetic improvement. Full account of such studies is not possible; however, major findings in case of important forage crops are as follows:

➢ **Sorghum:** studies on phenotypic stability revealed that genotypes of sorghum like C 433, C406-8, C19, IS Nos. 6090, 1040 and 1049; JS 73/53, HC 260 and JS 263 among single cut types and T 103, T 87, SSG 59-3, S 194, S 199 and IS 5722 among multi-cut types are highly stable for green fodder and dry matter yield. T 48 & JS 263 showed dominance for stability of yield (green and dry). Sorghum lines IS Nos. 1059, 3247 and 4776; JS 29/1 and NS 256 were stable for low HCN content.

Correlation and path-coefficient analysis indicated that number of leaves, leaf length and breadth and plant height were found to contribute maximum to both green fodder and dry matter yield. Leafiness was correlated with protein content and adds to palatability of fodder and this attribute needs due attention for breeding high fodder yield and better quality in sorghum.

Heterosis over better parent to the extent of 302.9 % for green fodder and 254.4% for dry matter was observed. Negative heterosis over better parent was observed for both HCN and tannin content in different environments. Combining ability analysis revealed that parents like CK 60A, T 30, C 406-8, PJ7R, IS No. 6090 & 1049; *Sorghum. roxburghii*, JS 263, JS 29/1, C 433, PC 9, SPV Nos. 98 and 99 were good general combiners for most of the fodder yield characters while *S. roxburghii*, IS Nos. 1049 & 6090, CK 60A and SPV 98 were good general combiners for almost all the quality traits. Tannin was governed by non-additive genetic component, whereas HCN was controlled by additive component. Low HCN, total phenols, aspartic acid, low Alanine and Cysteine were responsible for foliar disease resistance.

➢ **Berseem:** Correlation and path-coefficient analysis indicated that green fodder and dry matter yield were positively associated among themselves and with traits like plant height, leaf length, leaf breadth, leaf number, leaf weight and stem weight. Stem girth, stem weight and leaf stem ratio had direct and positive effect on green fodder, whereas reverse was the trend for dry matter. Berseem strains HFB 11, HFB 41 and P 3 were the most stable in their performance.

➢ **Oat:** G x E interaction studies revealed that genotypes like Fulgham, 5/104, 37/14, OS Nos. 5, 6, 7, 8, 9, 54 & 77 were highly stable for fodder yield and other attributes and also for digestibility of fodder. Plant height, tillers/plant and leaf breadth were the component characters of green fodder as well as dry matter yield. Genotypes HFD 114, HFO 55, Kent, L 78, Hindustan, HFO Nos. 123, 181, 235, 236, 54, 6, 9, 15, 64 and Flamming Gold have been found good general combiners for fodder yield and most of its related attributes.

➢ **Cowpea:** Genotypes HFC Nos. 617, 637 and No. 10 were good general combiners for almost all the fodder attributes while HFC Nos. 354, 42-1, 617 and No. 10 were best combining parents/genotypes for protein and *in vitro* dry matter digestibility in fodder cowpea. As per specific combining ability studies, the days to flowering, branches/plant and stem girth are controlled mainly by additive gene effects.

➢ **Guar:** Guar genotypes like HFC 381 and No. 2 were good general combiners for both fodder and seed yield and thus can be used for developing dual purpose types. Based on extensive studies on phenotypic stability, genotypes such as HFC Nos. 281, 444, 263 and 244, No. 2 and HG 75 were found to most stable for seed yield. For gum content, strains like IC 9229/P3, HG 75, IC 240-12, HFG 156 and IC 1260-17 were stable. Number of leaves and leaves/plant contributed maximum to dry matter yield and is related positively with protein content and digestibility of fodder.

➢ **Bajra:** Inbred line, D 1941 and A 296 were found to be stable for fodder yield as well as most of its components including IVDMD. Male sterile line MS 5141 was good general combiner for both green fodder and dry matter yield, whereas inbred F 1284 was good combiner for protein content.

➢ **Lucerne:** Both the fodder yields (green and dry) had very strong association with each other and the same were significantly and positively correlated with plant height, leaf length and breadth, leaf number and fresh weight of leaves and stem. Number of leaves and leaf length were the major components for dry matter yield. High genetic advance was observed for plant height, green fodder and dry matter yield.

➢ **Grasses and pasture legumes:** Correlation studies in Buffel grass (*Cenchrus ciliaris*) and Dhaman grass (*Cenchrus setigerus*) indicated that plant height, number of tillers/plant, leaf weight and stem weight were important forage yield contributing characters in these important grasses. In *khejri* (*Prosopis cinelaria*) canopy diameter, area and tree height were correlated with each other.

➢ **Crossing Techniques Evolved**

New crossing techniques have been evolved/ developed in fodder crops like guar, oats, cowpea and *metha* where lot of difficulties in crossing were experienced in the past. This new crossing techniques are simple, easy and efficient by about two to three times in terms of time saving and seed setting as compared to conventional techniques.

➢ ***Interspecies and Inter generic Hybridization***

Ten species of sorghum, three species of guar, six species of lucerne, three species of oats and three species of Brassica having useful attributes suitable for transfer through inter-specific hybridization have been used and are being maintained for further exploitation in various breeding programmes. Inter-specific hybridization attempted extensively in sorghum have resulted into creation of useful genetic variability for most of the forage and quality attributes and 2-3 fold heterosis over the existing best check in few crosses. Investigations on inter-generic hybrids of maize and teosinte revealed considerable heterosis and reciprocal differences for different forage attributes. Inter-specific crosses among lucerne species like *M. sativa, M. falcata, M. murck, M. littoralis, M. truncatula* and *M. scutellata* were attempted in both ways. However, detailed studies need to be taken to know the factors for failure of these crosses.

➢ **Breeding New Plant Types**

Utilizing the broad spectrum of available genetic variability, correlation and path coefficient, studies were conducted to evaluate the contribution of different morphological characters to fodder yield and quality and it was found that dry matter productivity and quality in different fodder crops were mainly dependent more on number of long and broad leaves. Accordingly, morphological frame work of the model plant in different crops was formulated. Through extensive hybridization and rigorous selection, it has been possible to develop ideal plant types having more number of long and broad leaves in fodder crops like sorghum, oats and guar. Such plant types were evaluated for their agronomical and

physiological behavior and it was found that desirable plant types in forage crops should invariably have more number of broad and long leaves for higher fodder yield and quality.

➢ Mutation breeding in forages

From mutation induction studies in some crops it was found that 20 KR dose was more effective in producing the desirable mutants in lablab been while in case of butterfly pea, a dose of 30 KR was most effective for induction of maximum and desired variability. The most striking example of mutation breeding in forages is the release of berseem variety (Hisar Berseem 2) in the year 2014 by selection from the Mescavi line irradiated (70 KR) material.

➢ Suitable forage for problematic conditions

Large number of grasses and few pasture legumes were evaluated under problematic conditions saline soils and dry land areas. It was found that Buffel grass (C. ciliaris) strains CC Nos. 388, 1156, 1169, 109 and 75 and CAZRI 357 gave good yield of green fodder and dry matter under dry land conditions. Two strains Nos. 10079 A and PLS 95 of lablab dean had very good tolerance to frost.

Different species of grasses were tested for number of years under salinity, alkalinity and water logged conditions to find out the best one for these conditions. Grass species like B. mutica P. clandestinum and P. laevifolium had good survival under salinity up to 24mmhos/cm. Under alkaline soils, C. gayana and B mutica gave highest yields of green fodder and dry matter. C gayana and P antidotale had yielded maximum green fodder and dry matter under water logged conditions.

➢ *Seed production and seed technology research*

Apart from seed production, the investigations on various other aspects of seed production and seed technology were also started particularly to know the causes of low seed production in berseem, lucerne and Sudan grass and to find out the agro techniques for increasing seed yields of various fodder crops. The salient achievements on these aspects are given below.

➢ Nucleus and Breeder Seed production

One of the main reasons of low productivity in majority of fodder crops is the non-availability of required quantity seed of their improved varieties. Accordingly, due attention was given in the past to produce maximum quantity of nucleus and breeder seed of all the fodder varieties developed at HAU in order to meet the requirement of various seed producing organizations for these seeds. The crop-wise detail of nucleus and breeder seed produced from 1979-80 to 1989-90 is given below in the Table 5.4. With the passage of time, only important forage crops viz. jowar, bersem, oats, cowpea, lucerne and guar (mainly for grain purposes due to its commercialization) are dealt in forage section, at present and we can look into their nucleus and breeder seed produced from 2007-08 till 2012-13 (Table 5.5). Perusal of data in table 5 revealed that in case of most important crop of *kharif* season of our state, sorghum, if we count individual variety as well as year also as one entry of indent, then indents for the production of breeder seed of this crop were received in 40% cases only and no indents were received in 60% cases.

In sorghum, sweet tall and leafy variety (HC 136) and a sweet with 3-4 cuts Sudan grass variety (SSG 59-3) has occupied more area and also choice of farmers among all the available varieties of sorghum but these two varieties has very poor ranking in seed production and availability of seed (Table 5.5).

Table 5.4: Nucleus and breeder seed produced from 2007-08 till 2012-13

S. No.	Crops	Seed (q)	
		Nucleus Seed	Breeder Seed
1	Sorghum	35.6	158.0
2	Guar	26.3	88.8
3	Berseem	17.3	39.0
4	Oats	54.0	118.0
5	Lucerne	2.1	9.0
6	Metha	2.0	4.5
7	Teosinte	4.4	19.0
8	Cowpea	9.5	14.0
9	Senji	0.9	3.1
10	Japan rape	0.2	3.5
11	Chinese cabbage	0.5	8.6

SSG 59-3 has got no breeder seed indent from the Govt. of India/ICAR or Department of Agriculture for four years and also very little quantity for two years i.e. only one quintal in *kharif*-2008 and 50 kg in *kharif*-2009. Invariably, HAU, Hisar has produced more than indented quantity of breeder seed in 50% cases for forage crops. Over a period of six years 96 indent entries of breeder seed of six forage crops (16 varieties) were received and no indent has been received in 47% cases, so how it can be expected that farmers are getting quality fodder crop seeds for the production of good quality fodder of required quantity. The grand total of quantity of seed produced in *kharif* and *rabi* seasons over the years is greater than total quantity indented over the years.

Table 5.5: Breeder seed production (q) of forage crop varieties during 2008 to 2013

Kharif Season															
Crop	Variety	2007		2008		2009		2010		2011		2012		2013	
		P*	I*	P	I	P	I	P	I	P	I	P	I	P	I
Cowpea	CS 88	-	0.6	0.2	0.5	-	NI	0.6	0.5	0.6	0.5	1.5	1.5	2.9	3.6
Guar	HFG 119	0.2	0.2	0.1	0.1	-	NI	-	NI	-	NI	-	NI	0.3	0.3
	FS 277	-	NI	-	NI	0.2	0.1	0.1	0.1	-	NI	-	NI	0.2	0.2
	HG 365	35.0	34.0	26.5	38.4	-	NI	-	NI	-	NI	1.5	1.5	63.0	73.9
	HG 563	22.0	21.5	36.5	24.7	-	NI	-	NI	-	NI	3.0	3.0	61.5	49.2
	HG 75	0.5	0.5	0.4	0.4	-	NI	-	NI	-	NI	-	NI	0.9	0.8
Jowar	HC 171	1.3	3.3	-	NI	-	NI	-	NI	1.1	1.0	-	NI	2.4	4.3
	HC 308	-	NI	-	NI	-	NI	-	NI	0.4	0.3	1.6	1.0	2.0	1.3
	HC 136	3.5	1.5	0.7	1.4	0.3	1.0	-	NI	0.3	0.3	-	NI	4.7	4.1
	HJ 513	-	NI	-	NI	-	NI	-	NI	0.9	0.9	4.0	2.8	4.9	3.6
	SSG 59-3	-	NI	1.0	1.0	0.5	0.5	-	NI	-	NI	-	NI	1.5	1.5
Sub Total -A		**62.5**	**61.5**	**65.3**	**66.4**	**0.8**	**1.6**	**0.7**	**0.6**	**3.3**	**2.9**	**11.6**	**9.8**	**144.2**	**142.7**

Rabi Season															
Crop	**Variety**	**2007-08**		**2008-09**		**2009-10**		**2010-11**		**2011-12**		**2012-13**		**TOTAL**	
		P*	**I***	**P**	**I**	**P**	**I**	**P**	**I**	**P**	**I**	**P**	**I**	**P**	**I**
Berseem	Mescavi	14.4	15.0	22.0	15.9	6.2	6.2	0.8	0.2	12.0	5.5	15.3	14.4	70.6	63.2
Lucerne	T-9	-	NI	0.4	0.20	0.4	1.6	0.2	0.6	*	0.5	1.0	NI	2.0	2.9
Oats	OS 6	26.0	32.0	31.0	31.0	-	NI	-	NI	5.0	5.0	23.0	26.0	85.0	94.0
	HJ 8	23.0	10.0	16.0	10.0	10.0	10.0	0.1	0.1	24.0	14.0	4.9	23.0	78.0	67.1
	OS 346	-	NI	-	NI	-	NI	-	NI	20.0	18.0	-	NI	20.0	18.0
Sub Total-B		**63.4**	**57.0**	**69.4**	**57.1**	**16.6**	**17.8**	**1.0**	**6.9**	**61.0**	**43.0**	**44.2**	**63.4**	**255.5**	**245.2**
Grand total A+B		**125.9**	**118.5**	**134.7**	**123.5**	**17.4**	**19.4**	**1.7**	**7.5**	**64.3**	**45.9**	**55.8**	**73.2**	**399.7**	**387.9**

*P – Produced, I – Indented, NI – No Indent, * - Less due to weather

(i) Factors affecting seed production in fodder crops: Seed productivity of majority fodder crops is affected due to change in environmental and management conditions. Seed rate, sowing time, application of fertilizers, number of cuts, harvesting time, application of seed setting enhancers, are some of the important factors that affect the seed production in fodder crops.

(ii) Studies on extent of out crossing and isolation distance: The important forage crop like sorghum and Sudan grass are often cross pollinated. Also *berseem* and lucerne comes under often/cross pollinated group, so all these crops require an isolation distance of 400 m an 100 m for breeder/foundation and certified seed production, respectively. Oats is self-pollinated crop therefore, isolation distance of only 3 m is sufficient for all categories of seeds. Similarly, guar and cowpea as self-pollinated crops with 1 or 2% out crossing require isolation distance of 10 to 5 m for these seeds.

5.4 Forage Agronomy

There was an urgent need to produce maximum fodder per unit area and time. Also production has to be oriented in such a manner that there is regular fodder supply for a longer period.

➢ Crop rotations for regular green fodder supply/green fodder Round the Year

Crop rotations, involving both annual and perennial fodder crops with varying intensity were tested. It was observed that Napier bajra hybrid (NB21) intercropped with berseem + Chinese cabbage/Japan rape in winter and with cowpea during both summer and kharif seasons gave the highest yield of green fodder ranging from 1800-2000 q/ha/year.

Another rotation Napier-bajra hybrid (NB21) + lucerne in which both the crops are perennial was the second best in green fodder yield (1500-1700 q/ha per year). Annual crop rotation, sweet Sudan grass (SSG 59-3) + berseem was found to be the best and gave 1400-1600 q/ha of green fodder yield per year. As both these crops are good for hay making, these can be fed with advantage at the time of non-availability of green fodder. For the areas having limited water supply, crop rotation like bajra + cowpea – jowar + cowpea – oats is most suitable. With only two post sowing irrigations, a fodder crop of bajra + cowpea can be grows in summer without any adverse effect on the succeeding crop.

These various crop rotations, besides providing sufficient green fodder during all the months, have also been found better in quality due to inclusion of legume crops. They have also been found to be economical. Another crop rotation for assured irrigation is maize + cowpea - sorghum + cowpea –

oats (MC) which can give 1100 – 1300 q/ha of green fodder per year. The highest net return of Rs. 4500/ha per year was obtained from the crop rotation Napier – bajra hybrid intercropped with berseem and cowpea. This crop rotation also gave highest digestible dry matter, protein yield and total digestible nutrients per hectare.

➢ Agro techniques for increased fodder production

Agro techniques like varieties (single cut v/s multi cut) differ in a number of traits like yield (green fodder, dry matter and seed), quality, absence/presence of toxic constituents and level of resistance towards biotic and abiotic factors; sowing time (timely/late sown), seed rate (more in case bold seeded); spacing (almost all the fodder crops are sown at a distance of 25-30 cm in rows except berseem) do exert an effect on fodder yield in all the crops. Application of nitrogenous fertilizers showed significant effect in increasing the fodder yield of all cereal fodder crops. Water is indispensable for fodder production in all the crops, although its requirement varies from crop to crop. Other factors like weed control, mixed or sole cropping, cutting management and stage of harvesting also affect the quantity and quality of fodder production. A good deal of work has been done at HAU, Hisar on all these aspects for all the important forage crops of the region.

➢ Agro techniques to seed production

At Haryana Agricultural University, agro techniques for seed production of all the important forage crops are being worked out. These include preparation of land, sowing time, seed rate kg/ha, fertilizer application (NPK), irrigation, plant protection, cutting management, rouging, field inspection, maturity and harvesting etc. All these operations have been worked out for all the fodder crops which are grown in Haryana state.

5.5 *Forage quality*

It is very necessary is know the quality and nutritional value of newly bred varieties and their fodder, which are raised under various management practices. A summarized account of the work carried out on the biochemical aspects of forages is given below:

➢ Toxic constituents

➢ HCN and nitrate–nitrogen in forage sorghum

Based on HCN estimation in different environments, some strains have been identified and being used in breeding programmes are IS Nos. 4776, 3247 and 2944, C 10-2, C 1059, C 6128, L 309, L 2194, T 30, NS 256 and T 26 (low in HCN content, below 200 ppm). The HCN was highest at 30 days stage and it varied from 25-710 ppm on dry weight basis. Multi cut strains of forage sorghum like Piper, NKT 2 and 334 were low in HCN content at all the stages of plant growth and thus, could, safely be used for early harvesting as well as grazing purposes. With regard to NO_3-N, the varieties tested were free from it after 50 days of growth.

➢ Tannin content in forage sorghum

Tannin content (as catechin equivalent) affects the palatability and digestibility in forage sorghum. In sorghum grains, the tannin content ranged from 0.1 to 6.2% as catechin equivalent. A significant negative relationship between tannin content and digestibility (r = -0.922**) was observed. Tannin content in the grains of sweet sorghum varieties was low while in non-sweet varieties it was high. Lines like PJ7R, S. roxburghii, IS 3247, HC 136, SPV 98, S 120, S 109, S 162, HC 269 and HC 171 have been confirmed to have low tannin content and are being used extensively in forage sorghum breeding programmes.

➢ Saponin in Guar meal

For the first time, the presence of saponin in guar meal has been detected which is thermo stable and highly haemolytic. The nature of these saponins is different than alfalfa or soybean saponins. At least, now, it is definite that among the alleged anti nutritional factors in green meal one is saponin which is wholly or partly responsible for its growth depressing effects.

➢ Coumarin content in *Mellilotus* species

The work on this aspect was carried out and the results have revealed that coumarin content in white senji (*M. alba*) is much less than in yellow senji (*M. parviflora*). Some of the strains of white senji viz, FS Nos 14, 19, 24, 30 and 31 has less than 3 mg/100 g of coumarin as against 4.2 mg/100g in yellow senji. Coumarin content above 3 mg/ 100 g reduces the palatability of the fodder.

➢ Mimosine in leucaena

The leucaena forage was having a high promise for south-western parts of the state, however, the mimosine content in this crop varied from 0.9 to 2.05% in different cultivars. The mimosine content was found to be maximum in early stages, whereas it was minimum at the flowering stage when the dry matter is highest. A variety of Leucaena, Peru was found to have higher forage yield with high protein content, better digestibility with low mimosine content.

A rapid method to determine and predict IVDMD by chemical and UV spectroscopy has been evolved which helps to examine and analysis a large number of samples in short time. Forage quality lab of Forage Section, HAU, Hisar was a very well established with a large number of equipment, chemicals, dedicated staff members where a large number of samples of fodder crops under the 5-6 state schemes, including All India coordinated schemes, chemical analysis was undertaken for all the quality and nutritional factors. The crops included were sorghum, *berseem*, fodder *bajra*, fodder maize, cowpea, oats, lucerne, guar, *moth*, *senji*, *metha*, teosinte, Chinese cabbage, NB hybrid and few perennial grasses. The work on variability in nutritional parameters gave way for further improvement in quality of forages.

Significant genetic variation has been found in nutritionally important characters of forages (Table 6) and there exists an ample scope of improving the varieties. The IVDMD should be used as promising selection parameter by breeders, however, at the same time sacrifice in yield at the cost of quality should not be allowed. A compromise may, therefore, be made between dry matter and digestibility for obtaining maximum nutritive yield of forage per unit area and per unit time.

Table 5.6: Range of genetic variation for nutritive parameters (% basis) in different forages

Sr. No.	Name of Crop	CP	NDF	ADF	IVDMD
1	Sorghum	3.0 – 06.6	57.5 – 68.0	30.9 – 38.0	55.6 – 68.7
2	Oats	6.3 – 10.1	52.6 – 70.3	30.8 – 45.5	59.7 – 71.2
3	Cowpea	9.6 – 18.6	46.8 – 58.2	32.3 – 41.3	59.7 – 70.9
4	Bajra	5.3 – 09.3	58.1 – 68.5	30.1 – 36.5	62.1 – 64.1
5	Guar	12.7 – 19.6	31.2 – 44.4	26.2 – 37.4	60.6 – 71.2
6	Moth	12.0 – 14.0	38.6 – 42.8	30.5 – 32.7	68.8 – 74.4
7	Teosinte	4.8 – 06.6	64.4 – 68.3	40.7 – 45.1	52.1 – 57.6
8	Dinanath grass	3.5 – 06.0	60.3 – 64.5	37.1 – 41.0	53.9 – 68.7

Also, structural carbohydrates and IVDMD as influenced by different agronomic practices were worked out. The effect of different factors like fertilizers, stage of harvesting and maturity, irrigation, environment, genotypes, dates of sowing and plant spacing were worked out. Studies were also carried out on different biochemical parameters to impart resistance in sorghum. Phenolic compounds appeared to be responsible for resistance to foliar diseases in varieties like 5171 and 5260 right from the earliest stages of their growth.

5.6 Forage pathology

Forage crops are attacked by various kinds of diseases which cause severe loss to their fodder yield and quality Survey work of many years showed the prevalence of various diseases on sorghum, *berseem*, guar, cowpea and lucerne in Haryana state. It was found that incidence of foliar diseases in sorghum varied from 10-90% in different parts of Haryana. The most common fungi associated with leaf spot diseases of sorghum were – *Helminthosporium, Colletotrichum, Gloeospora, Cercospora, Ascochyta, Curoulasia* and *Ramulspora*. Studies on chemical control of leaf spot diseases of forage sorghum were carried out. Major diseases affecting Lucerne were downy mildew, rust and leaf spot while fungal root was the main disease in *berseem*.

Guar was found infested with diseases caused by bacteria (*Xanthomonas cyomopsidis*) and fungi (*Alternaria cyomopsis*, *Myrothecium roudum*, *Fusarium* spp. and *Oidiopsis taurica*) in Haryana. Cowpea was mainly infested with yellow mosaic virus. Bacterial blight on guar is another potential diseases which can affect the plant and thus yield. Huge germplasm and cowpea were screened to identify resistant lines in these crops. Sorghum germplasm lines IS Nos. 4715, 4878 and 4068, P 37, 1062 B, S 151, S 153, S 162, *Sorghum roxburghii*, S Nos. 171, 178, 180, 198, 260, 308 and 411 were found to be resistant to leaf spot diseases. In case of guar HFG Nos. 14, 236, 554, 552 and 530 were observed having considerable resistance to *Alternaria* leaf spot.

5.7 Forage entomology

Insect –pest attacking forage crops cause tremendous loss to them at various stages of growth resulting considerable damage to their fodder yield and quality. The work on different aspects like survey of insect – pests, identification of resistant stocks, mechanism of resistance, have considerable effect on the fodder yield and quality. The work on different aspects like survey of insect – pests, identification of resistant stocks, mechanism of resistance, biochemical basis of insect – pests resistance, advance screening techniques, extent of losses due to insect – pests and their control measures were undertaken in different forage crops with special reference to forage sorghum.

Survey of insect – pests of fodders in different areas of Haryana revealed that main insect – pests attacking fodder crops in Haryana are shoot fly (*Alherigons socata*), stem borer (*Chillo pertelhes*), midge (*Contarinia sorghicola*), earhead worm (*Heliothis armigera*) and earhead bug (*Crenhcade sorghicola*) in sorghum, jassids, aphids and hairy caterpillar in cowpea, gram pod borer in *berseem* and lucerne weevil in lucerne. Leaf perforator (*Dichomeris ianthes*) in guar was recorded first time in Haryana. Screening of germplasm in sorghum revealed that four times IS- 2123, 5469, 18551 and 18584 had stable resistance to both shoot fly and stem borer. Tannin content, lignin and total phenols were found to be responsible for responsible for resistance to stem borer. Due to incidence of shoot fly and stem borer, 30-40% losses in fodder yield of sorghum crop were observed.

Due to the farmer friendly policies of the Govt. of Haryana, technological support from CCS Haryana Agricultural University and farmers willingness for adoption of latest farming technologies, the state has realized green, while, blue and yellow revolutions. Infect, Haryana agriculture has grown steadily from deficit to subsistence to surplus production. Haryana holds a very prominent place in the country

for its livestock wealth and a very good contribution in cattle farming has been added in terms of availability of feed and fodder in sufficient quantity with good quality. Thus, it is beyond doubt that concerted efforts have been made on R&D and also the foregoing pages shows the results in terms of a number of fodder varieties with high yield, batter nutritive value, input responsive and also high performance under low input conditions.

Now the time has arrived for retrospection and revaluation of our technologies and policies towards state agriculture. It is obvious of the fact that new challenges with regard to resource management, soil degradation, deficiency of key elements, misuse/over use of agrichemicals, making nutritional security, quality issues and production sustainability and management of post-harvest surplus are some of the areas to be addressed. The post revolutions had made it very clear to the public that genetic improvement of crops and animals has the capacity to dramatically increase the supply of food, feed, fodder and other plant parts and milk and their derivatives upon which man's existence depends.

Such a good progress on one hand on the other, we are facing problems like inadequate feed and available to rural poor and marginal farmers due to disappearing community pastures/grazing lands. Coupled with this, there is no Govt. Agency owning responsible for feed/fodder production. Also, there is lack of effective feed and fodder development strategy for the state. At national level, there is shortage of green fodder (40%), dry matter (30%) and concentrate (55%), although a rise in milk and other animal products has been noticed since last more than three decades.

6.1 Public Sector Programs, Policies & Extension Strategies

- **Policy initiatives for Animal husbandry and Dairying**

The driving forces for feed and fodder development to augment the livestock requirement in the coming years would be on productivity enhancement, shift to semi-intensive/ commercial production systems. All the schemes for feed and fodder development to enhance livestock productivity has not been able to deliver the desired results. Since most of the schemes have common objectives but are working in isolation, therefore, convergence or merging of some scheme with other flagship schemes will certainly deliver the desired result. Some of the schemes are:

NDP	:	National Dairy Plan
NLM	:	National Livestock Mission
RKVY	:	Rastriya Krishi Vikas Yojana
NFSM	:	National Food Security Mission
PDDULI	:	Pandit Deen Dayal Uppadhaya Livestock Insurance
FBY	:	Fasal Bima Yojana
MGNREGA	:	Mahatma Gandhi National Rural Employment Guarantee Scheme
SGSY	:	Sawarn Jayanti Sawrojgar Yojana

- **Subsidy to Dairy unit**

The Government is providing a subsidy to the extent of 50 per cent for establishment of dairy units of indigenous cows up to 5 milch animals, 17 dairy units have been established in the year 2017-18. During the year 2018-19, there is a target for establishing of 2,000 dairy units.

- **Development and conservation of Indigenous breed of cattle and buffalo**

For encouraging the farmers to rear good quality high yielding indigenous cattle of Hariana and Sahiwal and Murrah breed of buffalo are being recorded and for that incentive money on the basis of milk yield is being provided to the owners of these animals. During this year, performance of 481 Hariana, 136 Sahiwal and 2 Belahi cows and 436 Murrah buffaloes has been recorded till now.

- **National Livestock Mission**

For integrated development of small ruminants, equine, piggery and fodder development, the Department has started implementing different projects under “National Livestock Mission”. The provision of insurance of various categories of livestock has also been made under the Mission.

- **Genetic and Health improvement programme**

The Department has undertaken ambitious programmes for genetic improvement of the livestock as well as keeping it disease free for optimum production. Besides 2,879 existing veterinary institutions, the State has established veterinary polyclinics at strategic locations. So far, five Polyclinics have been established at Sirsa, Bhiwani, Sonipat, Rohtak and Panchkula.

- ***Pandit Deen Dayal Uppadhaya* Livestock Insurance**

  In order to provide socioeconomic security to the livestock owners of the State a scheme of "Pandit Deen Dayal Uppadhaya Livestock Insurance" has been launched in the State during the year 2018-19. Livestock owners can also insure their animals for 3 years by paying a nominal fee as insurance premium. For Schedule caste livestock owners no insurance premium has to be paid by them for insuring their livestock for 1 or 3 years period.

- **Scheduled Caste Sub-Plan (SCSP)**

  The State Govt. is committed to the upliftment of Scheduled Caste families under Scheduled Caste Sub-Plan (SCSP) for providing free insurance coverage to the animals owned by the Scheduled Castes families as well as for providing self-employment opportunities to them through establishment of 3 milch animals dairy, piggery and sheep & goat units. For establishment of dairy, piggery, sheep and goat units by Scheduled Caste families, subsidy @ 50 per cent would be provided.

- **Centre of Excellence**

  For the overall development of cattle and other milch animals on the basis of modern and best technology, an agreement has been signed with Government of Israel in 2015 to set up a Centre of Excellence at Hisar. This will lead to a new revolution in the field of milk production in the State. Process for setting of this centre has been initiated.

- **National Programme for Bovine Breeding & Dairy Development**

  For conservation, up-gradation and integrated development of indigenous breeds of cattle i.e. Hariana, Sahiwal and Tharparkar, "National Programme for Bovine Breeding & Dairy Development" to be implemented over a period of 3 years. The major components under NPBB are extension of Field A.I. Net Work, strengthening of existing A.I. Centres, development & conversation of Indigenous Breeds etc. A Gokul Gram is to be established at Sector-1, Govt. Livestock Farm, Hisar.

- **Hariana-PS and Murrah–PT Programme**

  NDDB has sanctioned two sub projects for production of High Genetic Merit Bulls (Hariana-PS and Murrah–PT) and strengthening of Sperm Station, Hisar over a period of 5 years. (a) For production of High Genetic Merit Hariana Bulls through pedigree selection. The subproject Hariana-PS is implemented in 4 districts namely: Bhiwani, Charkhi Dadri, Jhajjar & Rohtak. (b) For production of High Genetic Merit Murrah Bulls 'Murrah–PT' through progeny testing programme is initiated and under this sub project is implemented in 7 districts namely Bhiwani, Charkhi Dadri, Jhajjar, Rohtak, Hisar, Jind and Sonepat.

- **Haryana Gauvansh Sanrakshan and Gausamvardhan Act, 2015**

  For effective and complete ban on cow slaughter in the State, "The Haryana Gauvansh Sanrakshan & Gausamvardhan Act, 2015" has been enacted and is in force w.e.f. November, 2015. Provision of imprisonment and fine has been made for the offence of cow slaughter and for illegal trafficking of cows for slaughter purposes..

- **Rehabilitation of stray cattle**

  The Government has decided to establish "Gau Abhyaranyas" at strategic locations in the State for effective rehabilitation and upkeep of stray cattle. The process of establishment of Gau

Abhyaranyas at suitable places in the districts of Hisar and Panipat is under progress. To tackle the menace of stray bulls in the state especially of exotic and crossbred cattle, a proposal is under consideration to the Govt. to supply sexed semen in the veterinary institutions for artificial insemination of crossbred cattle wherein 90 per cent of calves born will be female.

Extension Strategies

Extension strategies can bring the desirable changes in behaviour of the farmers. The technology generating and disseminating activities like livestock research and extension have most critical roles to play in the state. Concerted efforts are needed to develop livestock technologies, dissemination of such technologies to the farmers, thereby promoting the adoption rate among them and also revamping of livestock production and marketing policy prescriptions by the planners and policy makers so as to attain the desired technological progress in the state.

Components of extension strategy can be described below:

- Creation of awareness among the farmers for about fodder production technology showing the monetary gain and benefits of cultivation of high yielding varieties fodder crops.
- Motivate farmers through campaigning for growing Perennial fodder crops (e.g. Napier and other grasses) on pond bank, road side, embankment etc.,
- The skilled staff in the Animal Husbandry Department is heavily loaded with veterinary activities alone and finds hardly any time to demonstrate farmers about the importance of feed and fodder. Besides strengthening the knowledge of the manpower of animal husbandry departments across the state about the latest technologies to support the livestock owners both in terms of animal health as well as feed and fodder production/management aspects, the farmers must also be trained with latest technical knowhow.
- Adaptive researches on fodder production technology through on-farm evaluation of fodder production technologies must be encouraged through providing necessary feedback from the farmers' field.
- Conservation of forages by ensiling and hay making to meet the demand in crisis at the time of fodder scarcity is to be promoted among the farmers. Conserved forages which are enriched with nutrients like energy, protein and vitamins and low cost methods of silage making are to be promoted among the farmers.
- Shrubs and small trees (like Gliricidia, Desmanthus, Leucaena, Sesbania spp.) and other Agro-industrial by-products are very good and cheap source of protein and minerals and can be introduced through intercropping between farm plots Motivate farmers for Indigenous Technical Knowledge (ITKs).
- ***Pashu Sakhi*** - a community based alternative extension system which is women centric, has also brought out a positive change in the lives of women and in the communities in Gondia district in Maharashtra. Through this community based approach, women are empowered through technical training to provide services to livestock farmers. A 5 days training in participatory mode is provided to them which focused on treatment and management practices. In a nut shell, *Pashu Sakhi* works more like an *Anganwadi* worker and ANM in human health management. Likewise livestock extension workers '*Pashu Miter*' the male counterpart should be trained to perform specific function as –

- Registration of animals
- Door step first aid and counselling services for disease prevention
- Balanced feeding and demonstration of fodder conservation
- Mineral mixture feeding and specific role of minerals in livestock production
- Demonstration of best practices of livestock production
- Environment friendly livestock production system
- Dung management and biogas production for domestic use
- Processing and marketing of local produce
- Farmer's school in villages and formation of self-help groups
- Awareness/training to farmers for adopting better livestock and fodder production practices

6.2 *Livestock Rearing viv-a-vis Climate Change*

➢ Global warming through Green House Gases

The agriculture and land use change account for approximately 24% of all greenhouse gases (GHGs) of which the large bovine livestock in India contributes maximum (9–10 Tg annually). Methane is produced from enteric fermentation during the normal digestive process of all ruminant livestock. Enteric methane is a normal by-product of ruminant digestion produced by methanogenic bacteria. The rate and quantity of methane is highly influenced by quality of feed-fodder and the nutritional status of the animal and the animal factors such as feed intake, chewing, salivation etc. Due to methane production the ruminant animal suffers a major loss (upto 20%) of ingested feed-derived energy. This necessitates the need for minimizing losses due to methane production so that more useful energy can be diverted for production processes form the animal.

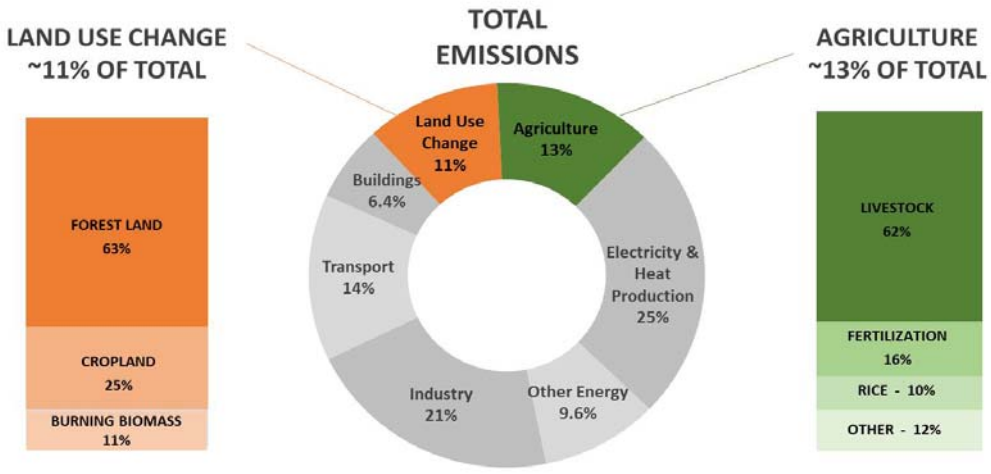

Fig 6.1: GHG emissions contribution from agriculture and allied sectors (IPCC 2014)

➢ *Peri*-urban dairies as source of Green House Gases in and around cities

With increased urbanization and growing demand for milk and milk products in urban areas, dairy farming in urban/ *peri*-urban areas is rapidly growing in some urban/*peri*-urban centres despite challenges. The key advantages of *peri*-urban dairies include easy access to market, remunerative

price in nearby urban market, lesser time and cost for transportation and better access to farm inputs and veterinary services. On the other hand, peri-urban dairies face number of challenges:

- Lower availability of space and water per animal - higher concentration of dairy animals on limited land *Peri*-urban dairy farmers basically rear relatively larger herds of cattle or buffalo than rural farmers to meet the growing market demand of milk in nearby urban centres.
- Lesser and costly feed / fodder availability is major constraint for managing dairy animals although access to concentrate feed is better than rural areas. Because of poor or no land holding *peri*-urban dairy farmers hardly go for cultivation of fodder crops. Unavailability of common grazing land makes managing of dairy animals more difficult. Therefore, *peri*-urban dairy farmers are more dependent on external supply of green and dry fodder which makes their farming costlier. Storing of these feed/fodder materials is also an issue in *peri*-urban areas along with safe storage of the same from fungal growth.
- More risk of *zoonosis* because of higher interaction between humans, animals and environment.
- Poor drainage, inadequate land and water in farm premises leads to unhygienic disposal of farm waste including infected/ contaminated materials like placenta, aborted materials etc. near the farm which create a conducive environment for microbial growth and disease transmission. This also leads to breeding of mosquitoes, flees, ticks, mites etc. Some of these serve as vector/carriers of diseases for humans and animals.
- Many *peri*-urban dairy farmers often settle in a small plot of land, more often unclaimed government land or rented, and therefore land ownership is an issue for them that hinders access to credit and basic facilities like municipality supply of water and/or electricity. Poor access to these services compelled them to rear dairy animals under temporary sheds/without sheds resulting in unhealthy housing of dairy animals that cannot protect them from adverse climatic conditions.
- Air pollution is another problem encountered in *peri*-urban dairy. Off smell emanating from the farms disturbs normal living environment for the farmers as well neighbours in the vicinity. Farm waste disposed near the farms contaminates water, more particularly during monsoon, when everything is drained out to nearby water streams.
- As the *peri*-urban dairy farmers get easy access to retail market in urban areas, large majority of milk produced is sold through informal market channel as raw milk. It gives the *peri*-urban dairy farmers much better price than selling to cooperatives or dairy plants. As milk is mainly sold as raw, maintenance of hygiene and quality (physical and bacteriological) of milk right from production to consumption becomes an important issue from the perspective of risk to consumers' health.

- **Imbalanced feeding and the resultant low health and productivity**

Buffalo farmers in general rear their animals in a poor infrastructure and have limited resources. They are mostly in dairy farming for earning their livelihood and are least bothered about climate change and enteric methane emissions emanating from their enterprise. They feed their livestock on whatever agriculture residue that is available and minimum or no addition of nutrients to make it more balanced. Ruminants like buffaloes maintained on such imbalanced ration cause:

- High production of enteric methane due to incomplete feed digestion because of low feed conversion efficiency
- Poor fertility of animals leading to failure/low success of breed improvement programs like Artificial Insemination (AI)

- Loss of nutrients causing lower milk production
- Poor health and high mortality especially among the claves

Production losses in livestock due to climate change

The adverse effects of climate change will ultimately lead to low returns from the production systems and therefore low sustainability for the communities involved. The general effects of climate change and indirect effects on livestock production systems are listed in the Table 6.1.

Combination of temperature and humidity, known as Temperature Humidity Index (THI) is counted for analysing comfort level. For best performance it has to be in the range of 70-75. When THI exceeds 80, which in North India happens normally during summer and hot-humid conditions, there is an increase in body heat storage beyond its capacity to tolerate heat in buffaloes. This adversely affects all production functions of the animals.

Table 6.1 Climate change and its impact on Animal production systems

Effect of climate change	Impact on buffalo production system	Impact on natural resources
Higher number of stressful days (THI>80) and increased frequency of warm days	Increased water requirement • For animal intake and housing maintenance • For feed and fodder production • For cooling artificially by sprinklers/desert coolers to sustain milk production Higher temperature will lead to decreased shelf-life of milk due to higher microbial load	• Water scarcity aggravated • Burden on water resources intended for human use • Faster depletion of ground water • Increased waste lands
High temperature		
Lesser area on pastures	Lesser fodder- poor nutrition- lower production	• Fodder scarcity, • soil erosion, • damage to urban infrastructure
Less feed and fodder		
Higher incidence of Natural disasters (heat wave, cold wave, draughts, floods etc.)	Lesser fodder and migration to other areas	
Conditions favourable for disease causing organisms, pests and vectors	Higher incidence of disease occurrence • parasitic and vector (tick, mites, flies etc.) transmitted • Viral diseases like FMD, HS • production related mastitis, infertility • Higher calf mortality There will be higher cost of production and maintenance of animals	• Soil and water pollution due to vectors; • Milk, meat / products contaminated with more antibiotics, insecticides and pesticides

Impact of Climate Change on milk production

- A sudden change in temperature, either a rise in T max during summer i.e. heat wave or a fall in T min during winter i.e. cold wave; cause a decline in milk yield. Both increase in T max (>4°C above normal) during summer and decline in T min (>3°C than normal) during winter negatively impact milk production.

- The decline in yield varies from 10- 30% in first lactation and 5-20% in second and third lactation. The extent of decline in milk yield occurs less at mid lactation stage than either late or early stage.
- Negative impacts of cold wave or heat wave on milk yield of buffaloes are not only observed on next day of extreme event but also on the subsequent day(s), thereby indicating that heat and cold waves cause short to long term cumulative effect on milk yield and production in cattle and buffaloes.
- The return to normal milk yield takes 2-5 days normally, however a variable response may also be observed in individual animal depending on stage of lactation. The decline in milk yield and return to normal after an extreme event is also influenced by subsequent day(s) T max and T min.

Impact of climate change on growth and reproduction

- The rise in temperature negatively impacts growth and time to attain puberty ; negative impact of THI rise on animals growing at higher rates will be more than slow growing.
- A change in temperature with changes in photoperiodicity could lead to reproductive malfunctioning due to hormonal events mediated through pineal – hypothalamo –hypophyseal - gonadal axis
- Hot dry summers with limited access to water affect estrus expressions of buffaloes particularly from March to June, when animals have relatively non-functional gonads with less number of sperms in semen of males and poor expression of estrus in females- mainly due to higher thermal heat loads that animals are unable to dissipate.

Impact of climate change on Animal diseases

Table 6.2: Technologies available for climate resilient crop production under crop-livestock mix

Technological options*	Climate Change Impact		
	Food Security	Adaptation	Mitigation
Climate resilient varieties	High	High	High
Laser land levelling	Medium	Medium	High
Zero tillage	Medium	High	Medium
Direct seeded rice	Reasonable	High	Medium
Water management (for rice)	Medium	Medium	High
Raised bed planting	Medium	High	Medium
Residue management/mulching	Medium	High	High
Crop diversification	High	High	Reasonable
Precision nutrient management	High	Reasonable	High
Nutrient expert (NE) decision support tool	High	Reasonable	High
Green seeker	High	Medium	High
Farming with perennials	Medium	High	High
ICT services /agro advisories	Medium	High	Reasonable
Crop insurance	Medium	High	Reasonable

- Elevated temperature and humidity will favour spread and growth of insects/ vectors. Incidences of diseases affecting buffaloes will spread in susceptible population. Frequency of diseases like FMD, HS and tick fever are most likely to higher due to climate change.

Table 6.3: Impact of climate change on livestock and food security

Intervention	Impact		
	Food Security	Adaptation	Mitigation
Increasing productivity per animal – Long term (Over generations) Germplasm improvement through adoption of Artificial Insemination with high quality frozen semen of superior / proven bulls. For more production from less number of animals – leading to lower GHG emissions	Medium	High	High
Increasing lifetime productivity per animal – Medium term Aimed at 'A calf - A year' through use of balanced nutrition, mineral supplementation, hormonal therapies and other fertility management tools including amelioration of infertility. Calf management to reduce age at first calving and higher production per day of its life – Calf management, vaccination, improved nutrition and mineral supplementation	High	High	High
Increasing productivity per lactation cycle – Short term (During current cycle of production) ➢ Increasing feeding value of low quality crop roughages/ residues ➢ Ration balancing for improved feed utilization and low methane emission ➢ Conservation of surplus fodder as silage and hay for use during lean season ➢ Ensuring round-the-year availability of quality ➢ Ensuring round-the-year availability of quality green fodder	High	High	High
Animal welfare considerations for 'One Health' concept (optimum human health through practicing environment friendly livestock and crop farming) ➢ Preventing disease to achieve minimum use of antibiotics e.g. mastitis prevention ➢ Clean milk production ➢ Vaccination and general health measures	High	High	High

6.3 Stubble Burning in Haryana

Farmers try to maximize their yields by planting the next crop as soon as possible after the previous crop has been harvested (generally wheat after rice). To quickly clear the fields for the next crop, they burn the leftover stubble rather than using the traditional method of clearing it by hand or machinery. The state suffers both from non availability of fodder for livestock in some parts and also heavy losses of crop residue by burning the potential animal fodder in other parts. The well to do farmers or those

not practicing livestock farming consider crop residue as burden and to save labour cost they go for burning of large quantities. This leads to:

- Heavy air pollution in the environment. This smoke combines with fog and causes smog which **causes respiratory ailments in human and animal population especially in North India. Problem** is worst in Delhi.
- Deterioration of general condition of the soil
- Lowering of soil fertility leading to lower yield in subsequent crops
- Damage to beneficial insects/microbes in the soil
- Financial loss to the farmer– if the farmer is able to sell the crop residue, he can earn some extra amount for his enterprise.

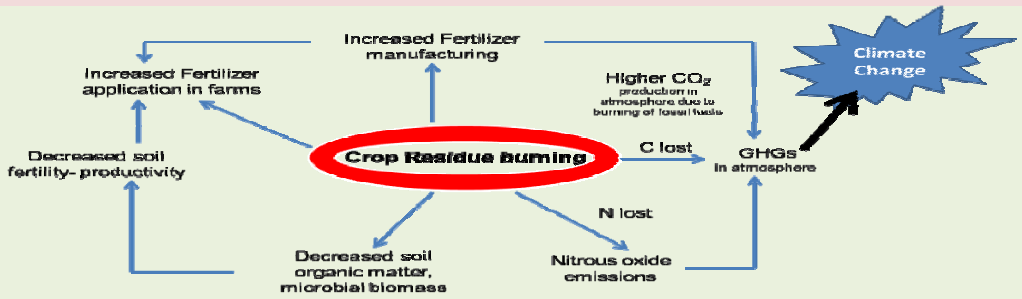

Fig 6.2 Losses due to crop residue burning

Living in districts with air pollution from intense crop residue burning (CRB) is a leading risk factor for acute respiratory infection (ARI). A new study at International Food Policy Research Institute (IFPRI) and partner institutes estimated the health and economic costs of crop residue burning (CRB) in Haryana. Besides worsening of health due to acute respiratory infection, especially among children, the researchers estimated economic loss of over USD 35 billion or nearly Rs 2 lakh crore annually, for the three northern states of Punjab, Haryana and Delhi annually. They also examined other factors that could contribute to poor respiratory health such as firecracker burning during Diwali (it usually coincides with time of CRB) and motor vehicle density. In fact, economic losses owing to exposure to air pollution from firecracker burning are estimated to be around USD 8.3 billion or nearly Rs. 58 thousand crore a year. In five years, the economic loss due to burning of crop residue and firecrackers is estimated to be nearly 1.7 per cent of India's GDP. It is here the govt. can act by collecting all the stubbles from the farmer fields and after proper harvesting supply it to the *Goabyarans* or *Gosalas*. Instead of giving grant in cash, the govt should provide fodder directly to the *gosalas*.

7. Salient Recommendations

In our country, in general, and in the states of Northern India, with particular reference to Haryana, in addition to crop husbandry, animal husbandry plays an important role to supplement the income of farmers in arid and semi-arid agriculture and we can go a long way by adopting the aforesaid strategies to promote the animal husbandry in our state. We have examined the status of R & D efforts in relation to means of producing quality feeds and fodders in sufficient quantity under varied agro-climatic zones of the state in detail and there exist a number of good fodder varieties, although we are lacking in extension of researched benefits to farmers, especially the feed and fodder technology and there exist a wide gap in production and availability of quality seeds at reasonable prices to the farmers.

To ensure the livelihood of marginal/resource poor farmers in rural areas, we have to observe and implement the points given in this report in a systematic manner to augment the feed, fodder and ultimately dairy farming which is the lifeline for our people. Indian agriculture achieved a surplus in food grain production but equal success has not been recorded on feed and fodder production, although a majority of rural community depends on dairy farming for their subsistence. For improving feed and fodder resources in Haryana state, following points are suggested:

➢ Feed and fodder improvement

➢ Optimum utilization of land resources

- Area under fodder cultivation in the state is about 4% in last four decades. Increasing area under feed and fodder crops through incentives, ensuring MSP and promotional schemes
- Owing to the importance of food crops and unlikely that would increase substantially.

- Adopt the practice of land use with multiple crops in a sustainable manner,
- Adopting Silvi-pastoral and Horti-pastoral models suitable to the area,
- The State falls under the category of open forests with less than 0.4 canopy density can be developed with fodder trees.

- Incentives to farmers on renting land for production of feed and fodder e.g. sorghum, *berseem*, oats, Lucerne, maize and oilseeds is advisable.
- Improvement of grasslands/ wastelands, and other community lands through closing the grazing lands from grazing for a period, clearing off the undesirable bushes /trees, adopting soil and water conservation practices, *a*pplication of fertilizers, introduction of improved perennial grasses and desirable fodder trees. Keeping in view the shrinking land resources, tress may be planted on field boundaries as shelterbelts, road sides, railway tracks, whereas perennial grosses can be planted on panchayat/community lands along with forage trees
- Agro-forestry can produce a wide range of products (5'Fs' i.e. food, fodder, fuel, fruit and fertilizer) from the same unit of land as well as due to its vital role in restoration of degraded lands, soil and moisture conservation and generation of self-employment for family and build up its economy. To overcome adverse agro-climatic conditions in semi-arid region various agro-forestry systems i.e. agri-horticulture, alley cropping, boundary plantation, agro-silvi-culture and silvo-pasture may be used.

➢ *Improving fodder production with high yielding varieties*

- Identifying improved fodder varieties on the basis of: High production potential; better quality traits; Adaptability to different agro-climatic zones and Suitability to different farming situations
- To combat the scarcity of both green fodder as well as pure and economic seeds of forage crops, dual crops/cultivars (sorghum, oats, barley, *bajra*, *berseem* and Lucerne) be grown and wherever possible, the farmers should go for cuts of fodder up to possibility and then seed from the regenerated crop.
- Production of high yielding variety seeds should be prioritized through incentives to farmers.
- ***Seed standards*** and production technology in case of important feed and fodder crops as in case of important grain/cash/industrial crops must be worked out.
- Free distribution of quality fodder seeds to marginal/poor farmers
- In the likely scenario of continuous climate change, emphasis be also laid on availability of seeds of short duration, salt tolerant, thermo tolerant and drought tolerant varieties of dual purpose crops,

➢ *Adopting suitable crop combinations*

- Farmers may be advised to grow cereal forages and legumes together in mixed/ intercropping to get a balanced and nutritive fodder.

➢ *Improving animal feedings*

- Feeding of balanced ration to livestock, besides improving in feed digestibility, milk production, fertility and health will reduces enteric methane production and thus save the environment through less emission of GHGs.
- Strategic supplementation of specific deficit nutrient/mineral to realise the production potential of our livestock.
- The use of bypass nutrients and area specific mineral mixture especially in the ration of high yielding animals must be advocated to the farmers.
- Development of low cost feeding strategy by utilization of agro industrial by-products
- Conservation of fodders during lush season by making hay and silage, be used at the time of scarcity.
- Proper storage of crop residues i.e. protecting them from rain and exposure to sun will prevent wastage and improve utility to an extent of 10-15%.
- To make transport and storage of dry fodder economical, installation of low capacity Fodder block making units at each Primary Milk Cooperative / Panchayat level is advocated. Tractor mounted fodder block making units are now available, which can be operated in the fields to densify and store surplus fodder / dry fodder.
- With the technology of feeding Total Mixed Ration, paddy straw could be incorporated up to 25-30% and utilized effectively
- Farmers to be acquainted to available technologies of chemical and biological treatments of low quality roughages to improve the nutritive their value.

- Export of oil cakes must be banned and import of oil seeds rather than oil should be preferred.
- Import of feed ingredients for livestock and poultry should be allowed duty free.
- Capacity building and skill up-gradation of the livestock farmers with special emphasis on scientific feeding of their animals, seed production and fodder development.

State Government policy imperatives

- Specific financial allocation proportionate to the contribution of livestock in agricultural GDP
- The programme like National Dairy Plan (NDP) and National Livestock Mission (NLM) which have an inbuilt component of fodder development must work in synergetic and convergence mode with the other The programmes/ schemes with special focus targeted to livestock like *Rastriya Krishi Vikas Yojna* (RKVY) and National Food Security Mission (NFSM) and MGNREGA.
- Haryana Govt. should establish, on priority, a Fodder Seed Development Corporation (FSDC) as subsidiary of either HSDC or Department of Animal Husbandry involving SAU/LUVAS and Govt. livestock farms for the requisition, production and distribution of breeder and foundation seeds. Also leading farmers, NGO's and private seed sector be involved to produce certified seeds of important/improved varieties/hybrids of fodder crops. Incentives in the form of subsides for fodder seed production be made available to the fodder seed producing farmers/private seed growers
- Establishment Livestock Skill Development Council dedicated to develop and trained state youths for self-employment
- A Fodder Skill Development council to be established dedicated to fodder production
- A Market hub (e-*Mandi*) at district level for trading of animals, feed & fodder, other agricultural produce
- Separate feed and fodder cell aimed at increasing the availability of feed and fodder in the Department Animal Husbandry is proposed.
- Haryana Regulation of Compound Cattle Feed, Concentrates and Mineral Mixtures order, 1999 should have enough teeth to impose the stringent quality control measures for compound cattle feed and mineral mixture
- To avoid stubble burning by farmers, the dry fodder available in farmers' field should be harvested by the Govt. and directly supply to the *Gausalas* instead of direct financial assistance.
- The Community/SHG/ Milk Cooperatives/ Panchayats may be assisted for keeping surplus fodder in fodder banks for use during crisis periods.
- Many of the operations in hi-tech dairy farms are power dependent. Adequate power supply to these farms needs to be ensured
- MSP for milk and milk product is the need of hour to support the resource poor farmers
- Technologies like bio gas production is to be encouraged to salvage the dung from livestock, which is otherwise contributing to environment pollution

➢ *Research initiatives*

- The various biotechnological tools include molecular techniques for understanding the genetic structure of the plants, inserting foreign genes directly into the plant genome, *in-vitro* regeneration of plants from any plant part and other techniques of micro propagation of plant may save time and energy required for conventional methods.
- To tackle the problem of stray cattle technologies like sexed sorted semen use may be put in place
- Establishment of a referral tech laboratory at LUVAS for quality control of premix feeds, concentrate mixture and other feed ingredient to implement and enforce the standard of BIS and specially
- Haryana Regulation of Compound Cattle Feed, Concentrates and Mineral mixtures Order, 1999
- Intensive R&D efforts are essential to evolve high yielding, thermo tolerant, salt tolerant varieties of different forage crops for varied agro-climatic zones.
- Focused research efforts are required to develop environment friendly housing, feeding and management practices to ameliorate the conditions prevalent in *peri*-urban dairies.
- *Khejri* an important tree of the western parts of Haryana has shown a poor regeneration as a result only old trees are commonly seen. For sustainability of this outstanding tree, the problem of regeneration should be seriously addressed through a brain storming session involving farmers, scientists and line departments.
- A brain storming session should be organized on *Moringa* to sort out the problem of quality seeds, agronomical practice, processing of leaves and pods and marketing**.**

➢ *Strengthening of Extension activities*

- Strengthen extension activities by associating KVKs and State Animal Husbandry Department, which must play a lead role in educating the farmers in maximizing fodder output with limited land and ensuring quality of 'feed**.**
- Progressive livestock farmers may be identified for training through KVKs/SAUs for growing improved varieties of fodder.
- The progressive farmers must be registered with the SAUs, KVKs and other ICAR institutes who can act as ***'Kisan Miter'*** on the line of ***'Pashu Sakhi'*** being implemented in Maharashtra who in turn train other farmers.
- Use and adoption of available technologies may be popularized through frontline demonstrations through the KVKs.
- The Regional Fodder Stations of the Government of India have the latest varieties and recommended crop mixtures for the region.
- The power of media and especially social media in this electronic age must be made use of to send the information/advisory to large number of stake holders in single attempt.
- Use of farmer oriented **'Apps'** to educate and sending timely information must also be exploited

- *Special emphasis for training of farmers with special reference to:*
  - Identification of energy feeds,
  - Identification of protein feeds,
  - Importance of minerals in animal nutrition,
  - Importance of optimum balanced feeding of heifers from birth,
  - Diet determination of pregnant – lactating animal,
  - Green fodder conservation as hay, haylage and silage.