

Status Paper

Feed Resources for Livestock in Pakistan

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ABSTRACT

The major constraint in the development of livestock sector in Pakistan is poor availability of nutrients. The nutrient reservoir like rangelands is subjected to deterioration and still no proper attempt is made to sustain and improve their productivity. Livestock farmers hesitate to use non-conventional feed resources to improve livestock feeding because they are unaware of the usefulness of such materials and thus, they strictly adhere to the traditional feeding patterns. The ever decreasing area under fodder production coupled with its scarcity period is the main factor which deteriorates the normal fodder supply. Livestock policies in Pakistan are supportive to the horizontal expansion of livestock rather than vertical expansion of the sector, which cause further problems. Currently, 121.1 million heads of animals in Pakistan annually require about 10.9 and 90.36 million tons of crude protein (CP) and total digestible nutrients (TDN), respectively. However, the respective availability of these two nutrients is 6.7 and 69.0 million tons and thus, CP and TDN are 38.10 and 24.02% deficient per annum. At present, livestock is receiving 51, 38, 3, 6 and 2% of nutrients from green fodder, crop residues, grazing vacant lands, post harvest grazing, cereal by products and oilcakes and meals, respectively. The gap between requirement and availability of nutrients could be minimized both through proper fodder research and extension policies in terms of better quality seed, seed rate, improved agronomic practices, and improved inputs (fertilizers, water, and pesticides). Rangelands are 60% of the total area of Pakistan and proper range management and improvement policies like artificial reseeding, introduction of exotic species, water conservation methods, community organization etc. could bring improvement. Agro industrial byproducts and non-conventional feed resources could be used for feeding of livestock if farmers are trained to do so. Situation may be further improved if fodder conservation techniques are introduced in livestock feeding systems.

Key Words: Feed; Livestock; Pakistan; Nutrient

INTRODUCTION

Agriculture is the most vital component of Pakistan's economy. It contributes about 25% to total GDP, employs around 44% of work force and is the main source of foreign exchange earnings of the country (Economic Survey, 1999-2000). Pakistan has a wealth of 117.09 million heads of livestock, which accounts for nearly 37% of agriculture value added and about 9% of the GDP. The foreign exchange earnings from this sector were around 35.0 billion rupees (Economic Survey, 1998-99), which is 9% of the overall export earning of Pakistan.

The livestock sector, the back bone of agriculture sector, is though a neglected sector in all respects but it still plays a vital role in our national economy by providing draught power, high biological value animal proteins and its byproducts (hides, skin, wool, mohair, bones and manure etc). Draught power and manure provided by the animal enhance the productivity and fertility of the land that is deficient in organic matter. More than 10 million heads of draught animals are engaged in agricultural activities. Their replacement with mechanization needs heavy financially inputs equivalent to 5.12 billion rupees approximately (Raza, 2000).

Geographical and climatic conditions of the country have large variability. Pakistan enjoys the benefits of both

irrigated plains and range areas extended from the coastal ranges in the south to the alpine pastures in the north. Despite of all these factors, growth of livestock sector is 2.8% as compared to 5.5% growth rate in agriculture sector (Economic Survey, 1999-2000). Moreover, per head animal production is very low and it shows horizontal linear graph. This may be due to the lunatic policies like horizontal expansion of livestock, poor germplasm, high disease risks, poor management practices, the availability of low quantity and poor quality feeds.

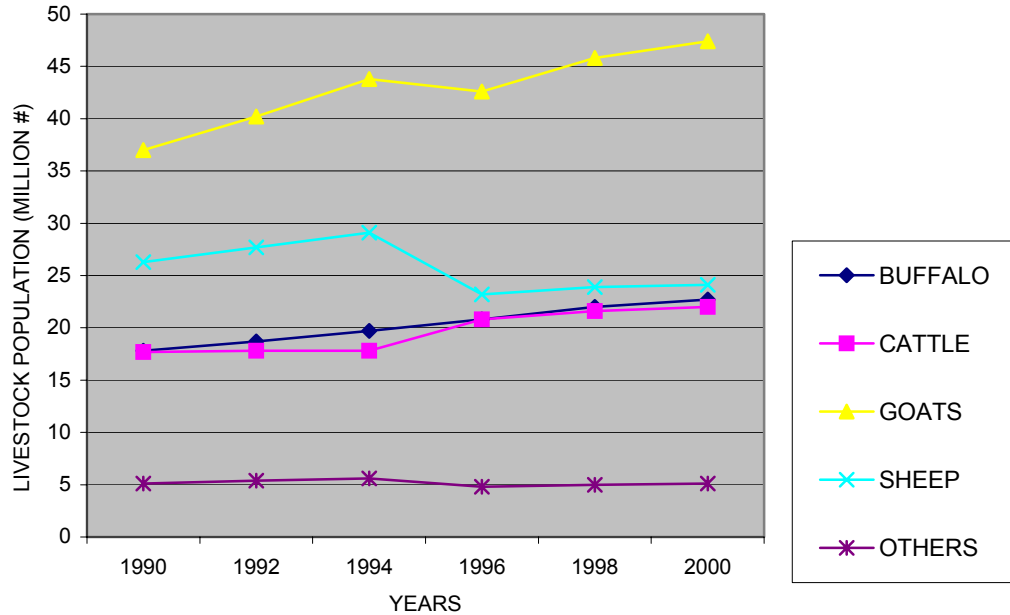
In Pakistan, nutritional requirements of animals are mainly met through fodder crops, shrubs, grasses and agro industrial wastes. In advance countries, where ruminants are fed liberal grains, forage still contributes about 75% of the nutrients and in countries, where grain feeding is not very common, ruminants derive more than 95% of their nutritional needs from forages (Bulla *et al.*, 1977). The existing available feed resources can only fulfill the maintenance requirements of animals. It has been reported that livestock are getting only 75% of the required amount of TDN and there was 60% shortage of digestible C.P. (Akram, 1990). Improving the quantity and quality of feeds could enhance livestock production up to 50% from exiting genetic pool of animals (Hasnain, 1983). The main objective of this manuscript is to explore the available feed resources and to suggest the remedies to minimize the gap between

nutrients availability and nutrients requirements of animals.

Livestock population trends. According to the Economic Survey of Pakistan (1999-2000; Fig. 1)), total wealth of livestock in the country is 121.1 million heads (60 million animal units) and out of this buffalo's share is 21.4 million,

buffalo, sheep and goat is 1.56, 2.36, 0.51 and 3.0%, respectively. The overall annual increase in livestock population is 1.97%. Increase in milk and meat per annum during the previous years is only due to horizontal expansion of the livestock sector. About 87% of the dairy

Fig. 1. Livestock population trend in Pakistan (1990-2000)



which contributes about 75% of total milk production in Pakistan. Nili Ravi and Kundi breeds of buffalo are considered the best breeds in the world. Cattle population of the country is 22.0 million and these are mainly raised for milk and draught purposes. Sahiwal, red sindhi, cholistani, bhagnari, rojhan, dhanni, kankarj and lohani are some of the important indigenous breeds of cattle. However, crossbred cattle (sahiwal-friesian) are also playing an important role in milk production.

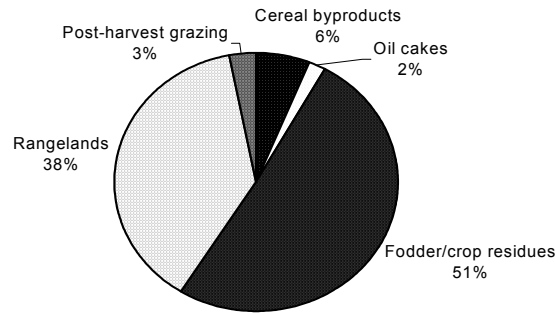
The important breeds of sheep in Pakistan for mutton production are Kajli, Thalli and Lohi. About 47.4 million heads of goats are available in Pakistan. They serve the purpose of mutton production (beetal and teddy breeds) and to a lesser extent they are considered as milk producers. The breeds like Beetal, Kamori and Daira Din Panah are considered good milk producers ($1.5-3 \text{ L day}^{-1}$). Pakistan owns about 0.8 million heads of camels (*Camelus dromedarius*), 0.3 million of horses and 3.8 million heads of donkeys, which are important for transportation and agriculture practices. Population data of livestock from 1995-2000 show that the annual growth rate of cattle,

animals (buffalo, cattle) are kept in small numbers (below 10) by the landless people or small holders (Pakistan Livestock Cens, 1996), which contribute to their daily income and agriculture work. Although the herd size in range areas is large but due to poor availability of inputs production per animal is quite low.

Land use at present. The total geographical area of Pakistan is 79.61 million hectare (MH) and only 59.28 MH is the reported area. Out of which, 3.61MH is the forest area, 24.51 MH is not available for cultivations, 9.30 MH is cultivable waste and only 21.86 MH are available for cultivation. Fig. 2 shows that the land under fodder production is 3.35, MH which is only 14.6% of the cropped area (22.96 MH). The area under fodder production is continually depleting due to high pressure for cash crops production. 49.5 MH is the rangeland which is the 62.18% of total geographical area of Pakistan and supports most of the small ruminants and camels.

Available feed resources. Before exploring, what is available to feed existing livestock? One should have an idea about livestock feeding systems in the country.

Fig. 2. Feed resources for livestock in Pakistan



Livestock are getting 50.7, 37.85, 6.10, 2.35 and 3% of their total nutrients requirements from crop residues, fodders, and cereal by products, oilcakes and other wastes respectively (Crowder, 1988). But, Hanjra *et al.* (1995) reported that animals in Pakistan were getting 51, 38, 3, 6, and 2% of their nutrients from fodders and crop residues, rangeland, post-harvest grazing, cereal by products and oil cakes, respectively (Fig. 3).

In Pakistan, livestock is raised under three different management circumstances.

- In irrigated rural areas (Punjab and Sindh provinces) in the form of small herds where livestock mainly rely on crop residues and fodder crops.
- Under peri urban environment where livestock are

maintained on fodder crops, agro industrial wastes and concentrates (oil cakes).

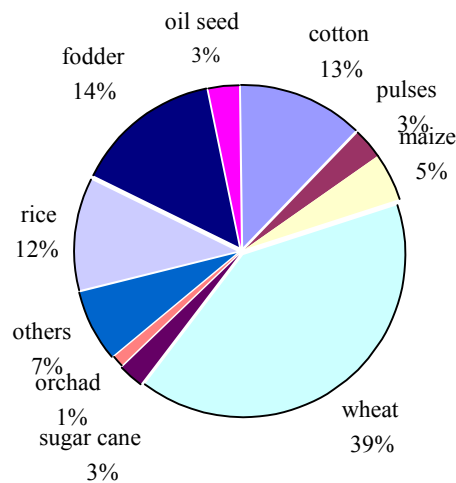
- Large herds of animals are raised under range and barani conditions where they are kept on naturally grown grasses, shrubs and tree leaves.

The available feed resources can be categorized as under.

1. Fodder crops
2. Range vegetation
3. Crop residues
4. Non-conventional feeds /industrial by products.

Fodder crops. In Pakistan, especially in irrigated areas livestock farmers depend only on fodder crops and about 85-90% of the nutrient requirements of ruminants are met through available forages. The 14.6% of cultivated area is

Fig. 3. Distribution of cultivated area



under fodder production but due to active competition with cash crops, it cannot be increased. The area under fodder production decreasing @ of 2% after each decade (Gill, 1998). Fodder production in Pakistan varies according to the ecological zone and with the time of the year.

Sorghum, sadabahar (crossbred fodder) maize, guar, cowpeas, mott grass, berseem, lucern, oats, turnip, mustard are commonly available fodders. However, poor inputs, low genetic potential of fodder varieties, lack of agriculture research and extension services, and orthodox agronomic practices leads to low production per acre and lower the quality of the fodders.

On one hand, livestock bears two scorching periods (May and October) of fodder scarcity, which extremely affect their productivity. On the other, increasing demands for cash crop reduce, the area for fodder production. Thus, depriving animals from getting adequate nutrients, which are required to perform according to their potential? These facts forced for immediate remedies to solve the fodder shortage problem in the country for the improvement in livestock production.

Crop residues. Crop residues in combination with fodders provide 51 % of total nutrients required for livestock (Hanjra, 1995). Wheat straw, rice straw, barley straw, gram straw, stovers, sugar cane tops etc. are important crop residues. Crop residues are not good source of nutrients if they are not treated with some chemical, physical or biological method and supplemented with some mineral mixture. But the livestock extension services in the country are too weak to train the farmers in this regard. About 18300 TT (000 tones) of wheat straw and 4898 TT of rice straw are available every year. This quantity of straw is not only meant for livestock but industries like paper, chemicals, organic fertilizer, etc. also compete with livestock. To make the effective use of straws and to minimize the gap between feed availability and requirements, it is essential that farmers should be trained to treat the straw by chemical, physical and biological low cost methods.

Range vegetation. About 60% of the total area of the country is rangelands. At present sheep and goat obtain about 60% of their feed from range areas (Zaffruddin, 1977), while horses, camels and donkeys receive about half of their feed from rangelands. In Balochistan, 90% of required nutrients for livestock is provided by range (FAO, 1983). Although rangelands in Pakistan have great variability in term of their altitude, vegetation, rainfall, temperature, animals and cultural heritage, but most of the rangelands in Pakistan are exploited by nomadic grazing. Local people and govt. could sustain and improve the productive potential of this big feed reservoir. *Cenchrus ciliaris* (Dhama), *Choloris gayana* (Rhodes grass), *Cyanadon dactylon* (Bermuda grass), *Lolium multiflorum* (Italian rye grass) *Panicum antidotal* (blue panic), *Pennisetum purpureum* (elephant grass) are important grasses in range areas of Pakistan (Muhammad, 1989). *Prosopis cineraia*, *Acacia senegal*, *Zizyphus nummularia*

and *Coligonum polygonoides* are considered important species of shrubs and trees for livestock feeding (Muhammad, 1989). Some exotic species of grasses, shrubs and trees for forage production, water conservation techniques (pitcher irrigation, drip irrigation and plastic mulching) and water harvesting methods had been studied at some range stations.

Nonconventional feeds/agro industrial by-products. As population of human and livestock increasing rapidly, traditional feeding resources for livestock likely to deteriorate in future, this might widen the present gap between nutrient availability and nutrient demand and poses a huge threat to livestock production in Pakistan. So, it is important now for livestock production to explore the other alternative ways to feed the animals.

Nonconventional feeds. It includes the followings:

A. It includes molasses, rice polishing, wheat bran, sugar cane pith, sugar beet pulp and molasses, filter press mud (sugar milling by product), hulls, maize gluten maize bran, corn steep liquor rice gluten, slaughter house by-product, bakery by products.

B. Crops by products which are usually left in the fields or used as fuels like

- Stubbles
- Straw leaves and pods of pulses and oil seeds.
- Banana /fruit by products
- Corn cobs

C. Farmyards manure and poultry litter (FYM)

D. Urea feeding

Some of the above given feed resources are being utilized by the farmers i.e. molasses, wheat bran. Rice polishing etc, but most of them are either ignored by the livestock farmers or they are unable to use them due to technical problems.

Present situation of livestock feed availability. Presently, livestock population (117.09 MH or 60 M animal units) is expanding at the rate of 1.97% but the area under fodder cultivation is decreasing. Therefore, many studies have been carried out to tackle this problem. Crowder (1988) reported that animals in Pakistan are 29 and 56.5% deficient regarding TDN and DP requirements, respectively. Khan *et al.* (1988) reported deficiencies of 39.41 and 56.66% in TDN and DCP requirements for livestock in Pakistan. Akram (1990) estimated that livestock in Pakistan are getting 75 and 60% of the required amount of TDN and DCP, respectively. Nutrient requirements for livestock were also estimated by Hanjra *et al.* (1995) and reported that about 63.2 MT (million tones) of TDN and 5.53 MT of DCP is required to maintain the animals at their existing production potential. Gill (1998) reported that livestock in Pakistan need about 61 MT of TDN and 11 MT of DCP and noted a deficiency of 24 MT and 4 MT for TDN and DCP, respectively. Recent estimates show that animals in Pakistan require about 10.91 MI and 90.361 MI of DCP and TDN, respectively to fulfill their existing potential for milk, work and for maintaining their bodies (Table I-V).

At present about 69.00 and 6.756 of TDN and DCP is available for livestock (Table VII). These estimates indicate a deficit of 24.02 and 38.1% for DCP and TDN respectively (Table VIII). Estimated daily fodder and nutrient requirements and availability for livestock in Pakistan is given in Table IX that indicate a miserable condition. On an average livestock heads in Pakistan require about 33.35, 102.85 and 19.42 of green fodder, dry fodder and concentrate to meet their requirements (Table VI). This prevailing condition is likely to deteriorate further because animal and human population is escalating and on the other hand our rangelands are facing drought during previous years.

Table I. Livestock population and animal units

| Animals | Population (Million #) | Conversion factor | Animal units (million #) |
|----------------|------------------------|-------------------|--------------------------|
| Cattle | | | |
| Bulls | 3.95 | 1 | 3.95 |
| Females | 10.8 | 1 | 10.8 |
| Young stock | 7.25 | 0.3 | 2.195 |
| Buffalo | | | |
| Bulls | 0.4 | 1.2 | 0.48 |
| Females | 13.67 | 1.5 | 20.5 |
| Young stock | 8.62 | 0.5 | 4.31 |
| Sheep | | | |
| Adults | 17.1 | 0.25 | 4.275 |
| Young stock | 7 | 0.1 | 0.7 |
| Goats | | | |
| Adults | 31.3 | 0.3 | 9.39 |
| Young stock | 15.85 | 0.1 | 1.58 |
| Camels | 0.8 | 1.7 | 1.36 |
| Horses | 0.5 | 1.3 | 0.65 |
| Donkeys | 3.8 | 0.6 | 2.28 |
| | 117.09 | | 60.00 |

Animal unit conversion factor are used as given by Ensminger (1976)

Table II. Annual total digestible nutrient (TDN) and digestible protein (DP) requirements for maintenance

| Animals | Animal units (million #) | D.P M.T (Million tones) | T.D.N M.T (Million tones) |
|--------------|--------------------------|-------------------------|---------------------------|
| Cattle | 16.92 | 2.03 | 20.26 |
| Buffalo | 25.29 | 3.04 | 30.28 |
| Sheep | 4.98 | 0.6 | 5.96 |
| Goat | 10.98 | 1.32 | 13.14 |
| Camel | 1.36 | 0.16 | 1.63 |
| Horse | 0.65 | 0.08 | 0.78 |
| Donkey | 2.82 | 0.34 | 3.38 |
| Total | 60.00 | 7.57 | 75.43 |

Calculated based on NRC (1988) nutrient requirements for maintenance of an animal unit daily (425 kg cattle); Total digestible nutrient /TDN (kg) =3.28; Digestible crude protein /DCP (kg) =0.329

Table III. Estimated annual nutrient requirements for milk production

| Species | 4%FC Milk (T.T) | TDN (T.T) | DCP (T.T) |
|--------------|-----------------|----------------|----------------|
| Cattle | 8714.91 | 2806.2 | 784.34 |
| Buffalo | 23057 | 7424.35 | 2075.3 |
| Goat/sheep | 703.22 | 232.99 | 65.12 |
| Total | 32475.13 | 10463.5 | 2924.59 |

T.T= 000 Tones; Calculated based on NRC (1988) nutrient requirements for 4% FCM; 4%FCM=0.4(kg of milk) +15(kg of fat); TDN / kg 4% FEM. =0.322 kg; DCP / kg 4 %FCM=0.09 kg; Butter fat basis for different species were used as under; Buffalo B.F =6.5%; Cattle B.F =4.5%; Sheep/goat B.F= 5%

Table IV. Estimated annual nutrient requirements for work

| Animals | Animal of 500 kg b. wt. (million #) | TDN (million tones) | DP (million tones) |
|-----------------------------------|-------------------------------------|---------------------|--------------------|
| Bullocks, camels, horses, donkeys | 8.75 | 4.471 | 0.415 |

Calculated on the basis of daily nutrient requirements of a 500kg animal for medium work (Morrison 1959); TDN = 1.4 kg /day; DP = 0.13 kg/day

Table V. Estimated annual total requirement of nutrients for livestock

| Requirements | DCP (million tones) | TDN (million tones) |
|--------------|---------------------|---------------------|
| Maintenance | 7.57 | 75.43 |
| Production | 2.93 | 10.46 |
| Work | 0.4152 | 4.471 |
| Total | 10.9152 | 90.361 |

Table VI. Estimated annual feed requirements of livestock in Pakistan

| Feed requirements | Green Fodder (Million tones) On DM basis | Dry fodder (Million tones) On DM basis | Concentrate diet (Million tones) |
|-------------------|--|--|----------------------------------|
| Maintenance | 33.35 | 102.85 | - |
| Milk production | - | - | 14.95 |
| Work | - | - | 4.471 |
| Total | 33.35 | 102.85 | 19.42 |

Calculated on the following assumptions

1. Green fodder contain on DM basis; TDN=57.7%; DCP=12.58% ; 2. Concentrate contain TDN=70%, DCP=20%; 3. Dry roughage contain on DM basis TDN=44%

Table VII. Estimated annual availability of nutrients and feed for livestock in Pakistan

| Feed stuff | Quantity (Million tones) | TDN (Million tones) | DCP (Million tones) |
|---|--------------------------|---------------------|---------------------|
| Green fodder | 159.5 | 31.9 | 4.39 |
| Straws | | | |
| Wheat | 19.27 | 7.7 | - |
| Rice | 5.16 | 2.12 | - |
| Maize | 1.35 | 0.611 | - |
| Barley | 0.132 | 0.052 | - |
| Millet (bajra) | 0.156 | 0.0663 | - |
| Sorghum | 0.225 | 0.0922 | - |
| Gram | 0.667 | 0.300 | - |
| Sugarcane by products | | | |
| Sugarcane tops | 13.91 | 1.822 | - |
| Sugarcane molasses | 1.85 | 1.48 | 0.055 |
| Pith | 2.32 | 1.044 | - |
| Filter mud | 11.59 | 8.113 | 0.93 |
| Sugar beet by products | | | |
| Crown and leaves | 0.076 | 0.0076 | 0.0015 |
| Sugar beet pulp | 0.0821 | 0.591 | 0.006 |
| Molasses | 0.0046 | 0.0033 | 0.00043 |
| Stubbles | 4.024 | 1.609 | - |
| Milling by products | | | |
| Wheat bran | 2.79 | 1.813 | 0.362 |
| Rice bran/polish | 0.415 | 0.035 | 0.298 |
| Range lands/pastures at 60% utilization | - | 9.65 | 0.69 |
| Total | - | 69.00 | 6.756 |

Fodder is calculated on the basis of 50 tones per hectare per year as reported by Hanjra *et al.* (1995); Rangeland potential is used as described by Muhammad *et al.* (1989).

Table VIII. Balance sheet of annual nutrient requirements and availability for livestock in Pakistan

| Particulars | TDN (million tones) | DCP (million tones) |
|---------------------|---------------------|---------------------|
| Total Requirements | 90.361 | 10.9152 |
| Annual availability | 69.00 | 6.756 |
| Deficiency | 21.36 | 4.159 |
| Deficiency % | 24.02 | 38.1 |

Table IX. Estimated daily fodder and nutrient requirement and availability per animal unite for livestock in Pakistan

| Fodder/nutrients | Required/day | Availability/day | % Difference |
|-------------------|--------------|------------------|--------------|
| Green fodder (kg) | - | 7.2 | - |
| TDN (kg) | 4.13 | 3.15 | 24 |
| DCP (kg) | 0.498 | 0.308 | 38.1 |

RECOMMENDATIONS

The following recommendations are important to be undertaken for better feeding of livestock in the country.

Fodders. To improve the yield of fodder crop per hectare it is necessary that:

1. Superior fodders germplasm should be identified and propagated in the field.
2. Hybrid seeds either be imported or indigenously produced and distributed among the farmers.
3. With the seed provision, a complete package of agronomic practices should be transferred to the farmer.
4. Year round fodder production systems should be devised according to the geographical conditions of the area.
5. Institutional integration is needed to get best out of fodder research stations.
6. Collaboration between crop and animal production sectors may improve the situation.
7. Research facilities should be improved in the fodder research stations and a national policy for fodder production should be devised.
8. Infrastructure and inputs required for enhancing the fodder production should be provided to the farmer.
9. To train the farmer about fodder conservation, special workshops be held.
10. Evaluation of existing fodder crops through chemical methods and biological trials is required.
11. Legume and non-legume crop combination may improve the feeding status of livestock.
12. A proper documentation of fodder crop situation is important before all the measures.

Range lands. Grasses, shrubs and tree leaves are the potential feed reservoir for livestock in Pakistan. It can be improved as follows:

1. Evaluation and identification of best local forage species should be undertaken.
2. Exotic varieties of grasses, which could tolerate heat and low moisture content be tested.
3. Water conservation techniques as if drip irrigation, plastic mulching, pitcher irrigation etc. could improve the range conditions.

4. Range management, conservation and improvement policies are required to be followed strictly.

5. Integration and collaboration between range management and livestock management departments is important to consider for betterment of range resources.

6. Involvement of local people through community organizations to prevent the deterioration of range resources should be undertaken.

7. Artificial reseeding, fertilization and other inputs could provide good results.

8. Rangeland act should be devised and implemented properly.

9. Artificial rain or water catchments areas should be developed to overcome the water shortage.

10. Allocation of funds to the rangeland department should be increased so that range research and rangeland condition could be improved.

Agro-Industrial by Products

Agricultural and industrial byproducts could contribute to a greater extent to meet the needs of animals in Pakistan. If the following steps are considered:

1. Chemical analysis and biological trials for evaluation of byproducts to see their potential for livestock feeding should be started.
2. Chemical, physical and biological treatments should be devised to improve the quality of byproducts.
3. Farmer training is required so that they can use cheaper feed resources.
4. Sugarcane pith could be used as an important nutrient source if steam treatment is done.
5. Molasses feeding through urea-molasses blocks and liquid supplements could minimize the existing nutrient deficiency for livestock.
6. About 376.23 MT of livestock dung is available in Pakistan which could be used for livestock feed after its recycling through chemical and biological methods.
7. Corncobs, cottonseed hulls, rice hulls could be used if proper treatment is done and awareness is created among the farmers.
8. Bakery, citrus industry and banana byproducts could contribute a lot to animal feed.

General Considerations:

1. Proper coupling of nutrients at dietary, and digestive and cellular levels is required to reduce the gap between nutrient requirements and availability.
2. Proper documentation of available feed resources under different ecological zones should be undertaken.
3. Actual worth of existing livestock feed resources should be estimated through laboratory and biological trials.
4. Work is needed to estimate the nutrient requirements of local livestock breeds at different physiological conditions and under various climatic conditions.
5. Better feeding of livestock could be achieved if vertical expansion of livestock production is followed.

6. Government should start and encourage the private sector to develop cattle feed industry in Pakistan.
7. Livestock production projects like small dairy holding development should be extended to other areas and livestock production scientists are needed to be involved in livestock extension works.
8. Urea and poultry litter as a source of NPN could help a lot to minimize the gap between protein availability and requirements of ruminants.
9. Ensiling and hay making systems should be devised and extended to the farmers according to local livestock production system.

REFERENCES

- Akram, M., 1990. *Pakistan, Animal Feed Resources in Asia and Pacific*. Asian productivity organization Tokyo.
- Baloch, G.M., 1983. Utilization of banana leaves and stems in livestock rations as roughage. *Proc. FAO PARC Workshop on Least Cost Formulation*, Islamabad. March 12-14, 1983.
- Bulla, R.J., V.L. Lichtenberg and D.A. Holt, 1977. *Potential of the World's Forages for Ruminant Animal Production*. Winrock International Livestock Research and Training Centre Petit Jean Mountain Monilton, Arkansas, USA.
- Crowder, L.V., 1988. *Fodder Crop Research in Pakistan: A Review*. PARC/US AID/MART-Win rock, USA
- Economic Survey, 1999-2000. Govt. of Pakistan, Finance division, Economic Advisors Wing, Islamabad.
- Economic Survey, 1999-2000. Govt. of Pakistan, Finance division, Economic Advisors Wing, Islamabad.
- Ensminger, M.E., 1976. *Beef Cattle Science*, 5th Ed. The Interstate Printers and Publisher's Inc. Danville, Illinois, U.S.A.
- FAO, 1983. *Report of the Assistance to Rangeland and Livestock Development Survey in Baluchistan*. FAO, Room, Italy.
- Gill, R.A., 1998. *Dairy and Beef Production in Pakistan: Key Note Address*. Workshop on Dairy/Beef Production at LPRI Bhadarnagar, Pakistan.
- Hanjra, S.H., J.B. David and M.J.A. Akhtar, 1995. *Fodder Production*. FAO, PAK / 88 /072. Smallholder dairy development in Punjab.
- Hasnain, H., 1983. Feed-the Key to More Food in Pakistan. *Proc. FAO PARC Workshop on Least Cost Formulation*, Islamabad. March 12-14, 1983.
- Khan, B.B., M.A. Sial, A.H. Gilani, 1988. Livestock feed resources and requirement scenario of Pakistan. Dairy production potential and challenges. *Proc. Natl. Seminar held in Faisalabad*. May 20-30, 1988.
- Khan, M.A., 1983. Extension service and the improvement of nutrition and feeding practice at various development levels. *Proc. FAO PARC Workshop on Least Cost Formulation*, Islamabad. March 12-14, 1983.
- Livestock Census, 1996. Agriculture Census Organization, Statistics Division, Govt. of Pakistan, Gulberg Lahore.
- Marshall, W.E and J.I. Wadsworth, 1999. *Rice Science and Technology*. Marcel Dekker, Inc., New York.
- Morrison, B.F., 1984. *Feeds and Feeding*, 2nd Ed., CBS Publishers and Distributors Shahdara, Dehli.
- Muhammad, N.1989. *Rangeland Management in Pakistan*. International Center for Integrated Mountain Development Katmandu, Nepal.
- NRC, 1988. *Nutrient Requirements of Dairy Cattle*, 6th Ed., National Academy Press, Washington D.C., USA.
- Raza, S.H., 2000. Role of Drought Animals in the Economy of Pakistan. *Drought Animal News*, (32) MAY: 17-18.
- Posner, E.S. and A.N. Habis, 1999. *Wheat and Floor Milling*. American Association of Cereal Chemists, Inc. St. Paul, Minnesota, USA.
- Sial, M.A. *et al.*, 1998. Livestock feed resources and requirement scenario of Pakistan. Dairy production potential and challenges. *Proc. Natl. Seminar*, Held in Faisalabad.
- Shah, S.I. and Z.O. Muller, 1983. Feeding crop residues and animal waste to ruminants in Pakistan. *Proc. FAO PARC Workshop on Least Cost Formulation*, Islamabad. March 12-14, 1983.
- Zaffaruddin, C., 1977. Development of rangelands in desert areas of Pakistan. *Proc. Intl. Conf. Alternative Strategies for Desert Development*. UNNITAR. Pergamon press, new york, USA.

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