INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/99/01–3–199–204

*Policy/Status Paper*

# Beef Production in Pakistan - Past, Present and Future

SHAUKAT ALI BHATTI AND MUHAMMAD SAJJAD KHAN†
*Livestock Extension Training Center, Bahadurnagar, Okara, Pakistan.*
*†Department of Animal Breeding and Genetics, University of Agriculture, Faisalabad-38040, Pakistan*

*The further back you can look, the further forward you are likely to see* (Winston Churchill)

## ABSTRACT

Beef produced in Pakistan is a by-product of dairy industry. Efforts have also been made in the past and are being made to develop a cattle breed purely for beef production. Limited resources and faulty breeding plans along with the lack of objectivity being the major shortcomings for any outcome. Most of the research to produce beef from cattle and buffaloes thus concentrates on nutritional aspects. This review is an effort to see what has been done in the past and how should we proceed for planning future beef production in Pakistan.

**Key Words:** Beef; Nutirtion; Forage; Policy; Pakistan

There are probably few people who keep animals merely as a hobby. Farmers keep cattle and buffalo to earn livelihood and make profit. Agriculture business or livestock keeping has thus emerged as an industry from a merely sustainable mode of production. With the rising competition for use of natural resources, it has become imperative to use these resources judiciously and efficiently. This trend in production in all businesses the world over has put an equal pressure on the animal scientists to look ways and means for economical livestock production to feed the growing human population. Specialized breeds for egg and meat production in poultry, the specialized breeds for milk, meat and draught in cattle are some of the examples.

Beef is used as a major source of animal protein in the world (FAO, 1998) with per capita availability varying from few kilograms to few hundred kilograms. The 1.1 million tons beef produced in Pakistan every year comes mainly from buffalo (65%) while the rest of it is shared by cattle. Yet, per capita availability of beef in the country is less than 8 kg (Anonymous, 1998) with mutton sharing equally. Masses, therefore, do not get the minimum required animal proteins. Beef produced in the country is a by-product of dairy industry. Research efforts have been made in the past to produce beef through crossbreeding of local cows with exotic semen and through fattening of cows and buffaloes. This review discusses various scenario for beef production in the country and evaluates work done in the past to get a true picture for planning future beef production in Pakistan.

## GLOBAL SCENARIO

**World beef breeds.** There are more than 100 beef breeds in the world. But no single breed of cattle can be claimed to excel all others in all aspects of beef production under all conditions; all breeds have strong and weak points and hereditary variation exists in all breeds. Although, the available resources, production system, and environmental conditions may determine which breed to choose, selection of a particular breed is usually a matter of personal choice (Ensminger, 1987). The 57 breeds found in U.S. have been grouped into fullbred (8), purebred (31), man-made (18) and a dozen others (Walker, 1989). Most of these breeds are owned by breed associations that act as a backbone of the beef industry. They not only add glamour to the industry, especially through shows but also with their programs create a 'belonging feeling' for the cattlemen. Comparative rating of economic traits of 59 beef breeds of cattle has been described by Ensminger (1987). Surprisingly though, most of the beef produced in the world does not come from beef breeds. In the U.K., for example, about 1/3 of total beef production is derived from the beef herds while 2/3 from the dairy herd (cull cows, pure bred and crossbred calves) (Baker, 1983).

**Basic principle of beef production.** The most important biological principal of beef production is that the animals should gain in weight so that it reaches a live weight suitable for slaughter within a reasonable period of time. Thus nutrient intake must exceed requirements for maintenance of body weight (Wilkinson, 1985). Beef can be produced with little or no grain with improved forage management, thus making beef production more competitive and profitable (Thomas, 1986). Beef production in most of the United States and elsewhere in the world is mainly dependent on forages, except during finishing stage of the animals. It is estimated that 85.7% of the total feed for beef cattle, in United States, is derived from roughages. Green and cured fodder can supply all the nutrients required for the beef cattle, except common salt and whatever energy rich feeds may be necessary for

additional conditioning or drylot finishing (Ensminger *et al.*, 1990).

## CURRENT BEEF PRODUCTION SITUATION IN PAKISTAN

**Beef production through cross breeding.** In Pakistan, cattle and buffalo are mainly maintained for milk production and to some extent for draught purpose. There are neither specific breeds of cattle or buffaloes nor any specific rearing system for beef production. Efforts have been made to develop a breed for beef purpose. The first effort was made by crossing Charolais with local cows (Sahiwal, Dajal and Thari). The average birth weight of Charolais crosses (25 kg) was lower than buffalo (32.7 kg). The average live weight at 6 and 15 months of age was higher in buffalo calves than in cross-breds (190 and 326 vs 172.5 and 311 kg, respectively) However, Charolais crosses had higher live weight (293 kg) than buffalo calves (277 kg) at the age of 12 months (Usmani *et al.*, 1979).

In another attempt, Australian Droughtmaster of Australia was crossed with Bhagnari . The plan started in 1969 at Beef Production Research Centre, Sibi, Baluchistan. The animals in the third cross (62.5% Droughtmaster, 37.5% Bhagnari) were named as 'Narimaster'. The mature weight of Bhagnari males and females is 545 and 341 kg, respectively (Bhutto *et al.*, 1993). The birth and weaning weights and pre-weaning daily growth rates of Bhagnari, Droughtmaster and Narimaster are 23, 27.5, 26 kg; 106, 113, 119 kg and 0.39, 0.42, 0.45 kg, respectively (Bashir *et al.*, 1998). These birth weights are not comparable with the birth weights (34-44 kg) of crosses of famous beef breeds of cattle in temperate zones (Thomas, 1986). The performance of other economic traits (weaning weight and daily growth rate) of Droughtmaster in this herd is also not comparable to the standards of any beef breed, therefore, continuation of this programme has not been justified (Khan, 1996).

The latest effort in beef production is being made by crossing Simmental with the local cattle population under a project named "Beef Production through Cattle Cross Breeding" at LPRI, Bahadurnagar, Okara (personal communication). The objectives and the approach of the project, however, does not seem to be rooted in lessons of Droughtmaster and Charolais crossbreeding.

**Buffalo as a beef animal.** Male buffalo calves grow at an average rate of 0.52 kg/day purely on forage based diet such as Sadabahar (Tahir & Rehman, 1987) The average initial body weight of the animals in this study was 190 kg. In studies conducted at LPRI, Bahadurnagar (Pasha & Tahir, 1985; Pasha, 1987; Jabbar & Iqbal , 1993; Jabbar *et al.*, 1993) it has been reported that daily growth rate of male buffalo calves from 0.78 to 1.01 kg having initial body weight between 116 to 188 kg. In an other study (Pasha, 1986), the average growth rate of male buffalo calves ranged between 0.43 to 0.7 kg/day. The average initial live weight of animals in all these groups was 142 and they were raised on diets containing wheat straw, rice husk or maize cobs. Information is not available on the energy consumption of the animals in this study. However, from the data presented in the aforementioned studies, it seems that the difference in growth rate was due to the difference in the energy intake and initial body weight of the animals. Basra *et al.* (1992) studied the growth response in buffalo male calves fed different levels of protein and energy. Calves ranged in age from 6 to 9 months (Av. weight 110 kg). Highest daily weight gain (728 g/d) was observed in calves fed low protein-high energy ration. The lowest growth rate (549 g/d) was in calves fed medium protein-high energy ration.

In a fattening trial of old bullock (Anonymous, 1963) done under the Directorate of Livestock Farms at College of Veterinary Sciences, Lahore, a maximum of 1.1 kg daily weight gain was recorded. Whether the gain in weight was due to fat deposition or lean meat in the body is not clear but it is assumed that mostly it should be due to fat deposition because at the old age this much growth rate in lean meat is not possible. In later studies on old bullocks (Barque *et al.*, 1980) weight gain of 0.8 kg has been reported with dressing percentage similar to buffalo male calves.

**Buffalo vs cattle as beef animal.** Comparative performance of buffalo male calves and pure and crossbred cattle calves have extensively been reported. Asrar (1986) reported that buffalo, Sahiwal and crossbred (Friesian x Sahiwal) male calves of 12-14 months of age had weight gain 0.91, 0.94 and 0.97 kg/day, respectively on a diet having 10.2% CP and 60% TDN. The average initial body weight in these calves was 180 kg. Dry matter digestibility and dressing percentage was slightly better in crossbred calves. Pasha (1988a) compared the fattening potential of Sahiwal calves and buffalo calves on a ration with 13.3 CP and 53% TDN. The average initial body weight of animals was 200 kg and they were fed *ad libitum*. The average growth rate of Sahiwal cow calves (.841 kg/day) was less than buffalo calves (0.970 kg/day). Similar trend in growth rate of Sahiwal cow and buffalo (0.715 vs 0.765 kg/day and 0.796 vs 0.840 kg/day in cow and buffalo, respectively) was reported in other studies (Pasha, 1998b; Ahmad *et al.*, 1995). However, Basra (1992) reported an opposite trend in the growth rate of male calves of Sahiwal , cross-bred cows and buffaloes at the age of 12-15 months. The concentrate ration had 11.12% CP and 61.75% TDN. Daily growth rate was the highest (839-869 g) in cross-bred followed by Sahiwal cow (795-805 g) and buffaloes (751-781 g). The FCR was 9.9-10.6, 9.5-9.8 and 10.6-10.9 in male calves of Sahiwal and cross-bred cows and buffaloes, respectively. Similar trend in the growth rate of cows

and buffaloes has been reported by Mohsin *et al.*, (1995). Varying the level of fiber and concentrate in their diets, cow calves had higher growth rate than buffalo calves (0.769 vs 0.566 and 0.666 vs 0.448 kg/day in cow and buffalo calves, respectively). Although their average initial body weight was almost same in all the groups.

**Limitations of nutritional experiments.** In most of the nutritional studies reported above, information on the energy intake of the animals is not available. Under these circumstances, it is difficult to know whether the energy requirements of the animals were met according to any feeding standards or not. More often than not, information on the feeding value of green fodder offered to the animals is lacking. These information are essential for future planning to increase production performance of animals. Most of the research conducted on nutritional aspects of buffaloes has serious limitations. That is why on international level, our research on nutrition has been termed as "feed them and weigh them" toward manner of utilization of products for the animals to survive or to determine performance in one or more traits when energy intake will not support biological efficiency (McDowell *et al.*, 1995).

**Stimulus for action.** Sincerest efforts are required to develop the local beef production. The first step would be to change the current approach in the research. Commercial viability of the beef production enterprise has to be established. Except in one study (Tahir & Rehman, 1987) from among the studies mentioned above, the animals were raised on either complete diet or combination of concentrate mix and available seasonal green fodder. Partial or full concentrate feeding may not be economical for beef production. In a recent study by Jabbar *et al.* (1997), the animals raised purely on green fodder had very low growth rate (211 gram/day). This growth rate is "unacceptable" in buffaloes heifers without any plausible explanation, if they were fed. Efforts should be made to explore the possibility of raising animals purely on the forages. The reasons for low productivity of animals on forage should be investigated. Why the science that can work in other parts of the globe has failed in this country. This is a food for thought for the animal nutritionists in this country.

Ecological and environmental conditions are not very dissimilar in India and Pakistan. India has made progress in the export of buffalo meat. Thus frozen buffalo meat is being regularly exported from India to the Middle East (Joshi, 1988). This is despite the fact that Murrah buffalo has lower adult body weight (584 kg) than Nili-Ravi (647 kg)(McDowell *et al.*, 1995). Studies in Egypt has also shown prospects for meat production in Egyptian buffaloes. Average daily gain in Egyptian buffaloes from a live weights of 120 to 450 kg ranges between 500 to 1000 grams per day on low to high energy diets (Graziani, 1988) despite that their mature body weight is 121 kg less than Nili- Ravi buffaloes (McDowell *et al.*, 1995). This also provides a stimulus for action to the Pakistani scientists in this field.

## VARIOUS ALTERNATIVES FOR BEEF PRODUCTION IN PAKISTAN

**1. Produce beef domestically**

**a. From available cattle and buffalo population.** The beef produced from the available cattle and buffalo population is as a by-product because these species have traditionally not been raised for producing beef. The main purpose have been the generation of draught power and production of milk. Animals are slaughtered to fetch beef if they are surplus and do not perform well for the main objectives. There is tremendous scope of improvement in this option because fattening the surplus and finishing the old has been suggested in the past (Barque *et al.*, 1980; Gilani, 1980) and most of the research efforts have been concentrated in this direction as evident from the studies reviewed in the preceding sections.

**b. From improved genetic potentials of buffaloes and cattle.** There is no buffalo beef breed in the world and so the only choice for improving buffalo to produce more beef is to select buffaloes for beef generation after generation. Selection for early maturity and better milk production is likely to improve growth because of positive genetic association between growth and maturity and milk production. Direct selection for beef is also possible but would reduce the rate of gain in milk production. Surprisingly though, unintentional selection of buffaloes for higher body size is going on especially on male side. At cattle/buffalo shows male are credited for huge size. The option of selecting buffaloes for meat has been suggested (Cady *et al.*, 1983) but requires extreme care (Khan, 1986) and can not be suggested under the prevailing circumstances.

There are more options in cattle to improve genetically for producing beef, both through introduction of exotic beef animals for grading up and/or through selection. The two dairy (Sahiwal and Red Sindhi), one dairy/draught - dual (Thari) and many draught breeds (Bhagnari, Dajal, Dhanni, Rojhan, Lohani) are available in the country. As discussed earlier for buffaloes, option to increase selection pressure for beef might not be feasible. Early maturity and higher milk production is likely to improve growth in these breeds. Although Sahiwal's growth potential under poorer feeding conditions can not be denied as Australians are advertising it as a dual purpose (beef/dairy) cattle breed (Turner, 1977). The growth potential of Bhagnari and Dajal can be explored for beef purpose although research efforts in this direction are non-existing. Dhanni is likely to continue as a popular draught breed. Similarly Rojhan and Lohani are likely to

fill the niche for demand for draught breeds in hilly and sub-hilly areas. Ahmad *et al.* (1995) reported the comparative growth and carcass performance of buffalo and Sahiwal, Cholistani, Dajal, Crossbred and Non-descript calves. It was concluded that average daily weight gain (0.75 to 0.86 kg) was similar in the six categories but Sahiwal calves were more economical to raise.

**2. Import beef breeds as pure stock**

This options is less feasible because it requires huge investment. Also, hash environment, more diseases and poor feeding resources compel to make this option even more remote.

**3. Import beef**

This option does not seems feasible in the presence of huge livestock population which even if not being raised for beef can meet the domestic demand provided efforts and resources are diverted for improving their growth, especially in male surplus calves of cattle and buffalo and fattening of the old/culled animals. Fear of dependency, introduction of diseases (such as BSE) and limited foreign exchange reserves also limit the scope of this option. Import of beef currently being undertaken by multinationals for specific purposes is hoped to stimulate quality beef production from local resources.

## FUTURE BEEF PRODUCTION IN PAKISTAN

In the light of global scenario of beef production vis-a vis its current situation in Pakistan, the animal scientists have to accept a challenge of making the beef production a commercially viable enterprise. Only then we can provide enough meat for the masses on affordable prices or the country has to depend on other nations for that. Summarized are some of the possible means through which we can achieve the goal of economical beef production in the country.

**1. Beef production from forage**

The major limiting factors in the productivity of beef cattle fed forages alone are that they limit intake of energy, digestibility of energy, and the efficiency of energy utilization for animal product (Waldo & Jorgens, 1981). The dry matter intake (DMI) and digestibility of forages by the animals can be affected by many factors. This is summarized below:

**i) High moisture contents of forages.** The moisture contents of the forages affects DMI. Limited data indicate that total DMI decreases as the moisture contents of the diets exceed 50 percent (NRC, 1989). The DMI of the animals, thus, may be increased by lowering the moisture contents of the forages either by drying it in form of hay or wilting. In Pakistan there is cut and carry system of feeding forages to the livestock. Fresh fodders have higher moisture contents than the wilted ones or hay. Replacing the fresh forage with the dried one may lead to better performance due to increased DMI. Studies are required to be conducted in the country on this aspects to give a sound direction to the beef producers.

**ii) Effect of high ambient temperature.** High ambient temperature outside the comfort zone (15-25 °C) of the animals also affects the DMI. With high temperature and humidity, intake may be depressed by upto 30 percent. The depression in intake is more pronounced on high roughage diets than on low roughage diets (NRC, 1984). In Pakistan, where average summer temperature is very high and can become a limiting factor for increased intake of the animals, studies be conducted to find ways and means to maintain the DMI. However, feeding the animals during night-times and providing regular showers during the day time may prove fruitful to offset the bad effects of high ambient temperature on DMI of the animals.

**iii) Low protein diets.** The lower protein contents of the diet limits intake and digestibility. The depression in intake is associated with the crude protein concentrations below 8 percent (Van Soest, 1982). The DMI of the animals on low protein diets can be increased if animals are provided with adequate quantities of proteins (Sharma, 1988) and animals on basal grass diets are supplemented with legumes (DelCurto *et al.,* 1990). In Pakistan, the crude protein contents of most of the non-leguminous forages is either lower than or close to 8 percent. These forages include sorghum (6.8%), millet (4.4%), sugar cane (6.2%) (Habib & Siddiqui, 1994); Paragrass (6.25%), Sadabahar (7.7%) ( Anonymous, 1989) and Mottgrass (7.5%) (Rafiq & Akhter, 1995). These forages, if supplemented with leguminous forages like berseem in winter and cowpeas and guar in Summer, may increase the DMI and digestibility (Sharma, 1988) of these forages and thus improve performance of the animals (Clanton & Zimmerman, 1970).

**iv) Hay and silage for beef production.** Provision of good quality forage to the beef animals is a key to successful beef enterprise. Feeding poor quality forage will not bring any good results in terms of meat production. In Pakistan, forage availability is not constant throughout the year. May-June and October-November are fodder scarcity periods in Pakistan. Even when the fodder is in abundance, the feeding quality of the forages is not really well taken care of because of cut and carry system. This results in poor performance of the animals. As a principle of good management, forages should be preserved during the period of availability by converting them to silage or hay (Habib & Siddiqui, 1994). This will continuously supply the quality fodder to the animals during the scarcity periods of the year. A good quality hay can play a very useful role in the feeding of young beef animals when their nitrogen requirements are high, while silage appear better suited to the finishing period, when protein requirements of the animals are lower (Wilkinson,

1985). In Pakistan, hay and silage making are not in vogue. Feasibility of hay making must be tried here as the sun-shine is abundant during most part of the year. Similarly, silage making should find its place in corn growing areas where farmers usually discard maize stovers after harvesting the grains.

**2. Nutrient deficiency**

An unbalanced ration may affect intake, digestibility and performance of the animals. Generally energy and protein get the first consideration in balancing the rations. Minerals are also important for promoting intake and energy utilization in the animals. Sodium chloride, for example, to a deficient diet may improve intake (Habib & Siddiqui, 1994). Deficiency of calcium causes rickets and phosphorus deficiency results in decreased growth rates, inefficient feed utilization and a depraved appetite in the young animals (NRC, 1984). These minerals, therefore, must be given special considerations in feeding beef animals for their higher growth rates.

**3. Use of growth promoters**

The non-nutritive feed additives and implants are used in the feedlot production (NRC, 1984). The growth promoting implants promote weight gain and feed efficiency by repartitioning energy toward muscle growth and away from fat deposition (Samford, 1987). Feed additives and antibiotics may increase growth rate by enhancing nutrient utilization (Heinemann *et al.*, 1978; Pendlum *et al.*, 1978) and/or decreasing expected weight loss due to sickness or natural but undesirable behavioral patterns (over eating and normal cycling by heifers) (Samford, 1997). The implants are preparations of sex hormones (Estradiol, Progesterone and Testosterone) (NRC, 1984) The non-nutritive feed additives include monensin, lasalocid and other antibiotics. The research is required to be conducted on the use of these growth promoters in cow and buffalo calves meant for meat production to give sound recommendation to the beef producers in the country.

**4. Cross Breeding vs exploiting indigenous resources**

Crossing of native type of cattle with improved breeds is an attractive approach as a population average can be moved to a new plateau for certain traits rather rapidly (McDowell, 1983). Dairy cattle cross breeding is underway in Pakistan and has increased average milk production per lactation in cross bred cows compared with their local ancestors. Trials have also been conducted to compare the meat production potential of crossbred calves with local cattle and buffaloes (Asrar, 1986; Basra, 1992). The results indicate good prospects for meat production from crossbred calves on the basis of their daily growth rates. However, for a long term strategy it should be carefully planned to achieve a goal in relation to environmental conditions (McDowell, 1983). Also, the susceptibility of crossbred animals to tick and other diseases should be included in the model to evaluate its suitability for the Pakistani environment.

In the absence of any typical beef breed in Pakistan, cattle and buffalo, because of their comparable growth rate with defined beef breeds of the world, have the potential to serve as beef animal. The present challenge to the animal scientists is to sincerely exploit their potentials. This also raises an other fundamental question that do we really need to develop or import a "Beef Breed" in the present situation and spend a lot of time and resources on it or simply to work with the "available livestock resources". The answer is easy to find if we compare the growth performance of 'Narimaster' with Bhagnari cattle or buffaloes. Any research effort should thus be based on the lessons from Charolais and Droughtmaster crossbreeding. Haphazard attempts without objectivity are not likely to lead us anywhere.

**5. Improving beef marketing**

In the order of priority the beef is likely to remain as the third choice after poultry and mutton among the masses in Pakistan. Majority of the people are not quality conscious and are less likely to pay higher prices for a good quality beef or for an old spent animal's meat. Hence there is less incentive for the farmers to produce a quality beef. However, with Government permission to export the beef, there is a lot of scope for the local beef industry to develop.

## REFERENCES


Ahmad, S., T.N. Pasha and N. Ahmad, 1995. Comparative meat production potentials and carcass evaluation of buffalo and different breeds of cattle calves. *Proc. Natl. Symp. Anim. Nutr.*, pp. 21–7. Held at Animal Nutrition Section, College of Veterinary Sciences, Lahore.

Anonymous, 1963. *Annual Report,* pp. 44. Directorate of Livestock Farms, West Pakistan.

Anonymous, 1989. *10th Annual Report 1988-89,* pp. 84. Directorate of Livestock Production Research Institute, Bahadurnagar, Okara.

Anonymous, 1998. Economic Survey. Govt. of Pakistan, Islamabad.

Asrar, H., 1986. Comparative beef potential of male buffalo calves and cow calves. *M.Sc. Thesis, Dept. Nutr.,* Univ. Agri., Faisalabad.

Baker, H.K., 1983. Beef and Dairy Crosses for Beef Production. *In: Beef Cattle Science Handbook 19,* Baker, F.H. (Editor). Westview Press, Inc. 5500 Central Avenue, Boulder, Colorado 80301, USA.

Barque, A.R., A.G. Khan and R. Firdous, 1980. Beef production in Pakistan. *Final Report. Dept. Nutr.*, Univ. Agri., Faisalabad.

Bashir, M.K., G. Mohiuddin, M.S. Khan, M. Abdullah and S. Ghulam, 1998. Environmental factors influencing early growth traits of Bhagnari and its crosses with Droughtmaster in Pakistan. *J. Anim. Pl. Sci.*, 8: 63–6.

Basra, M.J., 1992. Comparative growth rate study on feed lot fattening system in Sahiwal, Cross-Bred and Buffalo male calves. 2nd *Annual Report of Animal Nutrition Centre,* pp: 64–6. Dera Chahl, Lahore.

Basra, M.J., 1992. Growth response in buffalo male calves fed different levels of protein and energy. *Second Annual Report of Animal Nutrition Centre,* pp: 91–100. Dera Chahl, Lahore.

Bhutto, M.A., M.A. Khan and G. Ahmad, 1993. *Livestock Breeds of Pakistan.* Ministry of Food, Agriculture and Cooperatives (Livestock Division). Govt. of Pakistan, Islamabad.

Cady, R.A., S.K. Shah, E.C. Schermerhorn, and R.E. McDowell, 1983. Factors affecting performance of Nili-Ravi buffaloes in Pakistan. *J. Dairy Sci.,* 66: 578.

Clanton, D.C. and D.R. Zimmerman, 1970. Symposium on pasture methods for maximum production in beef cattle: protein and energy requirements for female beef cattle. *J. Anim. Sci.,* 30: 122–32.

DelCurto, T., R.C. Cochran, T.G. Nagraja, L.R. Corah, A.A. Beharka and E.S. Vanzant, 1990. Comparison of soybean meal/sorghum grain, alfalfa hay and dehydrated alfalfa pellets as supplemental protein sources for beef cattle consuming dormant Tallgrass-prairie forage. *J. Anim. Sci.,* 68: 2901–15.

Ensminger, M.E., 1987. *Beef Cattle Science.* The interstate printers and publishers, Inc. Danville, Illinois, USA.

Ensminger, M.E., J.E. Oldfield and W.W. Heinemann, 1990. *Feeds and Nutrition.* The Ensminger Publishing Co., Clovis, California, USA.

FAO, 1998. *FAO Year Book.* FAO, Rome. (http://www.fao.org)

Gilani, S.A.H., 1980. Comparative efficiency of buffaloes and cows for the utilization of various feeds. *Final Technical Report. No. A-17-AH-10,* Univ. Agri., Faisalabad.

Graziani, R., 1988. Meat production potentials in buffaloes. *Proc. 2nd Wrld Buff. Cong.,* 2: 465–74. Indian Council of Agricultural Research, New Delhi.

Habib, G. and M.M. Siddiqui, 1994. Feeds and Feeding. *In: Animal Husbandry.* Shah, S. I., Bashir, E., and Bantel, R. (Editors), pp. 177–205. National Book Foundation. Islamabad.

Heinemann, W.W., E.M. Hanks and D.C. Young, 1978. Monensin and tylosin in a high energy diet for finishing steers. *J. Anim. Sci.,* 47: 34–40.

Jabbar, M.A. and T. Iqbal, 1993. Efficiency of commercial and least cost formulated rations for fattening of buffalo calves. *14th Annual Report,* pp. 130–1. Directorate of Livestock Production research Institute, Bahadurnagar, Okara.

Jabbar, M.A., M. Abbas, W. Shehzad and L. Jabbar, 1997. Effect of different dietary energy levels on growth rate and age at sexual maturity in growing buffalo heifers. *18th Annual Report,* pp. 46–9. Directorate of Livestock Production research Institute, Bahadurnagar, Okara.

Jabbar, M.A., T. Iqbal and I. Haq. 1993. Effect of feeding untreated and urea treated rice straw for fattening of male buffalo calves. *14th Annual Report,* pp. 124–5. Directorate of Livestock Production research Institute, Bahadurnagar, Okara.

Joshi, D.C., 1988. Meat production in buffaloes. *Proc. 2nd Wrld. Buff. Cong.,* 2: 491–8. Indian Council of Agricultural Research, New Delhi.

Khan, M.A., 1986. Genetic analysis of a purebred herd of Nili-Ravi buffalo. *Ph.D. Thesis,* Dept. Anim. Breed. Genet., Univ. Agri., Faisalabad.

Khan, M.A., 1996. Performance of Bhagnari and its crosses with Droughtmaster in Balochistan: II. Genetic parameters of productive traits. *M. Sc. Thesis,* Dept. Anim. Breed. Genet., Univ. Agri., Faisalabad.

McDowell, R.E., 1983. Strategy for improving beef and dairy cattle in the tropics. Department of Animal Science, Cornell University, Ithaca, New York.

McDowell, R.E., J.C. Wilk, S.K. Shah, D.S. Balain and G.H. Metry, 1995. Potential for commercial dairying with buffalo. North Carolina State University. NC. USA.

Mohsin, E., T.N. Pasha, N.A. Mian, S. Abbas and M.A. Jabbar, 1995. Comparative study of growth rate and feed efficiency of buffalo and Sahiwal cattle on different fibre and concentrate rations. *Proc. Natl. Symp. Anim. Nutr.,* pp. 98–104. Animal Nutrition Section, College of Veterinary Sciences, Lahore.

NRC, 1984. Nutrient Requirements of Beef Cattle. National Academy Press, Washington, D.C., USA.

NRC, 1989. Nutrient Requirements of Dairy Cattle. National Academy Press, Washington, D.C., USA.

Pasha, T.N., 1986. Comparative efficiency of different agro-industrial wastes containing rations in feed lot fattening and carcass evaluation of male buffalo calves. *7th Annual Report 1985-86,* pp. 132–8. Directorate of Livestock Production research Institute, Bahadurnagar, Okara.

Pasha, T.N., 1987. Comparative meat production potentials of buffalo and crossbred calves. *8th Annual Report 1986-87,* pp. 107–11. Directorate of Livestock Production Research Institute, Bahadurnagar, Okara.

Pasha, T.N., 1988a. Comparative feedlot fattening and carcass evaluation of Sahiwal and buffalo calves. *9th Annual Report 1987-88,* pp. 132–6. Directorate of Livestock Production Research Institute, Bahadurnagar, Okara.

Pasha, T.N., 1988b. Comparative fattening of Sahiwal, crossbred and buffalo calves. *9th Annual Report 1986-87,* pp. 137–8. Directorate of Livestock Production Research Institute, Bahadurnagar, Okara.

Pasha, T.N. and M.S. Tahir, 1985. Comparative study on the feeding of urea treated Vs untreated wheat/rice straws in fattening of male buffalo calves. *6th Annual Report 1984-85,* pp. 130–2. Directorate of Livestock Production research Institute, Bahadurnagar, Okara.

Pendlum, L.C., J.A. Boling and N.W. Bradly, 1978. Levels of monensin with and without tylosin for growing finishing steers. *J. Anim. Sci.,* 47: 1.

Rafiq, M. and M.J. Akhter, 1995. Comparative study on the feeding value of Mott grass and Sadabahar in lactating buffaloes. *16th Annual Report 1995,* pp. 44–5. Directorate of Livestock Production research Institute, Bahadurnagar, Okara.

Samford, R.A., 1997. Modern tools for beef feedlots. Paper presented at seminar on Beef Production. Held on 30th May, 1997 at Bahadurnagar, Pakistan. Organized by U.S. Feed Grains Council, Dubai.

Sharma, D.D., 1988. Nutritional aspects in relation to meat production from buffaloes. *Proc. 2nd Wrld. Buff. Cong.,* 2: 475–90. Indian Council of Agricultural Research, New Delhi.

Tahir, M.S. and S. Rehman, 1987. Economical fattening of male buffalo calves on green fodder (Sadabahar). *8th Annual Report 1986-87,* pp. 115–6. Directorate of Livestock Production Research Institute, Bahadurnagar, Okara.

Thomas, V.M., 1986. *Beef Cattle Production: An Integrated Approach.* Lea & Febiger, Philadelphia, USA.

Turner, H.G., 1977. The tropical adaptation of beef cattle–An Australian Study. *FAO Animal Production and Health Paper* 1. FAO, Rome, Italy.

Usmani, R.H., M.A. Saji and S.E. Kazmi, 1979. Crossbreeding indigenous cattle with exotic blood (Charolais) for beef production and its comparisons with Nili-Ravi buffaloes. *1st Annual Report 1978-79,* pp. 18–9. Directorate of Livestock Production Research Institute, Bahadurnagar, Okara.

Van Soest, P.J., 1982. *Nutritional Ecology of the Ruminant.* Comstock Publishing Associates, Cornell University Press, Ithaca. USA.

Waldo, D.R. and N.A. Jorgensen, 1981. Forages for high animal production: Nutritional factors and effects of conservation. *J. Dairy Sci.,* 64: 1207–29.

Walker, H., 1989. *Blue Book of Beef Breeds.* PAW Publishing. Allen, Kansas, USA.

Wilkinson, J.M., 1985. *Beef Production from Silage and Other Conserved Forages.* Longman Group Ltd. Harlow Essex, England.

**(Received 26 April 1999; Accepted 15 May 1999)**