Working Paper No.125

Technological change in Milk Production: A Review of some critical issues with reference to South Asia

K. Narayanan Nair

Centre for Development Studies
Ulloor, Trivandrum 695 011

February 1981

Technological change in Milk Production:
A Review of some critical issues with reference to South Asia

1. Milk production in South Asian countries has been gaining increasing importance in recent years as is evident from the substantial rise in the scale of investment in dairying and the changing technology of dairy production. To aid this development effort there has been large scale import of capital and technology from the developed countries and the International Lending Institutions. The justification usually offered for this pattern of dairy development is two fold: firstly, if the traditional technology of dairy production is continued it will result in the years to come in significant decline in per capita milk production and, consequently, in the nutritional standards of the population; secondly, increasing investment in the dairy sector will be beneficial more to the vulnerable than to the rich sections of the population. Whether the pattern of dairy development emerging in these countries does in fact meet the attainment of these objectives has been a subject of extensive debate in recent years. (Sha et.al. 1980, Kuria and Achaya 1980, Rajapurohit 1979, S.Singh 1979, Nair 1980) However, it seems to us that some of the major issues associated with technological change in dairying have not surfaced clearly in these discussions.

2. It is our intention in this paper to undertake a fresh look at a few of such critical issues underlying the technology

due to variations in the availability of feed resources. In general, the yield per milch animal is, however, very low in these countries (See Table 1). This, combined with the low per capita milch animal stock, has contributed to low per capita milk production. Besides, the cost of milk production is also high in these countries because of the high cost of feed and the low average conversion efficiency of the milch animal stock. Since per capita milk production is low and the cost of milk is high per capita consumption of milk remains low and the bulk of the consumption is concentrated among the upper income groups. Most of the cattle and buffalo meat produced in these countries is obtained from the slaughter of old and unserviceable animals. Thus, with limited resources animals are reared for a multiplicity of uses.

4 The major technological change required to achieve rapid breakthrough in dairy production in South Asian countries is the development of High Yielding Varieties of milch animals through the application of the crossbreeding technology. Such an effort is currently under progress on a large scale in the Indian sub-continent. In simple terms, what this technology aims at is the enhancement of the milk production efficiency of the indigenous breeds of animals by transfering to them the milk production traits of exotic breeds. Since the world's best buffalo breeds exist in the South Asian countries (mostly in India and Pakistan) and their performance has been excellent relative to that of cattle, the latter species alone has been the target of breeding technology.

5 Whether crossbreeding in cattle is capable of achieving rapid break through in milk production has been examined by several researchers (D. Singh 1978, R.K. Patel et.al 1976, Mishra 1979, Nyholn Klans 1974). The general consensus is that the crossbred cows have a lower age at first calving, longer lactation length and shorter inter-calving interval; they also convert feed into milk more efficiently than the indigenous breeds. Therefore, productivity of the crossbred cow is seen to be substantially higher than that of the indigenous breeds. Besides the unit cost of milk production is significantly lower for the crossbred than for the indigenous cows.

6 The Kerala Experience: That these advantages of the crossbred cow can be used to attain rapid increase in milk production has been demonstrated by the experience in different parts of India. The most striking example in this respect is from the state of Kerala where it has been possible to achieve an annual growth rate of 9.6 percent in milk production during the past ten years. Crossbreeding in Kerala began only from the mid-sixties. During the initial years the progress was at a slow pace. But by the early seventies the state government gave a big push to this programme by undertaking a massive project under the Crash Employment Scheme. Under this Scheme, lay inseminators were trained and sent to those villages which had the necessary facilities for artificial insemination. The result was that the coverage of artificial insemination in cows increased from 10 percent in the early seventies to 65 percent by late seventies. In roughly abou

1/3 of the area of the state, the services of well qualified veterinary and dairy specialists are also available in addition to those of the lay inseminators, a fact which further ensures the success of the cross breeding programme. It is important to note that the success rate of crossbreeding in Kerala is currently about 30 percent which is significantly higher than the figures reported in other regions of the country.

7. The results of such intensive efforts of crossbreeding are reflected in the significant rise in the proportion of crossbred cows in the milch animal population. About 30 percent of the milch cows in the state is now estimated to be crossbreds. A qualitative improvement of this magnitude in the milch animal stock has resulted in substantial increase in the productivity of milch cows in terms of milk yield and calving rates. Besides the total production of milk has also shown rapid increase; from an estimated 2.7 lakh tonnes in mid-sixties to 8.11 lakh tonnes by 1977-78 (See Table 2). Analysis of the sources of growth in milk production over this period has shown that about 60 percent of the growth in milk production has been contributed by the improvement in technology of breeding and the remaining mostly by better feeding and management of the indigenous stock.

8 It is important to note that the success of the crossbreeding programme in Kerala is facilitated also by the existence of a rapidly expanding market for milk caused by the following factors. Fish is the principal source of animal protein in Kerala.[2/] As a consequence

of its rising demand and falling per capita availability, fish prices have been rising[3]. This factor may have introduced a shift in the pattern of consumption of animal protein: from fishery sources to land sources, namely meat, milk and egg. In the land-based animal protein basket, the major source of supply is bovines, in the form of milk and meat. Since protein from bovine sources has become cheaper than that from other livestock sources and fish, the consumption pattern of animal protein has shifted in favour of milk and meat. Such a shift, in the context of the rapid growth of population and income, has provided an expanding market for milk in the State. Consequently the price of milk has been increasing at a faster rate than the general price level. Rapid increase in milk prices has helped in the removal of the constraints of increasing milk production in the state. Milk production responded in recent years so well not simply because milk prices rose, but also because (a) the price of feed stuffs did not rise as fast as milk price and (b) the cross breeding programme substantially raised the productive efficiency of the milch animal herd and reduced the cost per unit of milk. Both these factors led to significant increases in profitability of milk production. All these factors must have, in their turn, contributed to an increasing rate of acceptance of crossbreeding programme among farmers in Kerala.

8 Another factor that contributed to the acceptance of crossbreeding programme is the very low requirement of draught power in agriculture. The cropping pattern of the state is dominated by perennial and plantation crops which hardly require

any use of animal power for cultivation. The only crop which needs draught power for cultivation is rice which accounts for roughly 20 percent of the net cropped area. Over the last two decades the net area under rice has remained unchanged and therefore the requirement of draft animals in agriculture has not been increasing. On the other hand, since the cost of draft power was increasing at a faster rate and the holding of draft animals becoming increasingly uneconomical to the farmers, a progressive reduction in the number of draft animal stock has taken place in the state. Consequently the demand for male calves has declined which made it possible for farmers to rear single purpose dairy animals.

9 Available evidence also suggests that the increased production of milk in Kerala has not only contributed to rise in per capita milk consumption, but also to a maginal reduction in the inequality of its consumption across different income groups. Besides, we have also observed that the ownership of milch animals has been slowly getting diffused to the bottom strata of rural households. Thus it comes out from the Kerala experience that the increase in the volume of dairy production through the adoption of modern technology has benefited all the sections of the population; both the poor and the rich.

10 To the extent to which the objective conditions which facilitated the success of crossbreeding programme in Kerala was the outcome of the interaction, in the past, of factors unique to Kerala's economy, we cannot expect to replicate in toto the Kerala

experience in other regions of South Asia. At the same time, the Kerala example points out the importance of favourable objective conditions for achieving successful technological breakthrough in milk production. Unfortunately, the present level of understanding of these objective conditions in large parts of South Asia is / limited / a fact which makes it difficult to undertake a critical evaluation of the potential for dairy production through crossbreeding technology in the rest of the region.

11 The Indian Debate Nevertheless, it is possible to highlight some of the serious constraints on increasing milk production through crossbreeding technology by a close examination of the evolution of the breeding policy. Fortunately, the thinking in the South Asian Countries on questions of cattle breeding was over the past five decades, along similar lines, shaped to a great extent by the Indian debate on the subject.

12 The advantages and disadvantages of cross breeding in cattle have been the subject of quite an interesting debate in the Indian context. As far back as 1938, this issue was discussed in some detail by Col.Oliver. While recognising the need to improve the quality of the Indian cattle, he strongly opposed large scale cross breeding for improving the milk yield of indigenous stock, but favoured instead a policy of selective breeding from within the indigenous stock. He emphasised that the breeding policy should take into account "the environment under which animals had to live and produce "and maintained that

"mating the domestic breed with exotic breeds will do more harm than good unless they were accompanied by measures to improve the environment of the stock including feeding". Peparall (1949), another British animal husbandary expert who went into the problem, while agreeing with Oliver, further maintained that under the then existing conditions in India, it would be difficult to maintain separate breeds of animals for milk and draught. He therefore stressed the importance of efforts to increase the milk yield of indigenous breeds of cattle rather than improve the quality of the cows through large scale crossbreeding with imported bulls. The Joint Committee appointed by the Sarva Seva Sangh and the ICAR (1949) generally agreed with the suggestion of Peparall. However, within a decade opinions changed radically.

15 The Board of Agriculture and Animal Husbandary Wing of the Government of India (1958) and the Expert Committee appointed to evaluate the KVS (1959) recommended a shift of policy to the crossbreeding of indigenous non-discript cattle with exotic stock for rapid increase in milk production. Though the Third Plan referred to the need to evolve better dual-purpose breed for increasing the work capacity and milk production potential of the Indian cattle, its programmes gave high priority to crossbreeding for increased milk production. More recently the National Commission on Agriculture (1976) endorsed the policy of large scale crossbreeding. Even though the Commission was aware of the fact that "such a step would hamper the supply of draught animals adapted to farm co[illegible]

in the country", they justified it on the ground that its overall result would be enhancement of the total draught power in the country.

14 The Commission however did not spell out the basis for their conclusion. A recent study which examined critically the performance of crossbred bullocks as draught animals seriously questions the Commission's finding (Raja Purohit 1979). While agreeing that the crossbred males are as good as the indigenous bullocks, he cautioned that the physical efficiency of crossbred males in draught power should not be mistaken with economic efficiency. (ibid). Available evidence shows that while a crossbred animal requires at least one-and-a-half times the amount of feed of its indigenous counterpart, its economic efficiency for the same unit of work output turns out to be only two-thirds that of the latter. The implication is that in areas where draught animals are the major source of motive power in agriculture and where cheap alternative sources of farm power are absent, farmers will be unwilling to accept crossbreeding in cattle.

15 That the technology of agriculture will undergo rapid shift from bullocks to mechanical power has been one of the major assumptions behind the crossbreeding programme in India and other South Asian countries. Available evidence marshalled so far from several regions shows that the increasing intensity of agricultural mechanisation, especially tractorisation, would not result in any significant reduction in draught animal stock. Even in the Indian and Pakistani Punjab's where tractorisation has been taking place

on a substantial scale, the decline in draft animal stock has been almost negligible in the last two decades. With the mounting pressure of the oil-crisis the cost advantage of mechanical power over bullock power is likely to shift in favour of the latter source. Therefore the role of animals as a source of motive power in agriculture might only continue to increase in the years to come. Hence, a breeding strategy which does not take into account the importance of draft power could turn out, in the long run, to be quite deterimental to the sustenance of agricultural production in India and other countries of South Asia.

16 Unfortunately this crucial aspect of cattle breeding has so far remained neglected by policy makers. The strategy widely debated in the context of the Operation Flood Project is an example in point. This project, which covered 160 districts and most of the important cattle tracts in the country, has not taken care of the vital aspect of conservation of the draft quality of the indigenous stock.

17 Another problem often neglected in the formulation of the crossbreeding strategy is the availability of feeds and fodder. The implication of this failure comes out quite sharply from the Indian case.

18 The fact that there is severe and growing shortage of fodder in India has been well argued by several experts, the latest being the report of the National Commission on Agriculture (NCA). The Joint Sub-Committee of the ICAR and ICMR (1964)

estimated that the gross supply of animal feeds in India is deficient by 30 percent in total Digestable Nutrient (TDN) and 70 percent by Digestable Crude Protein (DCP). Another study estimates the deficit of available supplies relative to requirement at 30 percent for animals in milk, 50 percent for dry animals, 60 percent for adult males and between 80 to 90 percent for youngstock. (Amble et.al. 1965). In such a situation the increase in size of the crossbred stock of the milch animal herd will exert further pressure on available feed supply. The NCA was aware of this problem when they recommended large scale cross breeding programme and suggested several steps to meet the shortage of feed. However, on the practical plane, these recommendations are difficult to implement because they involve: (a) considerable diversion of land and water from other, and often more important, uses to the production of animal feed, and, (b) large scale investment in research and development and extension work increase the production of animal feed and devise efficient ways (for its utilisation). While the first is essentially a question of the political economy of Indian agriculture (since it involves considerable reorganisation of the agrarian sector), the latter involves efforts to develop new technology of feed production including identification and propagation of new high yielding varieties of fodder. It is therefore quite unrealistic to expect that expansion of cultivated crops will make a significant difference to feed supply situation.

19 In the forseable future, the supply of animal feeds will continue to depend on the trends in crop production, especially of coarse cereals, pulses and oilseeds. Unfortunately the production of these crops in the last two decades increased at a relatively low rate compared to that of rice and wheat.[4/] Nor is there any sign of a major breakthrough in technology suitable for the rainfed conditions (in which most of the crops are grown) to warrant a break from the past trend. Therefore there is good reason to suspect that the large scale introduction of hybrid animal stock would only further intensify the pressure on available feed resources in the coming years. The result would be progressive underfeeding of the crossbred animals, which might lead to a deterioration in their quality and productivity. Or alternatively, if persons owning more crossbred stock are able to outbid others in the feed market, as they well might because of their superior economic strength, those with relatively few animals will be put to serious disadvantage.

II

Technology and Distribution

20 Whether the new technology of milk production is scale biased or not has been a subject of lively discussion in recent years. (F.A.O. 1976, Nair 1980). In the Indian context the issue has become all the more important because of the shift in emphasis on dairy development from a mere means of increasing milk production to an instrument for helping the small and marginal farmers and other

vulnerable sections of the population. It is possible to get some insights into the problem at issue by analysing the data on the distribution of milch animals by size group of farms.

21 According to the all-India Rural Debt and Investment Survey, only 48 percent of the rural households in the country owned milch animals (See Table 3). The proportion was very low in poor households (about 5 percent in the lowest decile) and rose steeply as one moved up in the scale of asset holding; thus the ownership of milch animals was concentrated in the top decile groups of households; the poorest (in terms of assets) 20 percent of rural households owned barely 5 percent of the milch animals.

22 Obviously, given such skewed distribution of milch animal holdings, the benefits of dairy development are unlikely, in the normal course to benefit the poorest classes. The efforts made under the various programmes to provide state assistance to enable these segments to acquire more animals do not seem to have been large enough to make a substantial difference to the above picture. The fact that the relatively weaker sections do not have the resources needed to maintain high quality milch animals makes it all the more likely that dairy development programmes based on crossbreeding, milk marketing, processing and distribution would hardly benefit them; instead, the benefits would mostly accrue to the better of segments. And in the long run, such efforts may even contribute to the acceleration of the process of concentration of asset ownership in agriculture rather than to a broad-based growth of dairying the benefits of which are more equitably shared by

different segments of rural society. Underlying our argument is the notion that since the new technology of milk production is capital-intensive and risky it would be the relatively better off sections in rural areas that would be able to make greater use of it.

23 Organisation of dairying under cooperative fold is an important institutional arrangement suggested for correcting the distortions in the factor and product markets and helping the poor in augmenting milk production. Here again, the attainment of this objective will depend on the people who control the cooperative organisations and their self interests. One has serious doubts whether the fate of such cooperative institutions will be in any way different from that of the agricultural marketing and credit cooperatives functioning in India. A careful study of the Anand Milk Producers Union could have provided valuable insight into this problem. Unfortunately, no serious attempt appears to have been made so far to study the functioning of this organisation. Even the Project authority which has drawn up the Operation Flood Project has not undertaken any critical evaluation of the Anand Model dairy cooperatives and the implications for replicating these models in other regions in India.

III

Summary and Conclusions

24 In the foregoing discussion, we have posed some of the critical issues relating to milk production through the crossbreeding technology. The analysis though mostly centred around the Indian

experience should be relevant to other countries of South Asia as well since the structure of their livestock economies is almost identical.

25 The Kerala experience shows that the new technology of cattle breeding can contribute to rapid breakthrough in milk production. But it also suggests the importance of certain objective conditions necessary to attain this. These objective conditions are: (a) an expanding market for milk and increasing profitability of milk production and, (b) decline in the requirement of draught animals in agriculture. The existence of favourable objective conditions in Kerala has been the result of the interaction of a number of factors peculiar to Kerala's economy. Therefore it is not possible to expect the Kerala experience to be replicated in other regions of South Asia. At the same time, this experience is a pointer to the need for understanding the objective conditions prevailing in each region within a country or for the nation as a whole, before recommending policies for improvement of its bovine economy.

26 Some of the major constraints and limitations of the cross-breeding technology have been examined by analysing the impact of this technology on cattle breeding. The analysis showed the following: (a) while formulating the breeding policy, the need to preserve the draft power qualities of the indigenous cattle breeds was neglected; and, (b) the availability of feeds and fodder and the potential for augmenting their production were not given due attention. The implications of these limitations, from the point

of view of long term development of agriculture and livestock sectors, are the following; (1) If the breeding programme proceeds at the present rate, it may adversely affect the supply of draught power in agriculture. Since the cost of mechanical power will continue to rise in the years to come, draught animals may continue as the principal source of farm power. Therefore the acceptance of crossbreeding may not find any significant place in the farmers' plans of cattle breeding; (2) If the supply of feed does not increase with demand, its prices may also increase. Consequently the profitability of milk production may decline and the cost of milk production may increase and these factors together may introduce serious obstacles to achieving rapid increase in milk production.

27 We have examined the scale-bias of the new technology of milk production. Our major conclusion is that the benefits of dairy production based on crossbreeding (milk marketing, processing and distribution) would go mostly to the better off sections of society. Thus quickening the process of concentration of asset ownership in agriculture rather than leading to a broad-based growth of dairying, the benefits of which are more equitably shared by the different segments of the rural society.

28 Before concluding, we may take not of some important issues that emerge from our discussion, particularly those relating to transfer of capital and technology from the developed countries and other international lending institutions for aiding dairy production in the Third World. In the plane of transfer of technology

in dairy production, the donor countries have not paid much attention to the overall effect of such transfer on the economies of the recipient countries. In fact, it is rare to find from South Asia, instances where the technology transfers made were suitable for the 'balanced growth' of the animal husbandary sector. The general line of transfer of technology has been to help the recipient countries to produce high yielding variety of cows, without taking into account the environment in which the animals have to live and produce. The role of international lending agencies has been one of aiding the recipient countries for broadening the base of dairy production. It is high time for these agencies to take stock of the possible consequencies of their aid.[5/] Besides, it is also essential to undertake a concerted effort by those who are interested in the future of dairy production in the Third World in evolving a package of technologies appropriate from the point of view of development of their energy and food resources on an egalitarian basis. We are happy that this seminar would be paying attention to issues of this kind which are of vital importance to the development of our predominantly agrarian economies efficiently and equitably.

Centre for Development Studies,
Ulloor, Trivandrum 695 011

K. Narayanan Nair

Notes

This paper is a key note address to be delivered at the opening session of the second seminar on "Maximum Livestock Production on Minimum Land" to be held at the Bangladesh Agricultural University, Mymensingh on 2nd to 5th February 1981. In the preparation of this paper I have benefited much from the discussions with Professor A. Vaidyanathan and Professor P.R.G. Nair. Needless to say, the responsibilities for the ideas presented here are mine.

1/ In an earlier paper (Nair 1979) we have analysed the recent trends in Kerala's milk production and the factors affecting it. Since then, we have updated the estimates of milk production with the yield data available from a very recent survey. Therefore the figures on output per milch animals, total milk production, annual growth rate of milk output etc. presented in this paper are different from our earlier estimates. But the conclusions will remain unaltered.

2/ The dominance of fish in Kerala's consumption pattern of animal protein reflects in part its easier access to marine fishery resources which provide a relatively cheap animal protein. The unit cost of protein from meat, fish and egg in Kerala is less than half the national average. But another important contributing factor which tends to depress the demand for milk is the higher cost ratio (6:1) of milk protein from other animal sources than in all India (2:1). This is due both to the low cost of fish and relatively high cost of milk in Kerala. For details see Nair and Vaidyanathan (1978).

3/ For a discussion of the recent trends in Kerala's fish economy, see John Kurien (1978)

4/ The following are the estimated percentage annual growth rates of output of rice, wheat, coarse grains, pulses and oilseeds in India during the past three decades.

Crop	1949-50 to 1964-65	1965-66 to 1977-78	1949-50 to 1977-78
Rice	3.4	3.3	3.4
Wheat	3.9	8.0	5.7
Jowar	2.5	1.6	2.1
Maize	3.8	1.2	2.6
Bajra	2.3	1.4	1.9
Oilseeds	3.1	2.2	2.7
Pulses	1.4	1.3	1.3

Source: T.N. Sreenivasan (1979)

5/ Whether increasing flow of capital and technology from the developed countries and other International Lending Institutions to the third world livestock sector has been a subject of discussion in recent years Ernest Feder's (1980) study of the beef cattle production in Lain America holds the view that it has become a great danger to the nutrition of the poor and provides enormous threat to the survival of the peasantry. He also argued that the investment in beef cattle production in these economies by the International Lending Institutions and Multinationals has only helped to increase the percapita availability of meat at a lower cost to the rich in the Industrialised countries. While we will agree with Feder on the Latin American example, it seems to us that in many of the South Asian countries the impact of dairy production (unlike meat production in Latin America) will lead to concetration of asset ownership in rural areas and production of cheap animal protein for the relatively richer sections of the population.

Table 1 : Arable land, Agricultural population and Bovine stock in selected countries of South Asia

	India	Pakistan	Bangladesh
Total arable land (million ha)	161.0	19.0	9.0
Agricultural population (millions)	427.0	42.0	67.0
Bovine Population (million)			
Cattle	178.0	15.0	26.0
Buffalo	57.0	11.0	0.4
Total	236.0	25.0	27.0
Draft animal population (million)	83.0	8.0	9.0
Milch animal population (million)	86.0	10.0	9.0
Agricultural population/ha of arable land	2.7	2.2	7.4
Bovine population/ha of arable land	1.5	1.3	3.0
Draft animal population/ha of arable land	0.5	0.5	1.0
Percentage of animals in milk			
Cows	59.0	52.0	na
She buffaloes	51.0	59.0	na
Yield per animal in Milk (Kg/year)			
Cow	486	800	475
She buffalo	1114	2140	na
Total Milk Production (million tonnes)			
Cow	8.4	2.0	0.8
She Buffalo	16.8	7.6	0.04
Total	25.2	9.6	0.84

Source: Data on agricultural population, arable land, milk yield and Milk Production are taken from F.A.O (1978) Data on Bovine population is from Indian Livestock Census (1972) for India, Pakistan Census of livestock (1976) for Pakistan. For Bangladesh, the data on Bovine Population is from Statistical Abstract of Bangladesh (1978)

Table 2: Trends in Milk Production - Kerala, 1965-66-1977-78

	1965-66	1977-78
Number of milch animals[1] (lakh)		
Cow	12.00	12.90
She buffalo	1.30	1.40
Total	13.30	14.30
Milk yield per milch animal[2] (Kg/day)		
Cow	0.49	1.54
She buffalo	1.18	1.68
Milk Production (lakh tonnes)		
Cow	2.14	724
She buffalo	0.56	0.87
Total	2.70	8.11

Source: 1. Data on Milch animal population is obtained from the 1966 and 1977 livestock Census Reports.

2. Data on Milk Yield is obtained from the Milk Production Surveys conducted in the Mid Sixties by the ICAR and mid seventies by the Animal Husbandary Department of the Kerala Government. For details see IARS (1964-65) and Kerala Government (1980).

Table 3: Percentage Distribution of Milch animal holdings and percentage of households reporting ownership of Milch animals by decile groups of households (Classified According to value of asset) in Rural India, 1971-72

Decile group of Households	Cumulative Percentage Distribution of Milch Animals	Percentage of Households owning Milch Animals in Each Decile
bottom 10 percent	1.0	4.7
10 - 20	4.9	16.2
20 - 30	12.0	34.4
30 - 40	20.4	38.3
40 - 50	30.5	44.2
50 - 60	40.8	49.4
60 - 70	54.4	62.4
70 - 80	65.9	52.8
80 - 90	83.9	82.3
90 - 100	100.0	73.8
Over all	100.0	47.7

Source: Reserve Bank of India, Department of Statistics, All-India Rural Debt and Investment Survey (1971-72), Special Tables on Livestock, Agricultural Machinery and Implements.

References

1. A.R. Rajapurohit : Cross-Breeding of Indian Cattle: An Evaluation Economic and Political Weekly March 1979

2. K.N. Nair : Milk Production in Kerala, Trends and Prospects Economic and Political Weekly March 1979

3. Surendar Singh : "Operation Flood; Some Constraints and Implications, Economic and Political Weekly October 1979

4. Government of India, Ministry of Agriculture and Irrigation, Report of the National Commission on Agriculture, 1976, Part VII Animal Husbandary.

5. Vinod K Huria and K.T. Achaya : Dairy Development in India: Some critical issues, Economic and Political Weekly November 1980

6. H. Guha : Operation Flood: Some constraints and Implications A Comment, Economic and Political Weekly April 1980

7. Tushaar Sha et.al, Impact of increased Dairy Productivity On Farmers use of Feedstuffs, Economic and Political Weekly August 1980

8. T.N. Sreenivasan "Trends in Agriculture in India 1949-50 1977-78" Economic and Political Weekly Special Number 1979

9. Earnest Fedder : Agricultural Resources in underdeveloped countries; Competition between Man and Animal Economic and Political Weekly Special Number 1980

10. K.N. Nair : "Operation Flood: Some constraints and Implications Economic and Political Weekly February 1980.

11. Amble V.N. : "Feed Requirements of Bovines and Possibilities of Meeting them, Indian Journal of Agricultural Economics No.I, January-March 1965.

12. Central Council of Gosamvardhana "Report of the Committee on Cross-breeding" 1963

13. Kuwar P.N : "Economics of Crossbred Cows, Indian Journal of Agricultural Economics, No.3, July-September 1975.

14. Nyholm Klams et.al. : "Socio-Economic Aspects of Dairy Development - Report from the Banglore Milkshed Area, Economic and Political Weekly December 1974.

15. Patel R.K. et.al : "Economics of Cross-bred Cattle- A study of the Cattle Breeding Programme of Indo-Swiss Project, Kerala" National Dairy Research Institute Karnal and Indo-Swiss Project Kerala 1976.

16. D. Singh : "Comparative performance of Crossbred cows and purebred Buffaloes" Institute of Agricultural Research Statistics New Delhi (unpublished)

17. Sundarasen D : "Livestock Breeding in India" Vikas Publishing House, Delhi 1975

18. Oliver.A : "The systematic improvement of Livestock in India" - Agriculture and Livestock in India Vol.No.9 1938

19. Wright Norman C : "Report on the development of Cattle and industries in India", 1937

20. Nutrition Subcommittee of ICMR and ICAR" : "Human Nutrition Vis-a-vis, Animal Nutrition in India", Indian Council of Agricultural Research, Government of India, New Delhi.

21. Government of India, National Commission on Agriculture : "Report of the sub-group on cattle breeding, November 1972.

22. S.N. Mishra : "Livestock Planning in India", Vikas Publishing House 1979.

23. John Kurien : "Towards an understanding of the fish economy of Kerala; A preliminary study of the current situation and Trends in Organisation of Technology production and distribution of Incomes" Working Paper No.68, Centre for Development Studies, Trivandrum.

24. K.N. Nair and A. Vaidyanathan	"Inter-State differences in Milk Consumption in India, A preliminary Analysis", Working Paper No.62. Centre for Development Studies, Trivandrum.
25. Government of Pakistan	"Pakistan Census of Livestock" Agricultural Census Organisation, Lahore 1976.
26. Government of the Peoples Republic of Bangladesh	"Statistical Pocket Book of Bangladesh", Bangladesh Bureau of Statistics, Statistics, Division, Ministry of Planning Daca 1978
27. Government of India,	"Eleventh Livestock Census" 1972, Directorate of Economics and Statistics, Ministry of Agriculture and Irrigation 1976.
28. United Nations	FAO Production Year Book Vol.32, Rome 1979.