GeoJournal 10.1 21–45

0343–2521/85/0101–0021$3.75

Cattle Development Problems and Programs in India: A Regional Analysis

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Abstract: India has the largest cattle production in the world. Generally, Indian cattle are considered to be of poor quality, and it is suggested that most of these animals are useful only for beef but for their religious significance to the Hindu majority. Such generalization at the national level ignores the regional qualities of several superior indigenous breeds. Further, India together with some international agencies has launched the most comprehensive cattle development programs in the world. Known as the Key Village Scheme and Intensive Cattle Development Projects, their main objective is the spatial diffusion of superior quality breeds throughout the country. This study is the first attempt towards mapping and evaluating the problems and success of these programs at the district level in India.

Introduction

The cattle play a significant role in the life and economy of the people in India where 70 % of the total population is dependent on agriculture. From subsistence to commercial farming, cattle form an integral part of farming providing draught power for various phases of agricultural operations from ploughing, irrigation, harvesting and transportation to supplying manure, fuel and milk. Although there is little demand for beef in a predominantly Hindu society, the main source of animal protein in India remains mostly the milk and milk products [1]; and in the fuel deficit thickly populated plains dry dung contributes up to 15 % of non-commercial energy requirements [2]. It is estimated that cattle yield more than 50 % of the total agricultural income in India [3].

* Grateful acknowledgement is made to the Social Sciences and Humanities Research Council of Canada for supporting the post-field work part of this study. The author also wishes to thank Dr. A. G. Phipps for helping in computer programming, Keith Bigelow for cartographic work, Keith Bell and Sue Ann Hipkin for data processing and mapping, and Mrs. Dorothy Young for the typing.

Objectives

India possesses the largest bovine population in the world totalling about 236 million which includes 178.3 million or 76 % cattle (Zebu) and 57.4 million or 24 % buffaloes [4]. Generally, the Indian bovine stock is considered a very poor quality and mostly uneconomical; it is suggested that a large number of cattle may be useful only for beef but for their religious significance to the Hindu majority 5). Developed nations involved in foreign aid to India claim that "... it's (cow's) status as a sacred animal precludes any further development" [6]. Such generalization at the national level, however, is common because little is known about the Indian cattle as an important economic resource. Particularly, there are few studies dealing with the *regional assessment* of the extent and the quality of cattle and their development problems and potentials. Most western researchers have studied cattle problems because they are intrigued by the "holy cow" in India, while Indians have done little perhaps because it is a "holy cow" [7]. The main objectives of this study, therefore, are to (a) examine the *regional* qualities and potentials of indigenous bovine breeds of India, (b) evaluate the problems and success of various cattle development programs including the cross-breeding with European cattle launched in different *regions*

of the country, and (c) delineate the level of cattle development *regions* in India.

Data sources

There is an excellent record of livestock census of India covering several decades and including data on the number of milch cows, draught and breeding stocks, age groups and some selected items on bovine population for about 360 districts within 22 states and 9 union territories [8]. Other relevant data such as types of bovine breeds and various development officers in selected breeding tracts and back- national and state level sources in India. Furthermore, field interviews were conducted with farmers, herdsmen and development officers in selecting breeding tracts and backward areas to supplement the published/unpublished reports and to assess development problems and conditions.

Nature of Indigenous Bovine and Development Problems

The indigenous humped cattle in India belong mainly to the species *Bos indicus* and are also known as Zebu [9]. Since humped bulls and cows are frequently seen in the ancient seals of Mohenjo-Daro and Harappa, it is contended that Indus people had domesticated the Zebu as far back as 3250 BC [10]. Over the centuries, these cattle have evolved qualities best suited to the physical environment and the economic condition of the areas. Under the hot, dry, or humid monsoon climates of India, for example, the Zebu cows have remarkable endurance to maintain the milk flow with little reduction in yields, the bullocks can work long hours and retain health and weight, they possess a high degree of immunity to major cattle plagues and tickborn diseases, and the Indian cattle have developed a very high digestive efficiency recycling the coarse residue of most food crops not fit for human consumption. Furthermore, the Indian cattle can survive on small quantity and poor quality of feed for a long period of time, becoming almost skeletons during droughts, floods, or famines, and yet can recover rapidly when better conditions return — a quality possessed by few other cattle breeds in the world [11].

The same qualities which have helped these cattle to survive the harsh conditions and yet remain useful to farming, have caused their deterioration in terms of their economic returns. Judged by the western standard, the Indian cattle are generally of poor quality. For the Zebu cow, it takes a longer time to mature from four to five years for calving as compared to only two to three years for western breeds. The dry period between calving is longer, the lactation period is shorter, and the average annual milk production is about 173 kg per lactation as compared to 3,000 to 4,500 kg from that in the western countries [12]. Thus, the average productivity of a cow in India is about 1/17 to 1/23 of that of the cow in the developed countries. Despite the low productivity, however, the fat content of the Zebu cow milk is remarkably high, 4 to 6 %; and a few purebreds have recorded more than 5,900 kg of milk production in one lactation.

Qualities of the Indian Cattle Breeds

The generalization of qualities of indigenous cattle ignores some very useful and productive Zebu breeds found in different parts of the country. Because of different climatic and edaphic conditions, the cattle population in India is highly varied in structure and body conformation. An effective development of Indian cattle is possible only if their qualities and potentials for various uses are recognized. The Indian Council of Agriculture, therefore, has made systematic studies and recognizes 25 important cattle breeds and 6 buffalo breeds. Based on these reports and other related studies, a map has been prepared showing the types and qualities of important breeds of cattle and buffalo in India (Fig 1) [13].

The best cattle breeds are generally found in the drier parts of India, such as in Punjab, Haryana, Rajasthan, Gujerat, and parts of Maharashtra and Karnataka. A noteworthy feature is that in most of the warmer and humid parts, such as in Assam, West Bengal, Orissa, Bihar, Tamil Nadu and Kerala, the animals are non-descript, of inferior quality, and poor milk producers (Fig 1).

There are two principal uses of developing superior bovine breeds in India viz., (a) for draft power for farming and transportation, and (b) for adequate milk production for the huge and rapidly rising population. The use for raising beef cattle is negligible in a predominantly Hindu society, where only old cattle and buffaloes are slaughtered for this purpose. Therefore, a three-fold functional classification of cattle breeds in India recognizes (a) milch breeds, (b) draft breeds, and (c) dual purpose (a + b) general utility breeds.

(a) *Milch Breeds.* In this group, the cows are valued for higher milk yield but the bullocks are of poor to moderate quality as draft animals. Among the five most popular indigenous milk breeds, viz., Gir, Sahiwal, Deoni, Tharparkar and Red Sindhi found in drier parts of India and Pakistan, only Gir and Deoni breeding tracts are in India (Fig 1). Red Sindhi and Tharparkar breeds common in Pakistan, are mostly raised in various government and military dairy farms in India. For these breeds, the average milk yield per cow in one lactation period of 300 days ranges from 1,675 kg to 5,440 kg with milk fat content of 4.5 to 4.9 %.

(b) *Draft Breeds.* In this group, the cows are poor milkers but the bullocks are powerful and fast and make efficient draft animals. Among all the categories of indigenous breeds, the draft breeds are predominant, con-

Fig 1 Quality and distribution of bovine breeds

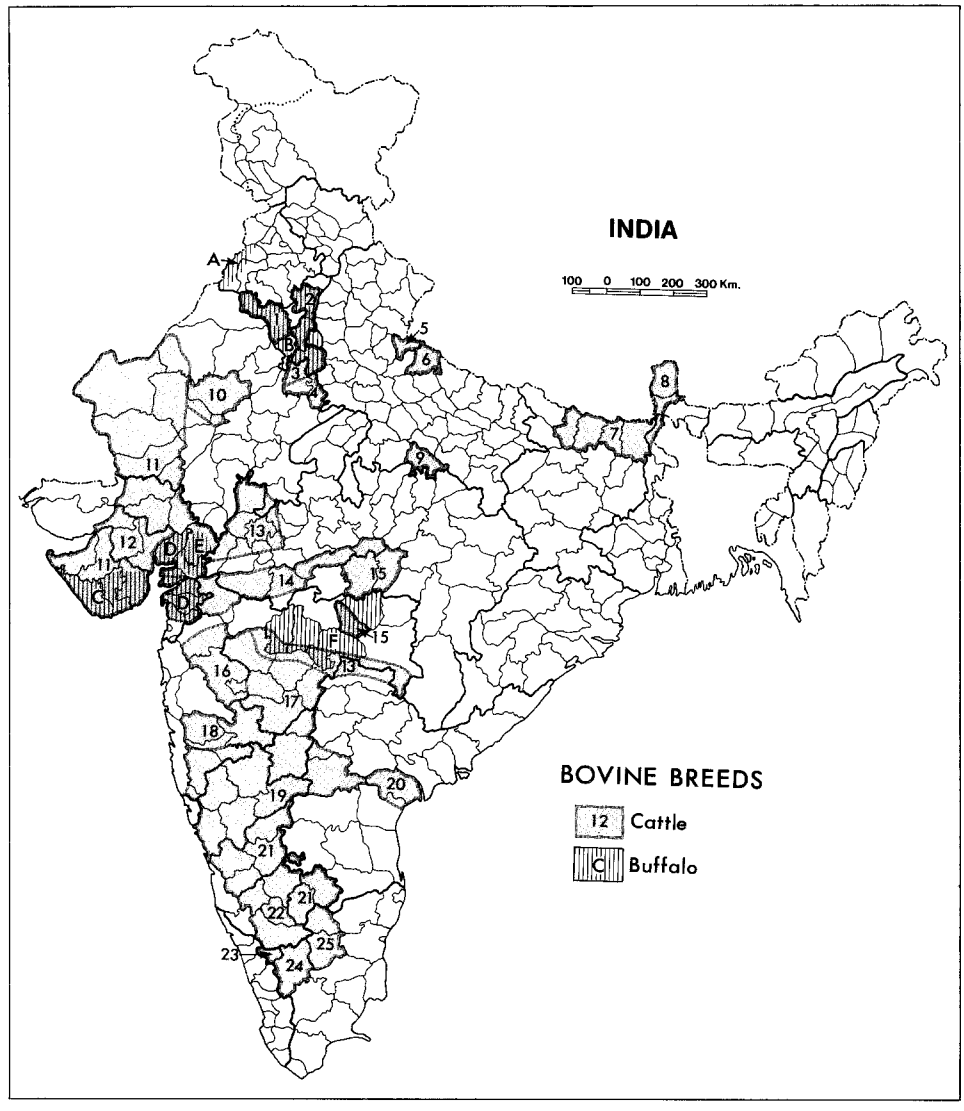
Cattle Breeds *

1. Hissar – D
2. Hariana – U
3. Rath – U
4. Mewati – U
5. Ponwar – D
6. Kherigarh – D
7. Bachaur – D
8. Siri – D
9. Kankatha – D
10. Nagori – D
11. Gir – M
12. Kankrej – U
13. Malvi – D
14. Nimari – U
15. Gaolao – U
16. Dangi – U
17. Deoni – M
18. Khillari – D
19. Krishnavalley – U
20. Ongole – U
21. Amritmahal – D
22. Hallikar – D
23. Bargur – D
24. Kangyam – D
25. Alambadi – D

Buffalo Breeds

A – Nili
B – Murrah
C – Jaffarabadi or Gir
D – Surti
E – Mehsana
F – Nagpuri

* D – Draft; M – Milch; U – Utility



sisting of 14 out of 25 types listed in India (Fig 1). There are different qualities of the breeds for various draft purposes. As for example, Nagori and Khillari are hardy, fast and useful for transportation-pulling carts; Amrithmahal and Ponwar are remarkable for stamina and employed for both transportation and ploughing.

(c) *General Utility Breeds.* These are dual purose cattle raised for both milk and draft purposes. The cows are fairly good milkers, and bullocks powerful work animals. There are as many as nine major breeds recognized in this group (Fig 1). The dual purpose or the general utility breeds are popular and in demand throughout the North as well as South India because of their functional advantages. Among these breeds, for example, Hariana (No. 2, Fig 1), is important in the North and recognized as powerful work animals used for ploughing and road transportation, and cows as fair milk producers. In the South, the large sized powerful Ongole (No. 20, Fig 1) bullocks are suitable for ploughing heavy soil or road transportation, while cows are good milkers. Similarly, Kankrej (No. 12, Fig 1), the heaviest of Indian breeds are popular in western India (Gujerat) as both superior draft animals and milch cows.

Buffaloes

The Indian buffaloes or water buffaloes (*Bubalus bulalis* Linn) are semi-aquatic animals, and are raised all over the plains and lower hills in the country. Love for water betrays the past environment of its original home as the swampy jungles of Punjab and Sind now dessicated; and even now buffaloes are more common in these areas than the cattle [14]. Buffaloes are large and massive animals and work well in humid lowland areas of India with predominantly paddy cultivation. The castrated males provide powerful draft animals for both transportation and ploughing.

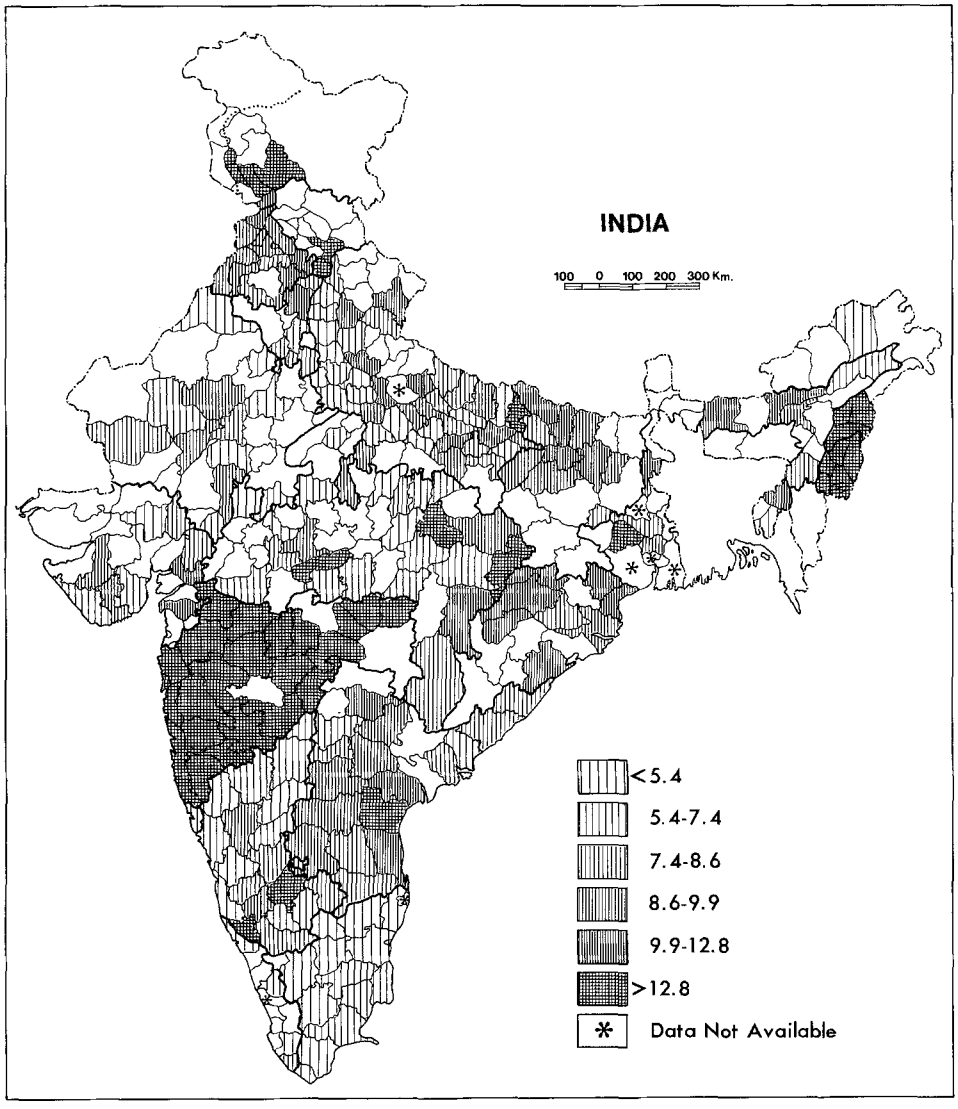


Fig 2 Number of Key Village Units per 10,000 breedable cattle (Zebu) and buffaloes

1 Key Village Block = 10 Key Village Units

Generally, they are slower than bullocks and cannot work during the hot parts of the day or season. An important feature is that buffaloes generally produce more milk (491 kg in a lactation) and their milk fat content is higher (7 %) as compared to cow milk production (173 kg) and fat content (4.5 %) [15].

Although Zebu milch cows are more than double the number of buffalo milch cows, the buffalo milk production is more than half (55 %) of the country's total milk production. Thus, buffaloes are more popular for milk production and their milk is in greater demand for manufacturing dairy products such as butter, *ghee*, cheese and *khoa* (for sweets) than the Zebu cow milk [16]. The Zebu cows are useful primarily to produce calves for raising draft animals for farming operations.

The Indian Buffalo Breeds. Generally, 6 major types of buffalo breeds are recognized in India as compared to 25 types of cattle (Fig 1). Most buffalo breeds are dual purpose, useful for both milking as well as draught, but the breeds are well known for their milk-producing qualities. Among the breeds, Murrah (B, Fig 1) is famous throughout North India and is considered most efficient milk and butter-fat producers in the country. Average yield of milk per buffalo cow during a 300-day lactation period ranges from 1,360 kg to 2,270 kg and several cows recording over 3,175 kg. Murrah is most common in large urban milk centers such as Delhi and Bombay, and also in several government and military farms. Among other breeds, Jaffarabadi and Nagpuri, for example, are bred in western and central India where the buffaloes are heavy milk yielders and castrated males are used for heavy draft work.

Non-Descript-Bovine: Although the standard indigenous breeds of cattle and buffalo are raised in their respective breeding tracts, they are found scattered in various farms

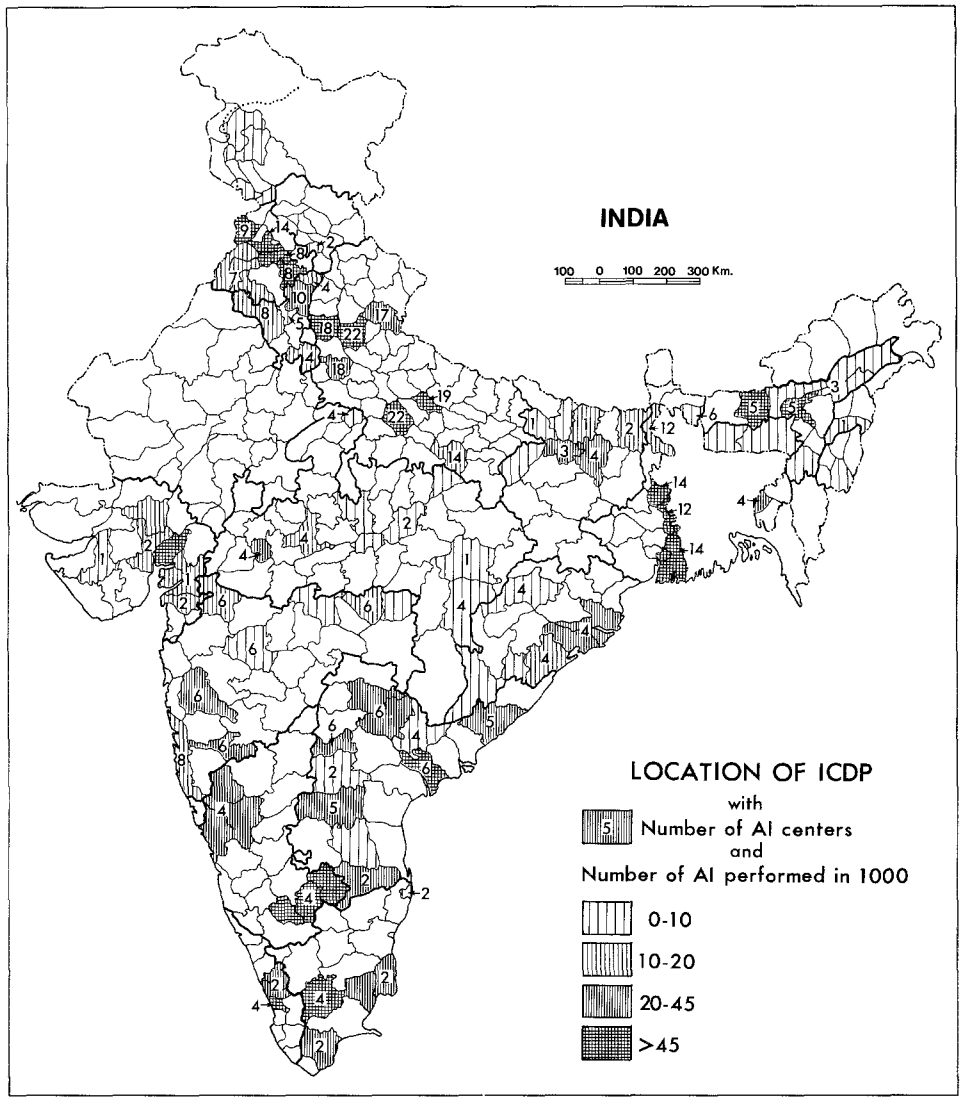


Fig 3 Intensive Cattle Development Projects (ICDP), with Artificial Insemination (AI) Centers and the Number of AI Performed, 1977

all over the country. Because of higher cost of these breeds, only large and richer farmers own the standard breeds. The majority of small and subsistence farmers who need these animals for farming operations, generally have cattle or buffaloes of no distinct breed classed as non-descripts. Particularly, in the hot, moist coastal areas, and east central and eastern states, the stocks are of inferior quality – both as milk producers and draft power (Fig 1). It is in these areas that a great need is felt for the improvement of bovine population.

Cattle Development Programs

The urgent need to improve the quality of bovine breeds in India is twofold viz., to increase the milk production, and to raise more efficient draft animals. Although India has approximately 23 % of the world's bovine population, the milk yield per cow is one of the lowest and the milk production is less than 7 % of the world's total [17]. Furthermore, despite milk being the principal source of animal protein in an Indian diet, per capita milk consumption remains one of the lowest in the world [18]. Particularly, with the rapidly rising population, urbanization, industrial growth and the increasing earning capacity of the people, there has been a great surge in the demand for fluid milk [19]. Therefore, more attention has been paid for improving bovine stocks for higher milk production beginning from the First Five Year Plan in 1950 and continuing with greater emphasis through the 1980s.

Key Village Schemes

Before Independence (1947), there were some efforts to improve the cattle breeds in India by the animal husbandry

Tab 1 Progress of selected cattle development programs in India

Programs/Year	1966–67	1968–69	1970–71	1972–73	1974–75	1975–76
Intensive Cattle Development Projects (ICDP)	21	30	51	60	67	82
Key Village Blocks	N. A.	528	565	615	622	623
Artificial Insemination Centers/ Sub-Centers	N. A.	N. A.	N. A.	12,945	10,928	N. A.
Number of Animals Inseminated	N. A.	N. A.	N. A.	3,891,000	2,944,000	3,167,000
Cattle Breeding Farms	N. A.	N. A.	N. A.	N. A.	1,861	1,958

Source: Ref. no. 47, IX ed. (1968), pp. 196–197; X ed. (1970), p. 169; XIII ed. (1974), p. 201; XIV ed. (1975), p. 193; XVII ed. (1978), p. 195, 219 and 235; ref. no. 22; and ref. no. 26, p. 113

departments and government and military dairy farms, mostly located in the northern provinces. Most of these development efforts were local, scattered and without any coordination. Particularly, these programs had little impact in the rural areas which supported the bulk of the bovine population. The first organized attempt to develop cattle in the rural areas on an effective scale began with the introduction of the Key Village Schemes during the First Five Year Plan (1951–52 to 1955–56) [20].

The Key Village Schemes (KVS) embraces all aspects of cattle development including controlled breeding, improved feeding, disease control, better management and marketing, and adoption of improved animal husbandry practices through proper extension methods [21]. It is a multifaceted scheme but the basic objective is the multiplication of superior germplasm from the established farms for improvement of cattle in other areas. Before the implementation of KVS on all India basis, artificial insemination (AI) techniques in cattle breeding had already been applied successfully. Therefore, AI became an integral part of the program. The KVS centers were first established in the breeding tracts and then were extended into other parts with no recognized breeds, or in areas of non-descript cattle. During the First Plan under this scheme, 146 Key Village Blocks (KVB) were started, each Block covering 10,000 breedable cows and she-buffaloes. Under the Second Five Year Plan (1956–57 to 1960–61), the Scheme was expanded to 197 Blocks and 64 urban AI centers.

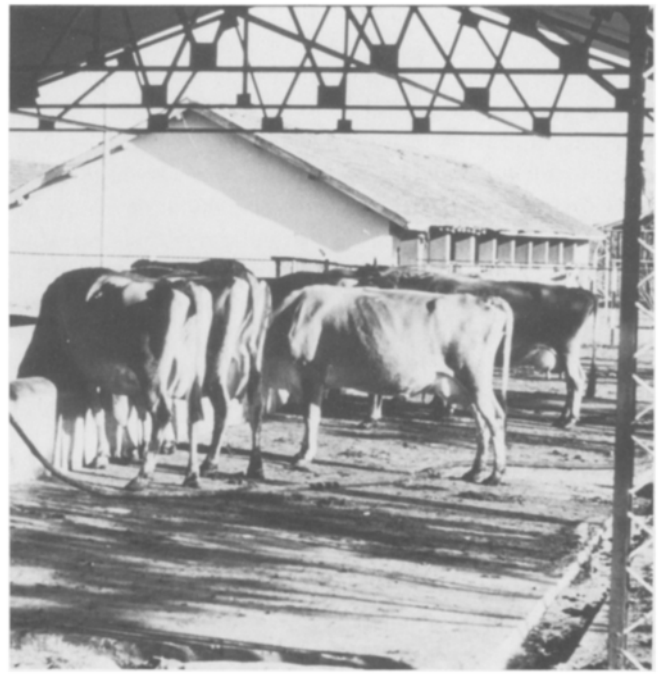


Fig 4 (A) Maharashtra State Government Cattle Breeding Farm at Tathawade, (B) Improved breeds of cows with higher milk production are maintained at the farm with all modern facilities

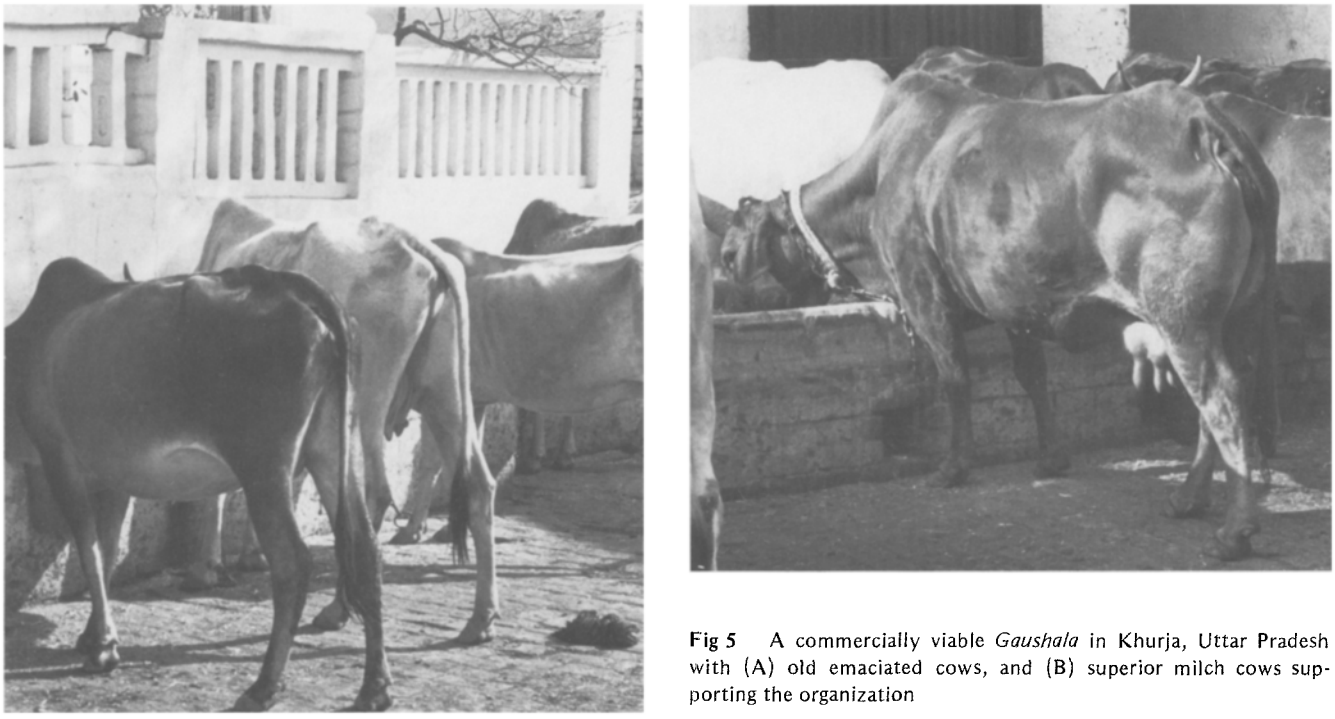


Fig 5 A commercially viable *Gaushala* in Khurja, Uttar Pradesh with (A) old emaciated cows, and (B) superior milch cows supporting the organization

During the Third Five Year Plan (1961–62 to 1965–66), both the scope of the improvement programs and the area covered were further expanded. By the end of the Fourth Plan (1969–74) as many as 587 KVB's were functioning. During the Fifth Plan period, some of the KVB's were merged with the Intensive Cattle Development Projects (ICDP) and Operation Flood Project (OFP), the latter for increased milk production.

The KVS which started with 146 Blocks serving only 1.9 % of the breedable cows and the buffaloes in the First Plan, had increased to over 600 Blocks by 1974–75, serving over six million or 7.3 % of the breedable cows and she-buffaloes in India (Tab 1). *The concept of KVS is unique as it is an attempt towards the spatial diffusion and development of good quality cattle throughout the country* (Fig 2) [22].

Besides the large areal coverage, the scheme has also an integrated approach towards an all-round cattle management and improvement program. But in view of the budgetary provisions between the federal and state governments on the one hand, and the vast magnitude of the cattle population on the other, the KVS has not been able to make any significant impact on the improvement of cattle breeds. Particularly, the centers are located in dispersed manner all over the country but in many centers all the facilities envisaged in the KVS are not available and implemented (Fig 2). Moreover, each KVB is a small island of organized activity surrounded by extensive areas of large cattle population without much effect. Therefore, the impact of the work done by KVB is diffused by the uncontrolled breeding going all around the country side [23].

Intensive Cattle Development Projects

It was realized during the Second Plan that the KVS would not make significant impact on the improvement of stock on account of insufficient inputs. Particularly, there was inadequate integration of production and marketing programs, including the collection of milk for a larger number of dairy plants. These problems led to the formulation and establishment of the Intensive Cattle Development Projects (ICDP) as a part of the Special Development Program during the later half of the Third Plan. The principal objective of the ICDP was to improve the bovine breeds for higher milk production. Therefore, the projects were located in the breeding tracts of indigenous breeds of cattle and buffaloes, and also in the milk sheds of large dairy projects. The linking of ICDP with the fluid milk marketing schemes and milk product manufacturing projects was considered essential since cattle improvement programs had to function complimentary to milk production and marketing. The program also included improved methods of breeding, provision of more feed and fodder production, disease control and adequate coverage for all-round development of animals [24].

The ICDP is a unique and ambitious program adopted by India on such a huge scale. This comprehensive project

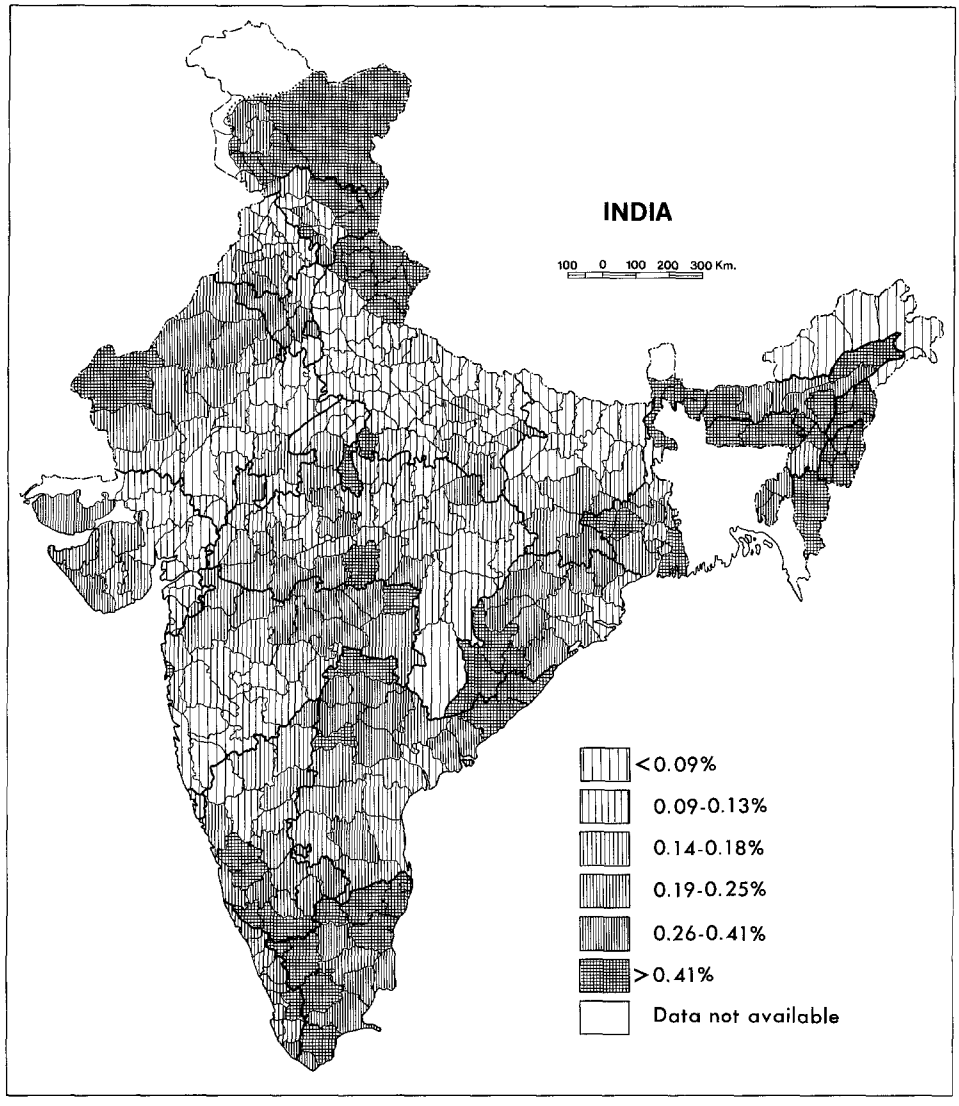


Fig 6 Male bovine used for breeding only as a percent of total bovine

aims at improving the bovine population throughout the country by an *area development approach* and resembles in some ways the Intensive Agricultural District Program (IADP) for the diffusion of high yielding variety seeds for increased foodgrain production in India [25]. For example, the ICDP's were started in those districts which had greater potentials and available resources to ensure effective response to inputs for cattle improvement and increased milk production efforts. The program envisaged the provision of all necessary inputs and services simultaneously. Further, each ICDP was expected to cover 100,000 breedable cows and she-buffaloes achieving a breeding coverage of about 70 % of the bovine population, and an increase in milk production by about 30 % in 5 years [26]. In 1966–67, there were only 21 ICDP's and by 1975–76, there were 82 (Tab 1). The district level data available for 1972–73 indicate that there were 62 ICDP's distributed all over India (Fig 3) [27].

Fig 2 and 3 indicate that KVS and ICDP cover all parts of India, including both the breeding tracts in the W and the poor non-descript bovine areas in the E, S and the SE. It is evident from Fig 3, that there are no ICDP's in Rajasthan State. An enquiry revealed that the ICDP's are not functioning in that state [28]. But the KVS and Artificial Insemination (AI) Centers have extensive coverage in Rajasthan with 246 AI centers performing 38,338 inseminations during 1972–73 [29]. This was only 0.6 % of the total breedable bovine population of the state. This small proportion was on account of superior breeds of bulls easily available for natural service in Rajasthan.

Since ICDP's were located in those districts of India with greater potential for cattle development, it was expected that their improvement methods and better bovine breeds would have areal diffusion in the surrounding districts. Also, after the establishment of the program, more ICDP's have been added for a larger areal coverage in the

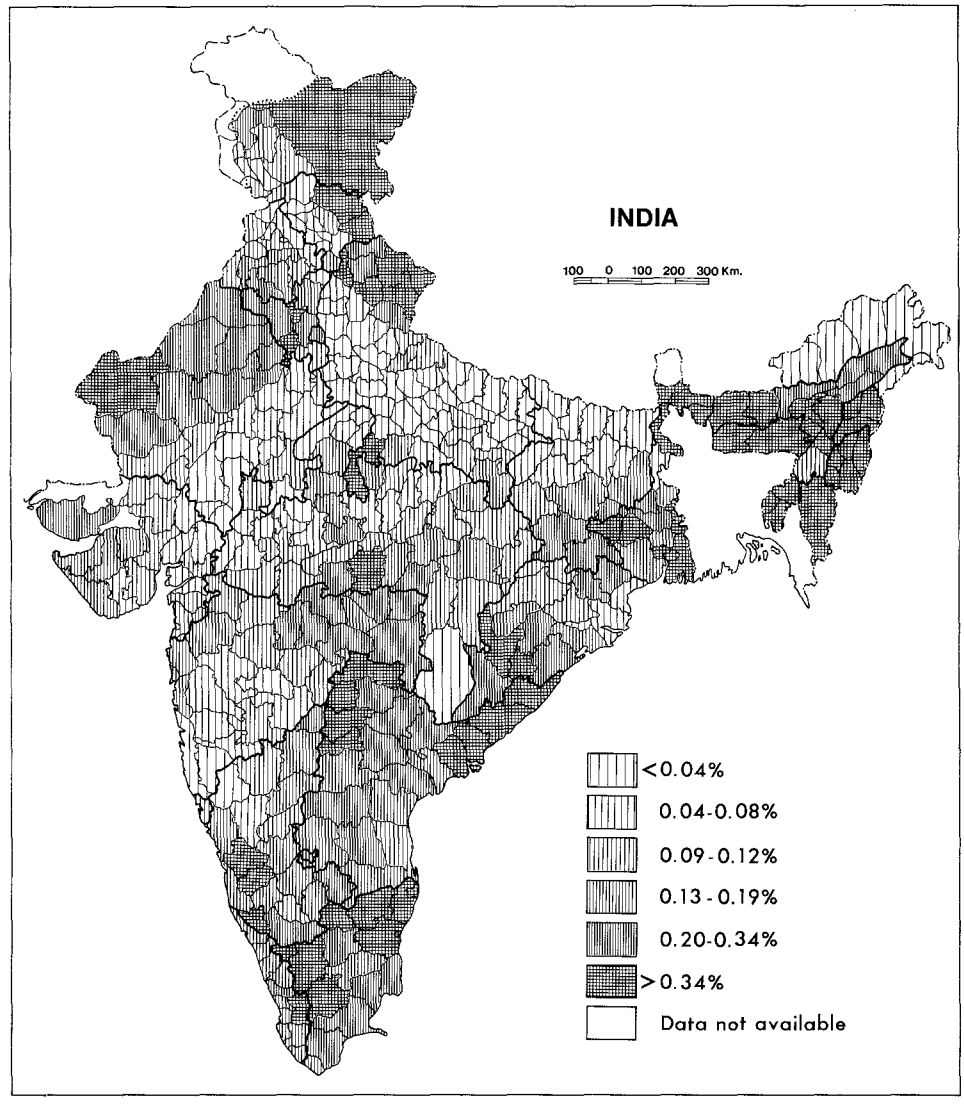


Fig 7 Male cattle used for breeding only as a percent of total cattle

following years totalling 82 by 1975–76 (Tab 1). Each ICDP covers about 100,000 breedable cows and she-buffaloes. It is estimated that in 1972 out of 82.03 million breedable animals, 60 ICDP's covered 6 million or 7.3 % of the total breedable female bovine population. The impact of the KVS on cattle development cannot be separated from that of the ICDP's since they have been merged in several districts. Assuming that 615 KVB each with 10,000 animals covered 6.15 million or 7.4 % of the total breedable bovine in 1972, the maximum combined coverage by both the KVS and the ICDP's would be about 12 million or 14.7 % of the total breedable cows and she-buffaloes.

Other Bovine Development Programs

Besides the coverage by the KVS and the ICDP, most state governments have set up their own cattle breeding farms to develop improved herds of indigenous and cross-breeds (Fig 4). There are also military dairy farms which are engaged in improvement of bovine breeds together with milk production on a quasi-commercial scale. In 1975, for example, there were 24 such farms with a total of about 10,000 cows and buffaloes [30]. Even the *Gaushalas* which are run on a religious basis to protect the old cattle mostly in the N parts of India have been reorganized on a commercial basis so that good herds of cattle are also kept for milk production and support their operation. A 1956 survey showed that there were 1,020 organized *Gaushalas* in 21 states of India which maintained 130,000 cattle, and 1,400 breeding bulls and produced 11.2 million kg of milk (Fig 5) [31].

There are also programs for progeny testing, registration of breeds and recording of milk production at village level in several breeding tracts. Development of animal sciences, research, drug and vaccination production, disease

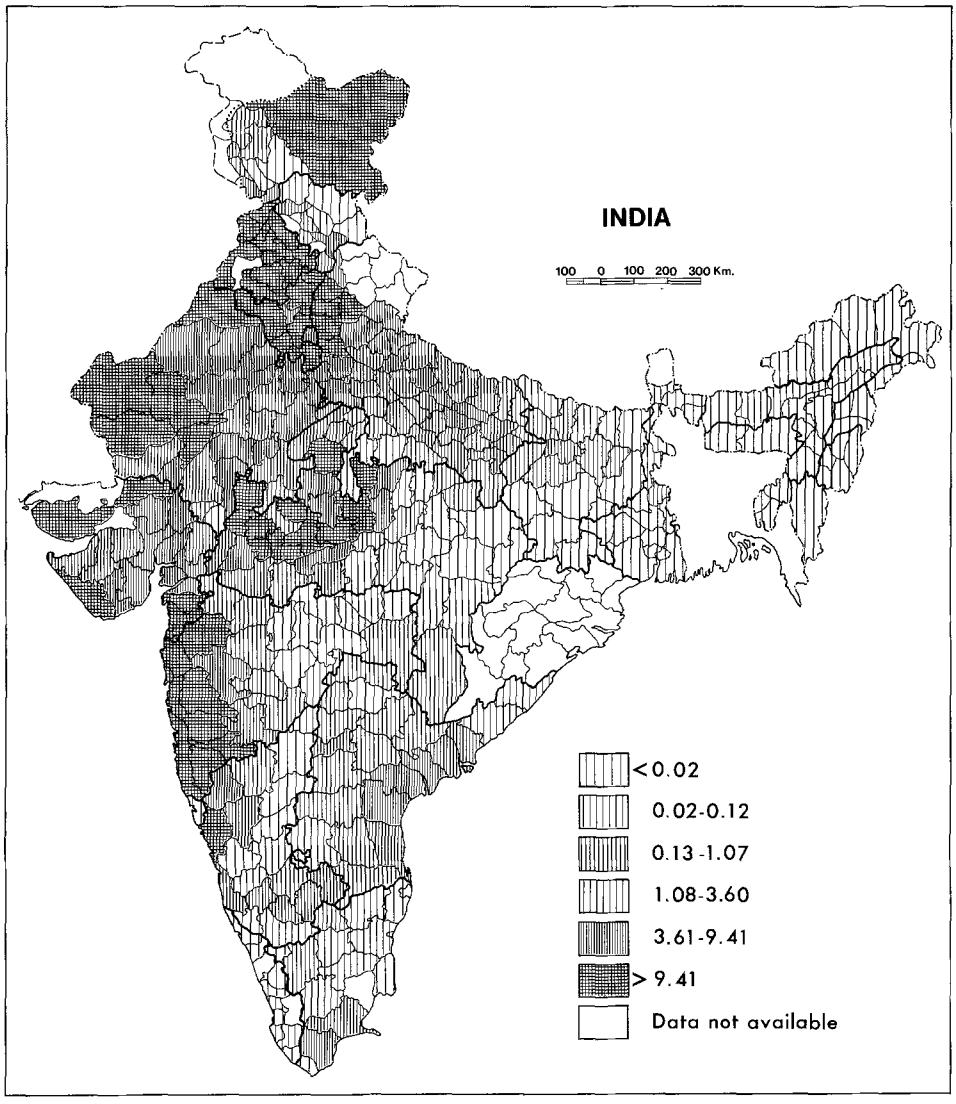


Fig 8 Male buffaloes used for breeding only as a percent of total buffaloes

controls and training of veterinarians have been stepped up through the Five Year Plans all over the country. There are about 6,000 veterinary hospitals and dispensaries; and veterinary institutions turn out more than 1,000 graduates every year besides training of thousands of stockmen and village workers for cattle development programs [32]. Some government and private organizations have introduced cattle insurance programs with limited success for dairy cattle in the developed parts of India.

Cross-Breeding Program

Cross-breeding draft cattle is not important since indigenous breeds are considered best for this purpose. Also, cross-breeding program is unimportant where indigenous breeds exist as in Rajasthan [33]. In most of other parts of India, however, it is recognized that in order to meet the ever-increasing demand for milk, cross-breeding of indigenous cattle with exotic dairy breeds with higher milk yield is a necessity.

Although cross-breeding with exotic dairy cattle was started in selected dairy centers in the early sixties, the program was implemented on a larger scale during the Fourth Plan period. The cross-breeding program also involved areal approach using two or more suitable exotic breeds for selected places each in hills, plateaus and plains. The program was executed in the field by several international organizations such as Indo-Swiss Project, Indo-Danish Dairy Projects, Indo-German Agricultural Development Project and by several Indian central and state government dairy schemes and private enterprises [34]. The program was further strengthened through KVS and ICDP. Such areas were selected in major dairy tracts which had the greatest potential for increasing milk production. For example, these tracts had progressive farmers and adequate

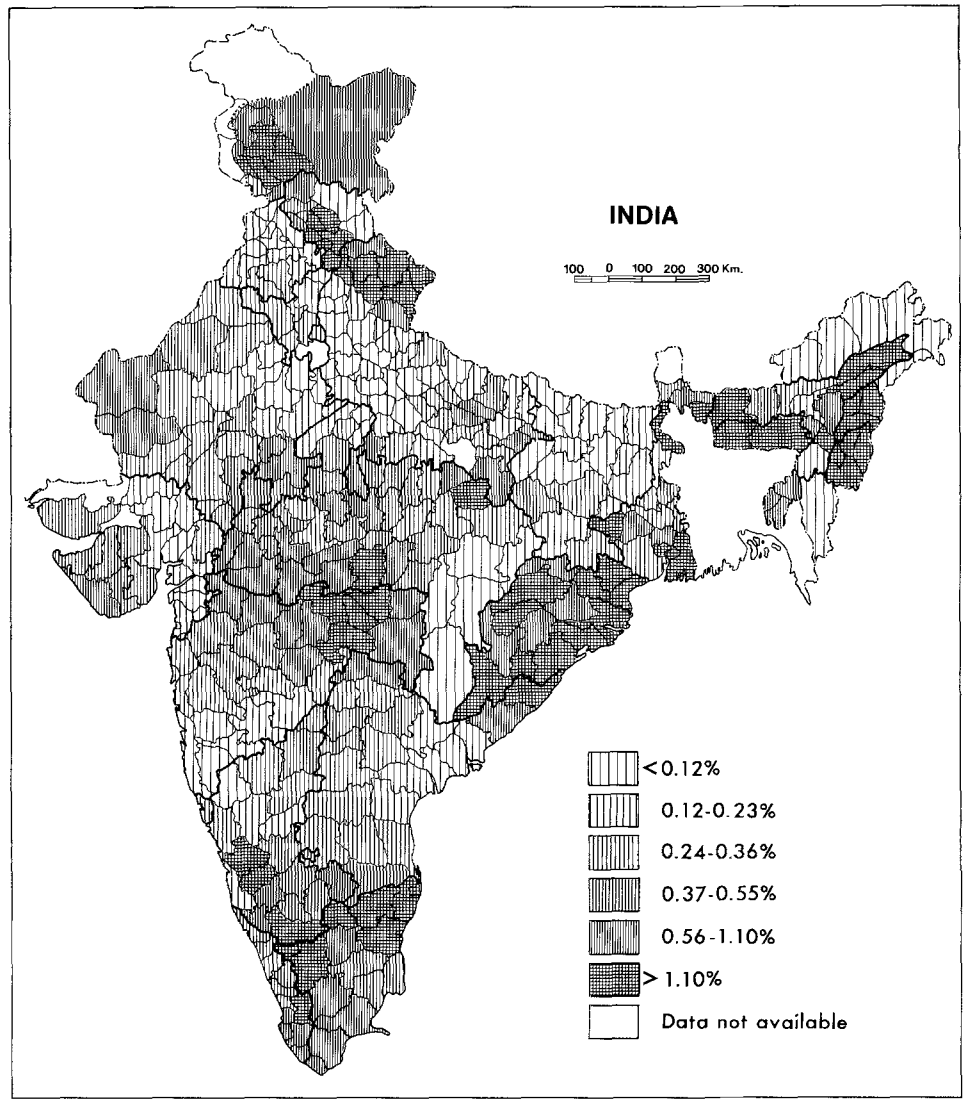


Fig 9 Hectares of fodder crops per 100 hectares of net sown area

infrastructure for effective cross-breeding including AI, frozen semen banks, fodder cultivation, and stall feeding, all geared towards commercial milk production [35].

As many as nine breeds of European cattle have been used for cross-breeding with the India Zebu. Depending on the area, its climate and availability of feed and fodder, the most common breeds for crossing are Jersey, Holstein-Frisian, Brown Swiss, and Red Dane bulls [36]. As for example, in Punjab where there is sufficient infrastructure for producing feed and fodder, heavy exotic breed Holstein-Frisian was recommended for cross-breeding [37]; in hilly areas with lesser facilities a smaller breed, Jersey, was selected.

With more concentrated efforts for increased milk production through Fourth Plan, Fifth Plan and the Operation Flood Project, almost all the states have now acquired herds of exotic cattle (15–250 heads each) in different places. Rajasthan State is an exception which has mostly indigenous breeds of superior quality. Since 1961, about 7,800 exotic cattle have been imported in India, and 80 % of these imports were between 1971 and 1978. By 1978, there were approximately 55 exotic herds with a total adult exotic cow population of 4,500. Further, there were about 965 exotic bulls located in AI centers, and 35 frozen semen production stations located in different parts of the country. An estimated 10,000 insemination units have been functioning in the milksheds, and the effective coverage under breeding was approximately 15 % of the breedable bovine population of India. It is estimated that about 3.8 million inseminations have been performed under *all the cattle development programs* during 1978–79, and the inseminations with the exotic bulls could be over 1.5 million (Fig 2 and 3) [38].

Owing to the increase in the number of AI centers and AI's performed, the number of bulls kept for breeding has declined in recent years. In 1966, there were 430,000 cattle

Fig 10 In poor agricultural areas, as for example eastern Tamil Nadu, cattle supplement their feed and subsist by wayside grazing

and 330,000 buffalo bulls used for breeding only; and an additional 2.26 million cattle and 620,000 buffalo bulls were kept for both breeding and work, all totalling 3.64 million male bovines used for breeding. The corresponding figures in 1972 were 390,000 cattle and 230,000 buffalo bulls, and the figure for both breeding and work was 1.99 million and 600,000, respectively, totalling altogether 3.21 million, a decline of 430,000 bulls or 11.8 % in just six years.

Although the KVS and the ICDP programs are uniformly distributed in the areas of both the indigenous cattle breeding and non-descript cattle, the male cattle and buffaloes kept for breeding purposes only have unequal distribution patterns. The male bovine used for breeding only as a percentage of total bovine is highest in the NW, NE, and SE parts of India (Fig 6). This pattern is distinct for the male cattle used for breeding only (Fig 7). For the male buffaloes kept for breeding only there is an additional large area of higher concentration in central India also (Fig 8). This indicates a definite effort to improve the bovine breeds not only in the areas with superior indigenous breeds, but also in the NE, E, and SE areas of inferior non-descript cattle.

There are no exotic buffaloes involved in cross-breeding since the indigenous breeds are considered best in their class for milk production as well as for draft purposes. Some cross-breeding programs, however, are in progress between different indigenous breeds for combining and improving such genetic characteristics as higher milk yields and butterfat content, large body size for draft and better heat tolerance [39].

Problems of Successful Implementation of Cattle Development Programs

India, with over 700 million people (1983), lagging food production and heavy pressure of both human and cattle population on a limited land, has set up the largest infrastructure and an ambitious plan to improve the cattle resources among the developing nations of the world. But despite the extensive and intensive crash programs, the results have not been as encouraging as with the High Yielding Varieties Program for increasing foodgrain production [40]. The problems with the cattle development programs are more complex which involve cross-breeding, suitable physical environment for exotic breeds, supply of adequate feed and fodder, disease control, milk production and marketing and, of course, the development of agriculture itself of which cattle form an integral part. While the data on various cattle development programs were easily available and collected in India, the Government of India did not allow the research visa to conduct extensive field evaluation of diffusion and success of the KVS and ICDP programs. Therefore, the following assessment is based on limited fieldwork and information collected through personal efforts by the author in different states of India [41].

Limitations of Implementing Cross-Breeding Program

There are two main problems of cattle improvement through cross-breeding. The first is the technical feasibility and successful cross-breeding of indigenous animals with exotic stock for superior milch cows with higher milk production; and the second is the spatial diffusion of the innovation and maintenance of the superior herds by providing adequate feed/fodder and health care in the vast rural areas.

Regarding the technical aspect of cross-breeding of exotic cattle with indigenous breeds and producing stocks with higher milk yield, there has been a long and continuous effort with very promising results. The experts have recorded that for the best adaptable genotype, the optimum exotic level is 50 %: The results showed an overall improvement from Zebu of 217 % increase in milk yield, 20 % in age at first calving, 42 % in the length of lactation period, and 17 % in calving interval [42].

A major physical constraint for introduction and *diffusion* of superior indigenous breeds or cross-breeds in

Tab 2 Actual annual net income and net food production over the lifetime of a cow or buffalo in India

Animal and Management	Milk Production in Litres	Net Income from Milk in Rs. *	Food Calorie Yield from Milk in M.cal.	Potential Food Calories in Feed or from Land Devoted to Fodder		Net Food Calorie Yields in M.cal.
				Feed in M.cal.	Land in M.cal.	
Indigenous Cow – on current feeding & no supplementary feed or fodder	200	175	135	0	0	135
Buffalo – on current feeding & no supplementary feed or fodder	450	900	526	0	0	526
Cross-bred Cow – 450 kg supplementary feed & fodder from 0.04 hectare	1800	1500	810	186	875	– 251

* US $ 1.00 = Rs. 8.50

Source: Ref. no. 50

non-descript cattle areas, however, is the hot and humid climatic environment. The indigenous breeds perform better in their native tracts of dry climatic environment such as in W and NW parts and drier tracts of the Deccan Plateau, leaving large, hot-moist E, central and SW parts of India to non-descript poor cattle (Fig 1). Similarly, the European cattle and their cross-breeds with higher milk yields also develop problems to adjust and maintain milk yields in these latter areas [43]. During the spring, summer and monsoon seasons, the average maximum temperature in most parts of India range between 35° and 40°C. The growth of European breeds of cattle is depressed at temperatures above 24°C and weight gains cease at 29° to 32°C. Their milk production also declines when ambient temperature exceeds 23°C [44].

The Problem of Subsistence Farming

Another significant limiting factor for the large scale areal diffusion of the cattle development programs through KVS and ICDP, including AI and cross-breeding is *the farming system* – particularly the agricultural economic condition of the majority of farmers in India. The majority of farmers in most parts of India operate subsistence farms where foodgrain production for their direct consumption is the chief concern [45]. In this subsistence farming economy, cattle raising is ancilliary to foodgrain production for direct consumption by the farmer and his family members. Cows are kept in most farms to provide mainly (calves) draft bullocks for all farming operation, some milk to supplement diet, and dung as fuel for cooking meals. Not only male calves of both Zebu and buffaloes are castrated for bullock power but also a significant number of cows and she-buffaloes are used for draft purposes [46]. Those farmers who can afford them would have a few more cows or she-buffaloes for milk, and if there is any surplus, the milk is sold to supplement their income.

Only about 4 % of the total area is available for pasture, and approximately 2 % of the sown area is devoted to fodder crops [47]. Furthermore, some densely populated parts such as E, SE, and S India, with mostly non-descript cattle, have one or less than 1 % of land under fodder crops; whereas W and NW parts with most of the superior indigenous breeds of cattle have 3 to more than 9 % of the sown areas given to fodder crops (Fig 9) [48]. Generally in

Fig 11 Cows grazing in open village pastures in central Madhya Pradesh are vulnerable to scrub bulls, adversely affecting the improved cattle breeding program

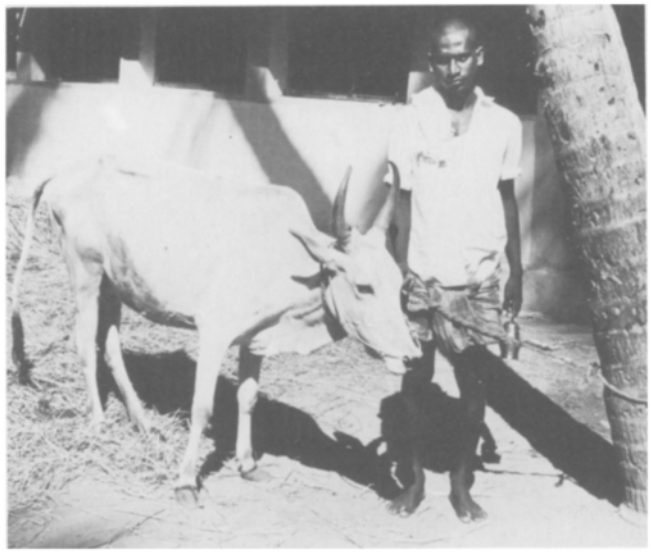


Fig 12 Excepting cows in milk, the rest are given poor feed such as straw, as for example, in SE Tamil Nadu

most poor agricultural areas under the predominantly subsistence farming system, cattle are fed mostly the unedible residue and by-products of crops, and grazed on road shoulders (Fig 10). The main function of cattle, therefore, is to provide the draft power by recycling the agricultural waste and unedible by-products.

Because of the increasing pressure of human population on land and less and nutritionally unbalanced feed available for cattle, the quality of cattle has deteriorated with declining milk yield and draft efficiency. Instead of improving the breeds by increasing the quality and supply of scarce feed and fodder, the effort has been to compensate the declining efficiency by increasing the number of cattle. The increase in the number of cattle in turn has resulted in further shortages of feed and fodder. Thus a vicious circle is in operation against any large scale cattle improvement program.

All cattle and buffaloes are kept in use in India till they stop giving any milk, or they cannot work and drop dead. For example, according to the Indian Livestock Census 1972, only 1.9 % of the total cattle population over 3 years was recorded as unproductive (not in use for breeding or work) [48], and 1.3 % of the total buffalo population over 3 years was recorded unproductive (not in use for breeding or work) [49]. Even these unproductive cattle given the left-over of the waste, recycle it by yielding dung towards fuel needs of a farmer. In the predominantly subsistence and submarginal farming economy of India, the issue is not the efficiency and productivity but a problem of scarcity and utilization of any resource to its final exhaustion including the cattle. Therefore, the upgrading of cattle resource is not possible in India without a simultaneous improvement of the farming system and agricultural production, including an adequate supply of feed and fodder.

The Problem of Feed and Fodder Supply

The non-descript cows give milk on very scanty feed. Raising the quantity and quality of feed/fodder does not result in proportionate increase in milk yield from these cows, and is economically not viable. On the other hand, superior indigenous breeds or cross-breeds have much greater potential and produce more milk but they must be supplied with adequate amount of feed and fodder. Between the indigenous breeds and cross-breeds, however, the latter respond better to improved feeding, and are economically more profitable for raising milk production [50]. But the major handicap for successful introduction of high yielding cross-bred cows in rural areas in India is the cost and the scarcity of feed and fodder. In

Fig 13 (A) cross-bred calves, produced with AI, and (B) a veterinary doctor attending a sick cow in village Sonkach (district Bhopal), Madhya Pradesh under the ICDP

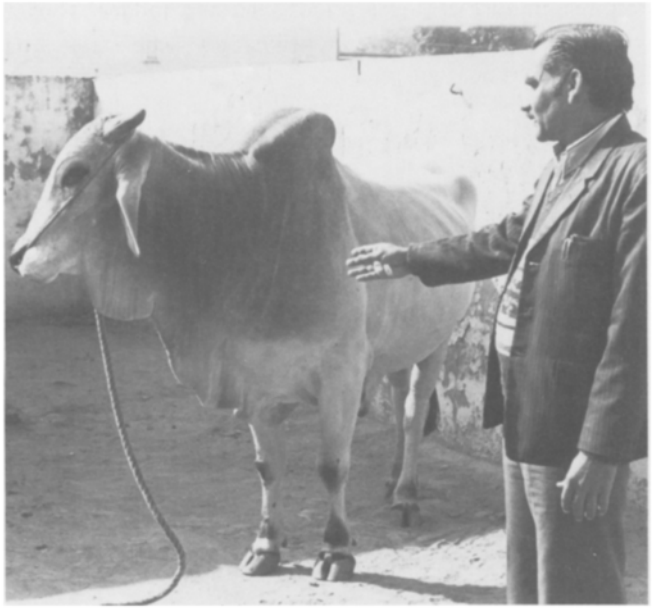
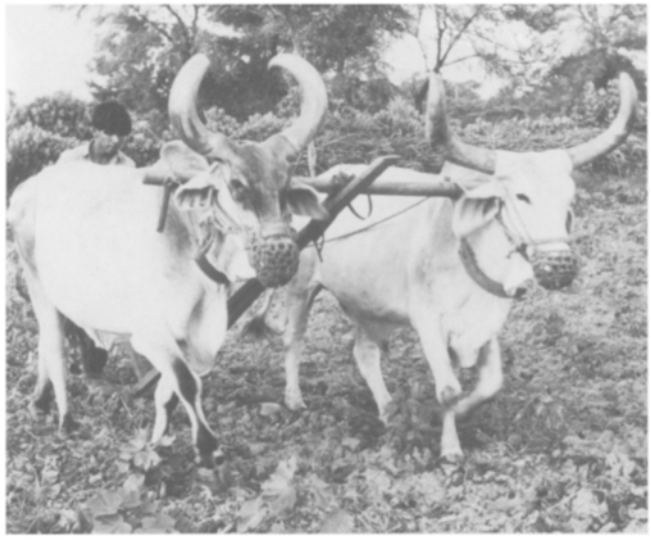


Fig 14 (A) a veterinary hospital with attending doctor at a nominal fee, and (B) a Hariana bull for loan to any village for improving cattle breeds in Bulandshahr, UP

order to obtain optimum production of milk from cross-bred cows, it is essential to provide them sufficient quantities of feed, fodder and concentrate [51]. In fact, past experiments have clearly demonstrated that lack of proper feeding has resulted in complete failure [52]. The field studies indicate that the feed cost per cross-bred cow per day is more than double the cost of that for non-descript. Besides the feed cost, the cross-bred cows require more attention in feeding and health care further raising the cost of inputs [53].

Tab 2 summarizes the potential for raising the milk yield per cow in India through cross-breeding. An indigenous cow kept on usual straw and other agricultural waste, produces 200 litres of milk per year, while a cross-bred cow produces 1,800 litres. This results in an increase in profits from Rs. 175 from the indigenous to Rs. 1,500 from the cross-bred cow a year. For buffaloes, however, the results are different since there is no possibility of obtaining quick results through cross-breeding [54]. But to raise the milk by adopting cross-bred cows, the feed must be supplemented by at least 450 kg, and fodder from 0.04 ha per cow (Tab 2). Increase in the consumption of feed and fodder at a large scale national level involving several million cross-bred cows may create two main problems. Firstly, a large part of the limited agricultural land in India capable of producing foodgrains has to be transferred to produce cattle feed and fodder. Since the indigenous cows are maintained on agricultural waste and way-side grazing, switching to cross-bred cows requiring more feed and fodder may lead to less land available for foodgrains and ultimately less foodgrain production. Secondly, intensive feeding of cross-bred cows with supplementary feed (concentrates) may constitute such amounts of potential food for human consumption that the total balance in the net food calorie yield from increase in milk production may be negative (Tab 2).

Fig 15 Small buffalo-milk dairies are common in urban areas such as Khurja, Uttar Pradesh



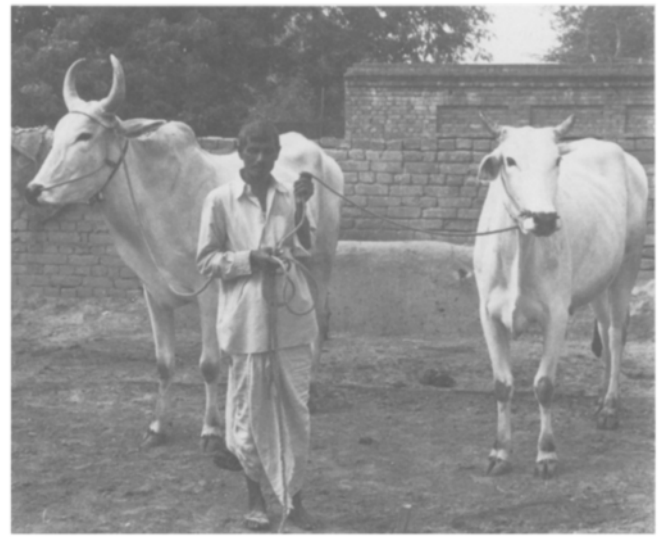


Fig 16 Some rich farmers are buying back superior bullocks for draft purposes as tractors are becoming difficult to maintain: (A) a proud farmer is showing his sleek and fast Nagori bullocks in UP, and (B) a pair of heavy Kankrej bullocks cultivating a cotton field in Gujerat

Therefore, although the present level of development with a limited number of cross-bred cows does not indicate any serious effect on India's already precarious food situation, any massive program of increasing feed and fodder production at the expense of foodgrains, may be dangerous in the long run.

The Problem of Scrub Bull

Another menace against maintaining an improved herd of cattle in rural India is the loose scrub bull roaming freely through the villages. Scrub bulls are inferior male calves which are discarded by the Hindu farmers without castration on religious grounds. These bulls are without any owners and they thrive by grazing on open fields and easily infiltrate and impregnate the superior dairy herds. Eradication of scrub bulls is not easy on account of Hindu religious sentiments. Although the Livestock Improvemant Act empowers mandatory castration of all unapproved bulls in the area covered by the different cattle development programs, scrub bulls remain at large, threatening the success of the controlled breeding (Fig 11).

Field Evaluation of Cattle Development Programs

The high cost of maintaining superior and cross-bred cattle has generally been the major deterrent in the large scale diffusion of cattle improvement programs in the rural areas; and only commercial dairy farms, and rich farmers have adopted them successfully [55].

The impact of various programs such as KVS, ICDP and AI was examined in the field and farmers were inter-

	1951	1961	1972
Working Bullocks (000)	58,475	68,704	70,656
Working Cows (000)	2,315	2,150	2,101
Working he-Buffaloes (000)	6,028	6,645	6,999
Working she-Buffaloes (000)	550	487	381
Total Working Animals (000)	67,368	77,986	80,137
Total Gross Cropped Area (000 ha)	131,898	152,716	167,412 *
Area Per Pair of Bullocks (ha)	3.91	3.91	4.16
Number of Operational Holdings (000)	N. A.	49,824	70,493 *

Tab 3 Working animals, total cropped area and number of operational holdings in India

* 1970–71 Data

Source: Ref. 26, p. 5; ref. 47, Tenth Edition, 1970, p. 48, and Seventeenth Edition, 1979, p. 58

Tab 4: Annual milk production in India (000 tonnes)

Year	Cow Milk	Buffalo Milk	Goat Milk	Total Cow + Buffalo Milk
1940	7,517	9,090	502	16,607
1945	7,698	9,778	498	17,476
1951	7,743	9,184	479	16,927
1956	8,180	10,976	561	19,156
1961	8,753	11,087	535	19,840
1966	7,368	11,813	571	19,181
1968–69	8,904	11,660	636	20,564
1971–72	9,450	12,375	675	21,825
1973–74	9,744	12,760	696	22,504

Source: Compiled from: Goel, B.B.P.S.; Rao, D.V.S.; Murty V.V.R.: Bovine Milk Production in India During 1966 and Its Per Capita Availability, Agricultural Situation in India, 1091–1097 (1970); ref. 26, p. 11, and ref. 47, Seventeenth Edition, 1979, p. 116

viewed in the villages in the N, W and S parts of India. From a number of questions on the development programs, the two most common and fundamental problems emerged were (i) the improvement of stock through AI, and (ii) the adequate supply of feed and fodder. Regarding the adoption of AI and the evaluation of conception rate – the basic foundation of cattle improvement program, even the National Commission on Agriculture in its most comprehensive report has evaded the question with the remark ". . . great variation in success rate . . .", and ". . . in some cases figures were unusually high . . ." [56]. In the field survey also, the author recorded a highly varied response. In the districts of Tiruchirapalli and Thanjuvur in Tamil Nadu State, for example, veterinary centers reported up to 70 % of the farmers with cattle participating in the AI program. In most areas, AI costs a few cents, and in some areas it is free. Yet an interview with the farmers indicated that the program was not popular because of poor success. They reported that the cows got sick after AI, the chance of conception was poor, and that the risk of abortion was higher. In response, the veterinarians blamed the farmers for their ignorance, including bringing their cows for AI even when the cows were not in heat. In some villages, farmers had little interest in the AI program since it involved the improvement of dairy cows, whereas they wanted dual purpose cattle, especially better bullocks for draft purposes. More importantly, despite the fact that cross-bred cows require more feed and fodder, it was observed that no fodder crops were grown in these villages, and excepting the cows in milk, the rest were given mostly straws (Fig 12).

The villages surveyed in Bhopal district, Madhya Pradesh State were under the KVS and ICDP and indicated more promising results. In the village of Sonkach, a success rate between 20 and 100 calving per 100 AI performed for cross-breeding was reported. The cross-breeding emphasized mostly dual purpose cattle. The village also had a successful disease control and fodder development program. Investigation showed, however, a small plot under green fodder with irrigation facility and it appeared to be more a model rather than producing enough fodder for all the cross-bred stock of the village (Fig 13).

In parts of the irrigated plains of Punjab and Western Uttar Pradesh, with developed agriculture and rich farmers, large areas were found under green fodder crops. Furthermore, in these areas, as for example in Bulandshahr district in Uttar Pradesh, besides free AI performed, and mostly free veterinary medical services provided at the centers, improved bulls are loaned at a nominal rental to village chiefs for improving the cattle population of the entire village. This district alone has 18 veterinary hospitals, a school for training village development assistants who help the veterinarians in the improvement of cattle and a successful disease (rinderpest) control program (Fig 14).

Cattle Development Program in Urban and Commercial Dairies

Although the shortage or the cost of feed and fodder has been the major deterent against the diffusion of the cattle development programs in most parts of rural India and for most of the subsistence farmers, rich farmers and particularly the urban and commercial dairy farms have adopted the programs with great success.

In 1971, India had nine cities with over one million population each and contained 25 % of the country's 109 million urban population. Of these about 20 million (18 %) were living in the four cities of Bombay, Calcutta, Delhi and Madras. Between 1961 and 1971, per capita expenditure on milk and milk production in these cities had more than doubled. Even allowing for price increases during this period, total effective demand for milk and milk production in these four major cities had increased by an estimated 93 %, whereas the milk production rose by an estimated 21 % [57]. Therefore, much of the development of dairying in India is attributed to the country's fast growing urban demand for milk and milk products; and there is a large number of dairy farms producing huge quantities of milk and related products concentrated in and around the urban and industrial centers. It has been

Tab 5: Per animal milk production and lactating cows and she-buffaloes in India

	Milk Production Per Animal in kg		Total Breedable Female Animals over 3 years in 000		Lactating Animals in 000		Lactating Animals as a % of Total Female Animals over 3 years	
Year	Cows	Buffaloes	Cows	Buffaloes	Cows	Buffaloes	Cows	Buffaloes
1951	408.4	898.9	49,873	21,850	18,960	10,217	38.0	46.8
1956	407.0	928.7	49,903	22,352	20,099	11,819	40.3	52.9
1961	417.3	889.6	54,204	25,023	20,667	12,463	38.1	49.8
1966	351.3	914.1	54,720	26,160	20,974	12,924	38.3	49.4
1972	426.0	812.9	56,773	29,553	22,181	15,224	39.1	51.5

Sources: Compiled from – ref. 26, p. 66; ref. 47, Editions Tenth, p. 110, Fourteenth, p, 103 and Seventeenth, pp. 116; ref. 19, p. 66–67; and ref. 61, March 1970, p. 1097.

estimated that 60 % of urban milk supplies in India are produced by dairy herds located within the built-up urban/urban-fringe areas [58].

Small urban dairies keep herds of both buffaloes and cows. There is, however, a distinct preference by consumers for buffalo milk which has a higher fat content. Consequently, buffalo milk commands a higher price than the cow milk, and in urban/industrial areas, buffalo herds for fresh milk supply are common (Fig 15). Regarding the economy and the comparative net income from producing buffalo versus cow milk, commercial dairy farmers surveyed point out that cross-bred cows have higher milk yield than buffaloes. Therefore, large-scale milk production is more profitable from cross-bred cows than buffaloes. Other studies also support the distinct advantage of producing milk from cross-bred cows over buffaloes (Tab 2).

Dairying is a profitable business and many private individuals, big cooperatives and even various governments have established their dairy operations on a highly specialized and commercial basis near the big cities. These dairy farms, such as Aarey Milk Colony in Bombay, Haringhata in Calcutta, and Amul (Anand) near Ahmedabad, have all superior high milk yielding cross-bred cows.

Scientific animal management, dairy production, and milk bottling and distribution are all very efficient like those in any developed country. Since these large commercial enterprises cannot meet the demand of rapidly rising urban population, many small individual producers have started dairy farming near the cities on a modern scale taking full advantage of cross-bred cows. As for example, Bhale Dairy Farm in the outskirts of Poona city, Maharashtra, has a herd of 106 cattle with 42 cows, 60 calves – young stock, 3 bullocks and one bull. There are 32 cows in milk – producing 302 litres per day. All cows and young stock are *cross-bred* Jersey and Holstein with indigenous Gir, Sahiwal and Sindhi milk breeds. The farm is operated on a full commercial basis having all amenities of electricity, running water, telephone, air conditioning, fencing, covered barn, and feeding pens. Besides, the cattle dung is used for producing gas for power, and the residue as manure for fodder production at the farm.

Impact of Cattle Development Program on Draft Power and Milk Production

Since cattle raising is an integral part of the farming system in India providing draft power and recycling the agricultural waste, it is difficult to isolate and measure the impact of various development programs on the cattle efficiency and productivity. It was pointed out earlier, however, that the major objectives of these programs are to improve the draft animals and the milch cows. Therefore, an attempt was made to evaluate the efficiency in the draft power and milk production as the two most important indicators of success of cattle improvement programs in India.

Improvement of Draft Cattle

There are no data on the number of *improved* draft animals in India. It is observed, however, that the low working efficiency of draft animals is compensated by continuous increase in their numbers [59]. Therefore, the changes in the total number of working animals (as recorded in livestock census) in relation to changes in the total area cropped and the number of farms in India may indicate their efficiency and the effects of cattle improvement programs on the quality of draft animals. It is contended that proportionately fewer draft animals would be required with improvement in their quality and working efficiency.

An examination of Tab 3 will indicate that the total number of working animals has changed from 67.4 million to 80.1 million, an increase of about 20 % between 1951 and 1972. During the same period, the gross cropped area

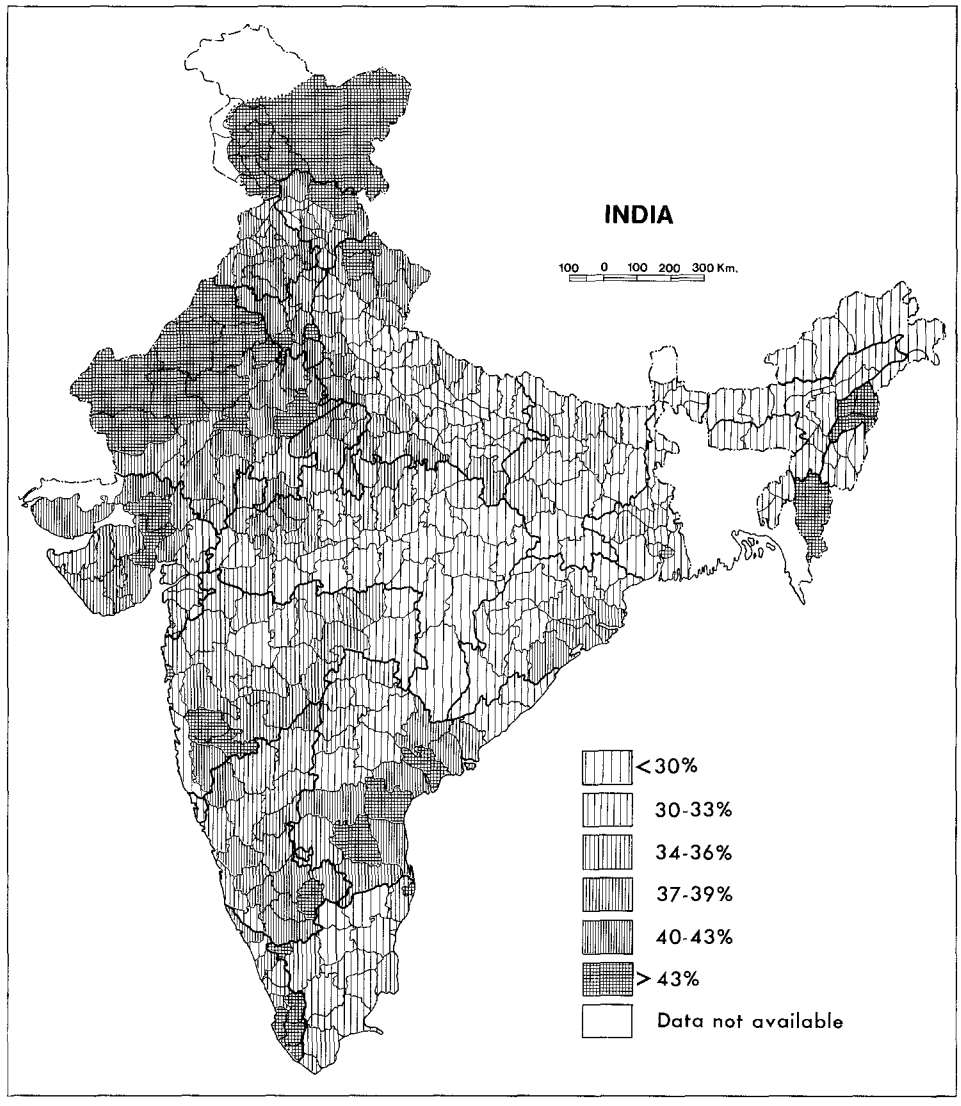


Fig 17 Female bovine over three years in milk, dry or not calved even once as percent of total bovine

has increased by 27 %. The area cropped per pair of bullocks has increased from 3.91 ha in 1951 to 4.16 ha in 1972. Also the number of operational holdings has increased from 49.8 million in 1961 to 70.5 million in 1971, but according to the National Sample Survey the average size of the operational holding has declined from 2.20 ha in 1954–55 to 2.07 ha in 1960–61. Furthermore, the National Commission on Agriculture reports that the average area covered by a pair of bullocks is less for farmers with smaller holdings and, generally, the bullock power is under-utilized from 16 to 45 % [60]. Therefore, the lower increase in the number of working animals, particularly bullocks as compared to greater rise in the gross cropped area, increase in the total number and decline in the average size of operational holdings and an increase in the cropped area covered by a pair of bullocks are certainly positive indicators of the improvement in the efficiency of working animals between 1951 and 1972. Furthermore, the decline in the number of working cows and she-buffaloes is an additional indicator of more efficient use of female animals for milk and castrated males for work (Tab 3).

The number of tractors used for ploughing in India is negligible (81,000 in 1972), and is confined to mostly large farms and rich agricultural areas. The field study revealed that farmers who could afford and had bought tractors, were having problems on account of frequent breakdowns, difficulty in getting spare parts, and scarcity of fuel oil for reliable and steady farming operations. Therefore, many farmers who had switched to tractors are buying back good quality bullocks to overcome the uncertainties during the time of need such as the monsoon season (Fig 16).

Improvement of Milch Cows and Operation Flood

With a predominantly Hindu vegetarian population, milk – a source of high class animal protein has a great potential

for improving the diet of the masses in India. There is about a quarter of the world's cattle and buffalo population in India, yet the per capita availability of milk and milk products is one of the lowest with 125 grams per day as compared to 845 grams in USA, 629 in the UK, and 187 in Pakistan [61]. Indeed, all the households throughout India are avid milk consumers, and there is a persistent and rapidly rising demand for milk and milk products resulting in a wide gap between requirements and availability [62]. This has led to serious efforts by the government and various private and international agencies geared towards raising the milk production. In recent years, therefore, the world's largest milk drive called Operation Flood I was launched as a crash program for speedy dairy development by increasing milk procurement and production in rural areas [63].

In Operation Flood II, the program was further extended to (a) increase milk production to a level which will close the gap between demand for and supply of milk and milk products, (b) improve national dairy industries, including cross-breeding program and animal care, and (c) develop a National Milk Grid to link up rural milk sheds to the major demand centers in urban areas [64].

In view of the overwhelming emphasis given to raising milk production – the so-called "White Revolution" in India, it is imperative that any changes in the total and per lactating animal milk production be examined as the ultimate indicator of the impact of cattle development programs.

According to the Institute of Agricultural Research Statistics, New Delhi, there have been regular estimates of total milk production in India particularly since the Second Five Year Plan period, "... using modern sampling procedure ..." and the results are considered very reliable [61]. It will be seen in Tab 4 that both the cow and buffalo milk production in India has increased from 7.5 million and 9.1 million t in 1940 to 9.7 million and 12.8 million t in 1973–74, respectively. In other words, the total cow and buffalo milk production has increased from 16.6 million to 22.5 million t or an increase by 35.5 % between 1940 and 1973–74. An independent investigation of the trend in milk production for 18 reorganized states observed a positive trend, with general increase of cow milk production by 10.1 %, buffalo milk by 15.6 % and the total cow and buffalo milk production by 13.1 % from 1951 to 1961 [65]. A more recent study of linear and compound growth rates in milk production in India from 1965 to 1973 indicated that the linear growth trend increased at a constant rate of 0.80 million t every year. Furthermore, it was noted that the cow milk production had increased at the rate of 0.163 million t per year, and buffalo milk production at the rate of 0.50 million t per year, as compared to the world milk production at the rate of 4.9 million t [66]. It was also observed that according to the compound growth model, India's milk production had increased at the rate of 3.24 %, with cow milk at the rate of 2.16 %, and buffalo milk at 3.77 % as compared to world milk production at the rate of 1.24 % per annum between 1965 and 1973. The study further pointed out that the increase in the buffalo milk production was faster than that of the cow.

The increase in milk production does not indicate, however, the productivity of cows or she-buffaloes since the number of milk animals has also increased during the 22-year period from 1951 to 1972 (Tab 5). Particularly, from 1961 to 1972 when cattle development programs were in full operation, the number of breedable cows over three years has changed from 54.2 to 56.8 million, an increase of 4.7 %; and the corresponding number of breedable she-buffaloes has changed from 25.0 to 29.6 million, an increase by 18.1 %. Also the number of lactating cows has changed from 20.7 to 22.2 million, an increase by 7.3 %, whereas the number of lactating buffaloes from 12.5 to 15.2 million, or an increase by 22.2 %. Therefore, the increase in milk production in India has been achieved to a large extent by increasing the number of cows and she-buffaloes.

But the significant point is that there has been a greater increase in the number of she-buffaloes, both the breedable as well as lactating. Further, the lactating cows, only 38.1 % of total breedables in 1961, had increased by only 1 % to 39.1 % in 1972 as compared to she buffaloes from 49.8 to 51.5 % during the same period (Tab 5). Such a large increase in the number of milk buffaloes were at the expense of milk yield per animal. It was computed that the average annual milk production per lactating cow had increased from 417.3 to 426.0 kg or by 2.1 %, whereas the same for the she-buffaloes had actually declined from 889.6 to 812.9 kg between 1961 and 1972. The sudden drop in cow milk production in 1966 to 351.6 kg was due to extensive drought in W India, and particularly in Rajasthan, the major tract of milch cow concentration [67]. Even in 1951 and 1956, milk production per cow was 408.4 kg and 407.0 kg, respectively, much higher than that in 1966, indicating unusual circumstances for the decline in 1966. An independent study for the period 1961 to 1971 also observes that the number of breedable cows increased by 4.3 %, but their milk production by 9.2 %, whereas in case of buffaloes, the respective increases were 19.2 % and 1.4 %. This study emphasizes that the significant increase in cow milk production was due to cross-bred cows [68]. Therefore, it may be concluded that despite the shortages of feed/fodder and other problems of animal husbandry related to predominantly subsistence farming economy, the increases in the total and per cow milk production in India are definite indicators of the positive impact of cattle development programs.

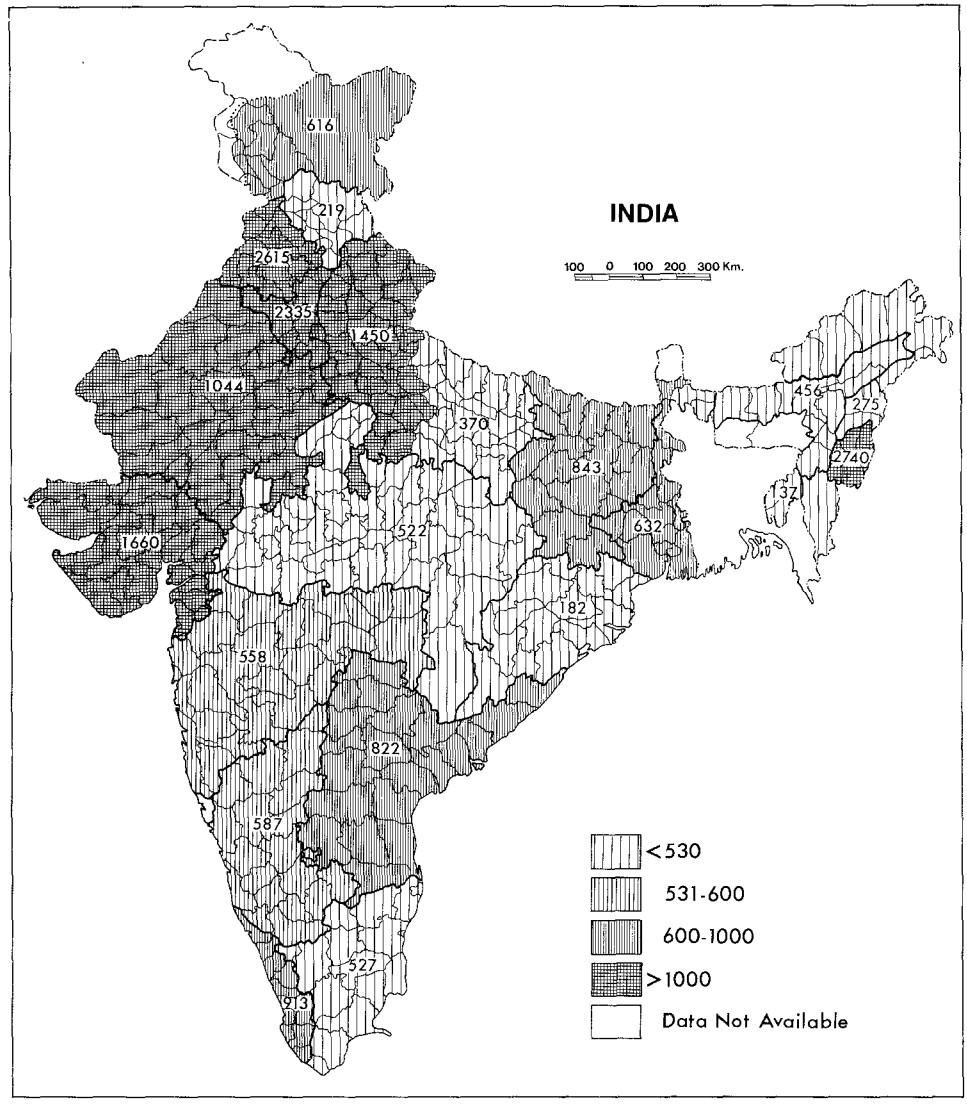


Fig 18 Daily milk production per milch bovine (in grams) by dairy regions

Regional Impact of Cattle Development Programs

Any information on the regional impact of cattle development programs is not available and there are also no published data on the quality of bovine and milk yield for each district of India. Therefore, an assessment of impact of various programs on different regions is attempted through examining the available livestock census data on milch and breeding animals, and the regional/state level data on milk yield based on National Sample Surveys.

An examination of Fig 17 showing the female bovines over three years in milk, dry or not calved even once as a percentage of total bovine presents an interesting pattern. The highest proportion of such bovine producing milk or having potential for milk production is to be found in W India, notably in Rajasthan, Gujerat, Punjab, Haryana and Uttar Pradesh. Other areas of high proportions are noticed in parts of Maharashtra, Kerala and along the SE coastal districts. It may be observed that, generally, these areas also support most of the superior indigenous breeds of cattle and buffaloes (Fig 1). Further, it is noticed that these areas with the highest proportion of bovine in milk or having potential for milk production also have the highest proportion of sown area under fodder crops (Fig 9). Conversely, large parts of central, E and SE India which have predominantly non-descript bovine and proportionately very little area under fodder crops have smaller percentage of bovine for milk production (Fig 1, 9 and 17).

The distribution of male bovine used for breeding only as a percentage of total bovine population has a different pattern, however, (Fig 6). There is only a smaller percentage in W India but a larger percentage of male bovine used for breeding only in central, S and E India. Such higher concentration is to improve the quality of predominantly non-descript bovine in the latter areas.

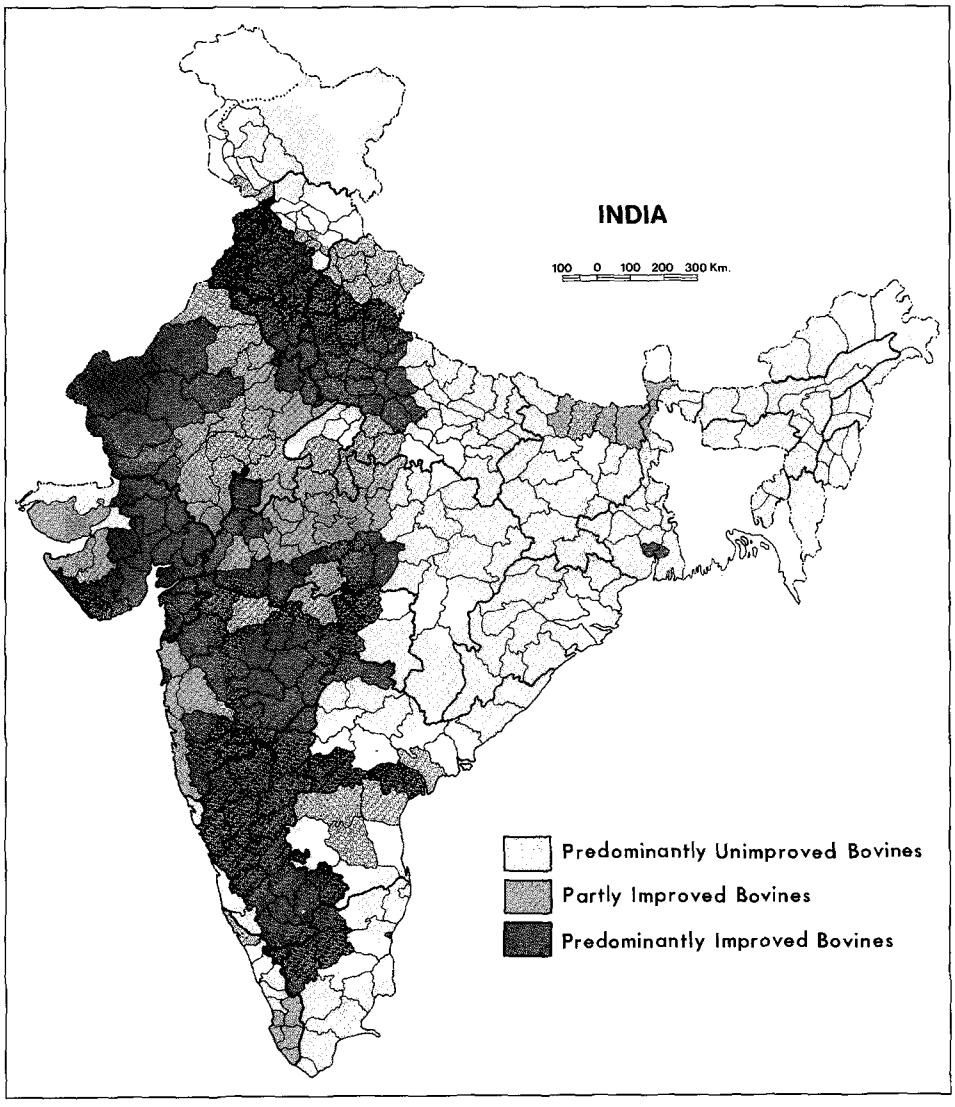


Fig 19 Level of bovine improvement and improved bovine regions

The milk production per milch bovine is the best indicator of the quality of cows and she-buffaloes. Fig 18, based on regional data available, shows that Gujerat, Rajasthan, Punjab, Haryana and Uttar Pradesh have the highest yield of milk per milch bovine, ranging from 1,066 g per day in Rajasthan to 2,615 g in Punjab. The lowest milk production per milch bovine ranging from 182 to 527 g occurs in Madhya Pradesh, Tamil Nadu, E Uttar Pradesh, Assam and Orissa – the states with mostly non-descript bovine and smaller proportion of sown area under fodder crops.

The above analysis indicates that generally milk production per milch bovine tends to increase in agriculturally developed areas and/or in areas with higher proportion of land given to fodder crops. Conversely, milk production per milch bovine tends to decline in agriculturally poor areas and/or in areas with little land under fodder crops. Such generalizations have also been made by National Dairy Development Board of India which concludes that "... Punjab's advantageous agricultural situation has enabled it to take the lead ... In particular, yearly production of milk per milch animal is higher than the rest of the region" [69].

An attempt was made to determine the relationship between the degree of agricultural development and the quality and development of bovine population in India. Such an attempt was limited, however, to the type of data available at the district level. For example, the Economic Division of the Reserve Bank of India has prepared a report ranking the districts of India according to the level of agricultural development [70]. This *composite agricultural development index* is based on weighted indices of soil fertility, rainfall, intensity of cropping to irrigation, crop production and gross value of output. It is hypothesized, therefore, that the higher the agricultural development (composite index) of a district (Y), the greater the proportions of (X1) female bovine over three years in breeding,

(X2) bovine in milk, (X3) male bovines over three years used for breeding only, and (X4) productive bovine used either for draft, milk or breeding purposes. (The data for X1, X2, X3 and X4 are available through the livestock census report [8].)

The results of simple correlation analyses indicate that Y is positively related to X1, X2, and X4. The correlation R^2 between the composite agricultural development index Y: and X1 is 0.06055, X2 is 0.07066, and X4 is 0.02490, all significant at the 99 % level. However, a negative correlation is observed between Y and X3 – male bovines over three years used for breeding only. This may be on account of greater use of artificial insemination in the agriculturally developed regions of India. Furthermore, a statistically insignificant correlation is found between the composite agricultural development index (Y), and unproductive bovine not used either for draft, milk production or breeding purposes. In view of the above analysis, it may be concluded that the agriculturally developed districts tend to have a greater proportion of improved and productive bovine population than the agriculturally less developed districts. Thus, the development of agriculture is the primary condition and a key to improve the cattle of any area in India.

Improved Bovine Regions of India

From the limited district level data available, an attempt was made to generalize the improved bovine regions of India. Fig 19 shows three regions of (i) predominantly improved bovine, (ii) partly improved bovine, and (iii) predominantly unimproved bovine. The first category includes all the districts with superior indigenous breeds of cattle and/or buffaloes (Fig 1 and 19). In these districts there is practically no government sponsored cross-breeding program, and the indigenous breeds are either high milk yielders, superior draft animals, or both. The remaining districts are divided into Partly Improved and Predominantly Unimproved bovine regions on the basis of ranking the districts according to milk production per milch bovine, percentage of total bovine population in milk, and percentage of net sown area in fodder crops (Fig 18, 17 and 9). These three parameters are indicative of quality of bovine, its productivity and emphasis given to them in the agriculture of a district. Those districts having at least two of the following three qualities viz., the top one-third rank of percentage of bovine population in milk, top one-third rank of percentage of net sown area under fodder crops, and daily milk production per milch cow of 822 g or more (the latter based on regional data) are included under the category 'Partly Improved Bovines' (Fig 19). In other words, the districts in this category with higher than national average daily milk production per cow, 40 % or more of total bovine under milk production, and 3.6 % or more of net sown area in fodder crops should have some quantities of improved bovine stock of both superior indigenous as well as cross-breeds.

The remaining districts covering Middle and Lower Ganges Plains through E Uttar Pradesh, most of Bihar, West Bengal, Assam, E Madhya Pradesh, Orissa and large parts of Andhra Pradesh, Tamil Nadu and Kerala, there are mostly unimproved and non-descript bovine with very low milk yield per milch cow, lower percentage of bovine as milch animals, and negligible proportion of net sown area under fodder crops. Thus, excepting the large urban areas and military and government dairy farms, in roughly half of the total area of India containing more than half of human population and bovine population, there is little impact of bovine improvement programs; and *these areas must be given the priority for any further development of bovine resources of the country* (Fig 19).

Conclusions

This is the first attempt toward a spatial analysis of a large number of scattered cattle development programs using district level livestock and agricultural census data and a variety of reports by economists, veterinarians, dairy scientists and planners on bovine problems of India. Contrary to common view, India has at least one-third of its bovine population of superior indigenous breeds, and these breeds are highly adapted to physical environment and economic conditions of their breeding tracts. In more than half the country in E and S parts, most of the cattle are non-descript and inferior quality.

The significance of cattle in farming economy is fully realized by the central and state agricultural planners. As a result, India has launched perhaps the most extensive and ambitious programs for the improvement of the world's largest bovine production. The study reveals that there is a greater emphasis on raising the milk production, and the milk production has increased together with the increase in the number of milch bovine. But the important point is that with the increase in the number of milch bovine, *there is also an increase in milk production per milch bovine in recent years*. Therefore, despite many limitations of a large developing nation – particularly the demand for and priority of raising foodgrain production for human consumption, there has been some improvement of bovine indicating a positive impact of various development programs.

Because cattle constitute an integral part of farming economy and because a large proportion of farmers are at the subsistence level, most development programs have affected the large commercial farms, particularly the dairy sector and the developed farming regions of India. The

major constraint for improving the bovine stock is the shortage of feed and fodder. In other words, there is a keen competition for scarce land either for foodgrain production for human consumption or feed-fodder production for animal consumption. Obviously small farmers have no choice leaving a large part of India under subsistence agriculture with inferior bovine and unaffected by development programs.

The cattle development program like the High Yielding Varieties Program – the so-called Green Revolution is a kind of "trickle down" economy affecting mostly the top large and rich farmers. Furthermore, the statistical analysis indicates a significant correlation between agriculturally developed districts and improved and more productive bovine. Therefore, it is strongly recommended that the agricultural development must be considered as a primary condition for improving cattle or buffaloes of any region in India.

Rather than biological improvement of bovine breeds alone through AI and/or cross-breeding, primary efforts should be made to improve the farming conditions with adequate provision for feed/fodder and *surplus farm production*. Once the farmers have *surplus*, the income above subsistence level can be channelled to provide feed/fodder, improve the stocks and to *maintain them*. Without agricultural development, therefore, any effort and expense incurred in cattle improvement will be short lived and a waste.

Finally, this is an integrating basic regional analysis of a complex and wide range of problems of cattle improvement programs in India. Therefore, it was not possible to focus on any specific issue. It is hoped, however, that this study will provide a general background for more detailed and small scale studies of any specific problem in an area concerning cattle development problems and programs in India.

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