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Aspects of India's Bovine Economy:
Some Preliminary Results

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Introduction

1.   Past studies on India's livestock economy [1] have more or less
exclusively centered on whether or not there is surplus cattle in India.
Those who assert that the existing stock is far in excess of what is
needed, with prevalent technology, to meet current demand for livestock
products and services, base their conclusion on essentially the
following arguments: (a) The current replacement and growth
requirements of adult stock can be met with substantially fewer adult
females than the number presently maintained in the country by reducing
the mortality rates among young stock. (b) At the same time, a
reduction in animal population will increase the feed availability per
animal and that better feeding alone, without any other change in
technology of the livestock industry, can increase the productivity
of milk, work and also calving rates atleast in proportion. While
the first argument is indisputable, the empirical evidence for the
second is not clearly established. More importantly, one has to
recognise that, as in the case of human labour, the removal of redundant
animals and the effective utilisation of the reduced stock for meeting
the existing demand for work, milk and calves, would require major
changes in organisational arrangements in the agricultural sector.

1/ A select bibliography of earlier work is given in the annex.

Preoccupation with the question of "surplus cattle", important as it is, has unfortunately deflected attention from a study of the reasons why the size and composition of livestock in India are what they are. It has been, of course, recognised that the present pattern of livestock holding and management may be the result of rational decisions in response to economic forces operating within the constraints of the existing socio-economic institutions, rather than of irrational religious prejudice. Marvin Harris has made a forceful statement of this view point. Raj[1] has pointed to the existence of wide variations in the composition of cattle herds between regions which are apparently unrelated to the religious composition of their respective human populations. Misra has suggested[2] the secular trends towards a deceleration in the growth of cattle population, and towards increasing specialisation in the use of cattle for work, and buffaloes for milk, reflect adaptations in response to economic forces. However, these observations have not been followed by a systematic study of the variations in the composition of bovine herds or their productivity across regions, and over time, much less to explore the factors which might explain these phenomena. This paper is a preliminary attempt in that direction.

1. Marvin Harris, "The Cultural Ecology of Indias Sacred cattle, Cultural Anthropology, 1966

2. K.N.Raj, "Indian Sacred Cattle: Theories and Empirical Findings", Economic and Political Weekly, March 17, 1971.

3. S.N. Mishra, "Some Inferences from Compositional Changes in Livestock Population" IJAE, 1970

We begin, in Section 2, with a general review of some salient facts regarding the size and composition of bovine population as well as its behaviour over time. This is followed by a discussion mostly of an exploratory nature, of the reasons for observed variations over space and time, of selected dimensions of the bovine population. In particular we shall discuss mortality patterns, the use of bovines as draught animals, relative roles of the cattle and the buffalo ; and the pattern of variation in the composition of the bovine herd across States and land holding classes.

II

Size and Composition of Bovine Population

The overall picture: India's bovine population in 1972, the year of the latest livestock census, was a little over 235 million. There are thus some 40 bovines for every 100 human beings and about 150 bovines for every 100 hectares (ha) of cultivated area. By either index, the density of bovine population in India is among the highest in the world. About 29 per cent of the total consists of youngstock, i.e. animals age 3 years and less. Among the adult animals, the females slightly outnumber the males. More than three-fourths of the bovine population are cattle; buffaloes constitute a little under a fourth. There are significant differences in the age/sex composition of these two categories of bovines (Table 1)

Table 1

Composition of Bovine Population . India, 1972

(in millions)

	Cattle		Buffaloes		Total	
	No.	%	No.	%	No	%
Adult males	74.5	41.8	8.1	14.1	82.6	35.0
Adult females	56.4	31.6	29.2	50.9	85.6	36.3
Youngstock	47.5	26.6	20.1	35.0	67.6	28.7
Total	178.4	100.0	57.4	100.0	235.8	100.0

Source: GOI, Directorate of Economics and Statistics, Ministry of
Agriculture and Irrigation, Eleventh Livestock Census, 1972
based on final figures of 18 January, 1976 (mimeographed).

In the first place, while there are 140 males for every 100 females,
among adult cattle, there is an overwhelming predominance of females
among adult buffaloes, with less than 30 males per 100 females. Second,
cattle account for about 90 per cent of all adult male bovines while their
share in adult females is only 66 per cent. These point to (a)
the dominance of cattle as a source of draught power; and (b) the
relatively high degree of dependence on buffaloes as a source of milk.
They also suggest that, unlike in the case of cattle, farmers maintain
buffaloes primarily for milk production. Third, the proportion of
youngstock is considerably higher among buffaloes than among cattle.

Inter-State Variations

As may be expected, the density of bovine population, as well as
its composition, varies widely among the States. The extent of these
variations can be seen from Table 2. The overall density of the
bovine population relative to cropped area ranges from less than
100 per hundred hectares of gross area sown in Rajasthan to over
200 in Assam. In general, and relative to cropped area, States
with a relatively high density of human population (rural) also
tend to have a high density of bovine population. Significantly,
however, the bovine density does not increase in the same proportion
as human density. In fact the rate of increase in the former trends
to decline as the latter rises, and eventually levels off. The
density of adult males and of adult females also shows a similar
relation with human density. But there is hardly any correlation
between human density and the number of youngstock per hectare
(Table 3).

Table 3:   Relation between human and bovine densities

Adults/Males/hectare

$$0.5619 + 0.6796^* \; x - 0.0897 \; ^* \; x^2 \; 0.7521^{R^2}$$
$$(0.1242) \quad (.0177)$$

Adults females/hectare

$$0.0151 + 0.2583^* \; x - 0.0332 \; x^{^* \; 2} \; 0.5656$$
$$(0.0756) \quad (0.0108)$$

Youngstock/hectare

$$0.3083 + 0.0438 \; x - 0.0030 \; x^2 \; 0.1399$$
$$(0.0989) \quad (0.0141)$$

Total Bovines/hectare

$$-0.2149 + =.0317^* \; x - 0.1323 \; x^{^* \; 2} \; 0\text{-}6825$$
$$(0.2358) \quad (0.0337)$$

X=Rural population/ha.

Table 2

Human (Rural) and Bovine Population relative to Cropped Area : States, 1972

| STATES | Rural Population 10⁶ | Bovine Population 10⁶ | | | | Cropped area 10⁶ ha. | Density per ha. of cropped area | | | | |
		Adult Males	Adult Females	Young stock	Total		Rural Population	Adult Males	Adult Females	Young-stock	Total
Andhra Pradesh	34.99	6.83	7.73	5	19.56	12.24	2.859	.558	.632	.408	1.598
Assam	13.70	2.46	1.97	1.86	6.29	3.04	4.51	.809	.648	.612	2.069
Bihar	50.67	8.01	6.09	4.49	18.59	11.0	4.61	.728	.554	.408	1.690
Gujarat	19.18	3.09	3.86	2.96	9.92	9.91	1.935	.312	.390	.299	1.001
Karnataka	22.15	4.10	5.54	3.59	13.23	9.93	2.231	.413	.558	.361	1.332
Kerala	17.82	.62	1.46	1.25	3.33	3.01	5.92	.206	.485	.415	1.106
Madhya Pradesh	34.88	10.75	10.17	10.84	32.26	20.55	1.70	.523	.569	.527	1.57
Maharashtra	34.63	6.51	6.46	5.04	18.01	17.29	2.00	.377	.374	.292	1.042
Orissa	20.13	5.29	4.48	3.12	12.81	7.94	2.54	.666	.564	.393	1.623
Punjab/Haryana	18.46	2.69	4.88	4.58	12.15	10.68(H)	1.73	.252	.457	.429	1.138
Rajasthan	21.19	4.09	7.10	5.87	17.06	17.28	1.23	.237	.411	.340	.986
Tamil Nadu	28.65	5.04	5.14	3.24	13.42	7.55	3.79	.668	.681	.318	1.777
Uttar Pradesh	76.00	15.34	13.34	10.16	38.84	23.02	3.29	.665	.578	.440	1.684
West Bengal	33.51	5.26	4.01	3.43	12.70	7.08	4.73	.743	.566	.488	1.798

Source: Rural Population: Census 1971. Bovine Population, Livestock Census 1972.
Cropped area: 3 year average for 1970-1, 1971-2 and 1972-3.

7   A comparison of the regression of coefficients for adult males
and adult females suggests that, as population density increases, the
number of adult males per hectare tends to rise faster than that
of adult females initially,   and that, while both of them
decelerate, the degree of deceleration is greater among females.
In other words, as one moves from areas of low to high human
densities, not only does the bovine density rise, but the proportion
of adult males in the herd seems to rise and that of adult female to
fall.

8. As regards the relative importance of cattle and buffaloes, cattle
are seen to outnumber buffaloes in all States except Punjab and
Haryana; the degree of their dominance in the bovine population,
however, varies a great deal (Table 4). The ratio of cattle to
buffaloes is well below the national average in Andhra Pradesh,
Gujarat, Rajastan and Tamil Nadu, while in Assam, West, Bengal
and Orissa the ratio is much higher than average.
The dominance of cattle is generally more marked among adult males
than adult females. In general, the cattle-to-buffalo ratio
among the former is higher and is indicative of the overwhelming
                                    in most parts of the country.
role of cattle as a source of draught power Kerala, and to a much
smaller degree, Assam, Orissa and West Bengal, are exceptions
to this general pattern. In Kerala, for instance, though the cattle
population is about six times that of buffaloes, there are only
170 adult male cattle for 100 adult male buffaloes. This reflects
an unsually high mortality rate among adult male cattle, as well
as the considerably more widespread use of buffaloes for draught
purposes.

The proportion of adult females to adult males is much higher
for buffaloes than for cattle in a large majority of the States
However, in Assam, Kerala, Orissa and West Bengal the proportion of
adult males among buffaloes is considerably greater than that of adult
females. In these areas the use of buffaloes for draught purposes is
at least as important as for milk. Ecological factors might be
responsible for this: All these States happen to be areas of
relatively high rainfall with rice as the dominant crop;and buffaloes
are particularly well suited for ploughing and land preparation for
paddy cultivation under these conditions. It is also possible that
the buffaloes in these regions are of inferior breeds with relatively
low milk yields, and consequently their attraction as milch
animals is not as great as in other parts of the country.

The ratio of young stock to total population is generally higher
among buffaloes. This is true in all States except again, Assam,
Orissa, Kerala and West Bengal. Apart from the differences between
the two groups of States mentioned above, there are considerable inter-
State variations in the proport ono of youngstock both among cattle
and buffaloes. Since the number of calves born is a function of the
number of adult females, States with a relatively high proportion of
adult females may be expected to have a larger proportion of young-
stock. The correlation coefficient between these two variables is in
fact positive and significant for cattle. (0.4769 , significant at 5%)
and even more so, for buffaloes (+ 0.7255, significant at 1%).
Nevertheless, this leaves a substantial part of the observed variations

Table 4 - Composition of Bovine Population By States, 1972.

	Cattle				Buffaloes				Ration of cattle to buffaloes			Lactating efficiency		Sex ratio among young stock	
	AM	AF	YS	Total	AM	AF	YS	Total	AM	AF	Total	Cattle	buffaloes	Cattle	Buffaloe
Andhra Pradesh	43.9	33.8	22.3	100	19.0	49.6	31.4	100	4.09	1.21	1.77	42.4	59.8	92	70
Assam	45.0	31.1	23.9	100	49.1	39.9	11.0	100	11.25	11.06	14.17	60.4	53.1	102	95
Bihar	48.9	28.1	23.0	100	19.5	51.7	28.8	100	10.16	2.20	4.05	32.8	43.1	94	55
Gujarat	47.5	28.1	24.4	100	1.2	58.8	40.0	100	71.28	.89	1.86	54.8	58.4	92	20
Haryana	38.7	29.6	21.7	100	2.4	50.9	46.7	100	15.29	.57	.97	58.4	66.9	92	44
Himachal Pradesh	41.5	31.0	27.5	100	2.6	66.6	30.8	100	64.43	1.56	4.00	47.0	15.1	94	29
Jammu & Kashmir	33.5	37.2	29.7	100	10.1	58.0	31.9	100	13.78	2.68	4.77	53.1	57.5	--	--
Karnataka	37.9	37.3	25.8	100	9.5	56.0	34.5	100	12.44	2.07	3.12	46.1	59.5	94	59
Kerala	13.7	45.5	40.8	100	47.9	33.1	19.0	100	1.73	8.33	6.05	51.1	60.5	50	91
Madhya Pradesh	36.3	30.7	33.0	100	19.8	45.1	35.1	100	8.37	3.19	4.57	39.3	47.4	91	61
Maharashtra	42.2	31.1	26.7	100	9.3	56.4	34.3	100	20.15	2.45	4.45	41.9	58.4	95	44
Orissa	40.7	35.2	24.3	100	45.0	31.5	23.5	100	7.40	9.16	8.22	39.9	47.0	94	89
Punjab	41.7	27.2	31.1	100	7.2	51.3	41.5	100	5.44	.54	.89	64.0	66.6	106	46
Rajasthan	31.6	37.0	31.4	100	3.2	54.3	42.5	100	26.81	1.85	2.72	48.6	54.2	90	50
Tamil Nadu	43.9	34.6	21.5	100	13.9	52.1	34.0	100	11.40	2.46	3.71	52.2	64.1	94	73
Uttar Pradesh	52.3	25.7	22.0	100	12.9	52.3	34.8	100	8.43	1.02	2.08	47.6	57.0	110	59
West Bengal	39.9	32.0	28.1	100	63.3	24.9	11.8	100	9.08	18.57	14.42	50.9	63.0	89	83

Source: Livestock Census 1972.   AM - Adult Males   Lactating efficiency - Ratio of No. of
AF - Adult Females   Females in milk to total adult
Ys - Young Stock   females.

to be explained. The other relevant factors would be the mortality rates among youngstock, the breeding efficiency of female animals, and the rate of growth of adult stock. The first two factors, one expects, will be negatively associated with the proportion of young-stock, while the last should show a positive association.

Variations by size of holdings

11   The relation between human and bovine densities can also be seen from the variations in the pattern of bovine stock in relation to size of landholdings. Such data are available from NSS for the country as a whole relating to 1960-1, and by States for 1972. The all-India data for 1960-1 are set out in Table 5.

12   The average number of bovine stock per unit of cultivated area declines sharply as the size of holding increases. Thus holdings with less than one acre carry over six times as many bovines per unit area as holdings of 30 acres and more. Since the land man ratio is positively related to size of holdings, these data also corroborate the positive association between human and bovine densities shown by the across-State comparisons.

13.   The composition of bovine stock held by holdings below 1 acre are quite different from the rest. The proportion of adult males in the bovines owned by them is considerably smaller than the average, and that of adult females and of youngstock correspondingly larger. This pattern holds both for cattle and buffaloes. The preponderance of adult females in the very small holdings would seem to suggest

Table 5 Composition of Cattle and Buffaloe by Size Class of operation holdings, All India 1960-61.

Size Class (Acres)	Bovines per 100 acre	Cattle				Buffaloe				Adult/Male/Female		Cattle/Bovine		
		Adult Males	Adult Females	Young stock	Total	Adult Males	Adult Females	Young stock	Total	Cattle	Bovines	Adult Males	Adult Females	Total
below 0.49	270	19.4	43.8	36.8	100	12.6	58.5	28.9	100	.44	.21	.83	.71	.77
0.5 - 0.99	181	37.7	31.8	30.5	100	17.5	52.8	29.7	100	1.99	.33	.89	.67	.78
1.0 - 2.49	138	46.8	28.3	25.9	100	26.6	45.0	28.4	100	1.69	.59	.87	.69	.78
2.5 - 4.99	105	47.4	28.7	23.9	100	21.0	48.4	30.6	100	1.65	.44	.90	.72	.81
5.0 - 7.49	75	45.8	29.4	24.8	100	21.7	46.5	31.8	100	1.56	.47	.88	.69	.78
7.5 - 9.99	70	45.9	29.1	25.0	100	21.6	46.8	31.6	100	1.58	.46	.89	.70	.79
10 -12.49	66	47.7	29.3	23.0	100	19.3	47.5	33.2	100	1.62	.41	.89	.66	.76
12.5-14.99	64	44.8	29.8	25.4	100	17.7	49.0	33.3	100	1.50	.36	.89	.67	.77
15 -19.99	56	47.0	29.3	23.7	100	12.4	52.3	35.3	100	1.61	.24	.92	.64	.76
20 - 24.99	42	45.1	30.6	24.3	100	12.8	52.8	34.4	100	1.47	.24	.92	.66	.77
25 -29.99	39	45.1	30.8	24.1	100	13.6	51.0	35.4	100	1.47	.27	.91	.65	.76
30 -49.99	32	44.2	30.5	25.2	100	11.4	51.8	36.8	100	1.46	.22	.93	.65	.76
Over 50	28	42.2	31.2	23.3	100	12.7	53.3	34.0	100	1.35	.24	.92	.65	.78

Source: Cabinet Secretariat, National Sample Survey Report No.113, New Delhi, pp.79 & 97

that they concentrate more on producing milk. Beyond the one acre limit, the pattern changes: both among cattle and buffaloes the ratio of adult males shows a mildly falling trend, and that of adult females a rise as one moves up the scale of land holding. There is some indication that larger holdings have a somewhat larger proportion of buffaloes as youngstock; there is no clear trend in the proportion of youngstock among cattle.

14 The relative importance of buffaloes doesnot seem to vary much between different landholdings. However, it would appear that larger holdings tend to have a higher proportion of adult males as cattle, while the ratio of cattle to buffaloes among adult females seems negatively correlated to size of holding. Larger holdings apparently depend to a greater extent on buffaloes as a source of milk. The ratio of cattle youngstock to total youngstock also seems to be the lower in larger holdings, though the relationship is less pronounced, and more erratic, in the adult female category. But since the cattle-buffaloe ratio is highly variable between regions, one should be cautious in drawing conclusions from all-India data.

Trends in total population

15 The total bovine population has risen by about 19 per cent over the last 2 decades (Table 6); Most of this increase however took place during the fifties, especially between 1956 and 1961. (The reasons for the exceptionally large increase in the latter period need to be examined). Since 1961, the population has risen by barely 4 per cent, most of it between 1966 and 1972. The adult male and youngstock popula-

Table-6

Trends in Bovine Population, All India, 1951-1972

(Nos. in millions)

		1951	1956	1961	1966	1972	% change 1956/51	1961/56	1966/61	1972/66
Adult Males										
	C	61.87	64.87	72.53	73.32	74.49	4.85	11.2	1.1	1.6
	B	6.78	6.51	7.68	8.20	8.07	-4.0	18.0	6.8	-1.6
	T	68.65	71.38	80.21	81.52	82.56	4.0	12.4	1.6	1.3
Adult Females										
	C	49.87	49.93	54.20	54.68	56.40	0.1	8.6	0.9	3.1
	B	21.86	22.35	25.02	26.16	29.24	2.2	11.9	4.6	11.8
	T	71.73	72.28	79.22	80.84	85.64	0.8	9.6	210	5.9
Youngstock										
	C	43.58	43.81	48.83	48.05	47.49	0.5	11.5	-1.6	-1.2
	B	14.76	16.09	18.50	18.59	20.12	9.0	15.0	0.5	8.2
	T	58.34	59.90	67.33	66.64	67.61	2.7	12.4	-1.0	1.5
Total										
	C	155.26	158.67	175.62	176.06	178.38	2.2	10.6	0.3	1.3
	B	43.40	44.95	51.20	52.92	57.43	3.6	13.9	3.3	8.5
	T	198.69	203.61	226.82	228.98	235.81	2.5	11.4	0.95	2.98

Source: Livestock Census

C = Cattle

B.= Buffaloes

T = Total

tion seems to have grown considerably faster than adult female during fifties. In the sixties, while there was hardly any rise in the former two categories, the number of adult females continued to grow.

16   Throughout the period, the population of buffaloes has consistently grown faster than that of cattle, the difference being most marked in the adult female and the youngstock categories. Significantly, and in sharp contrast with buffaloes, cattle youngstock population has been declining in absolute terms during the last decade inspite of the reduction in mortality rates. The decline is especially marked among male youngstock and presages a reduction in the number of adult male buffalo population is rather erratic. After declining some 5 per cent between 1951 and 1956, it rose sharply in the subsequent decade, but fell again during 1966-1972.

17   The steady rise in the ratio of buffaloes to cattle among adult female shows that farmers have been progressively shifting to buffaloes as a source of milk. In 1951, there were 44 adult female buffaloes for every 100 adult cows; by 1972, the ratio had risen to 52. The lactating efficiency of cattle seems to have remained remarkably stable; that of buffaloes rose sharply between 1951 and 1956, fell in subsequent decade and despite a recovery in 1972, still remain well below the 1956 level (Table 7)

Table-7

Trends in Adult Female Bovine Population
All India, 1951-1972

	1951	1956	1961	1966	1972
Breeding Cattle					
Total	46.38	47.26	51.00	51.76	54.42
In milk	18.97	20.10	20.67	20.97	22.04
Per cent	40.9	42.5	40.5	40.5	40.5
Breeding Buffaloes					
Total	21.01	21.69	24.24	25.52	28.51
InMilk	10.22	11.82	12.46	15.92	15.07
Per cent	48.6	54.4	51.4	50.6	52.9
Ratio of breeding cattle to buffaloes	2.28	2.18	2.10	2.02	1.92

Changes in Land holding classes

18. Some idea of the behaviour of bovine stock, overall and by major categories, by size class of holding is available from the National Sample Survey for 1961 and 1972. The data are summarised in Table 8 Changes in total bovine population, and its major components, obtained from the NSS data are broadly in accord with Livestock Census data: Between 1961 and 1972, there has been a marginal increase in both adult males and adult females, but hardly any change in youngstock population. The increase in adult female population is however, less than in the Livestock Census.

19. The data show total bovine population per household as well as that of adult males, adult females and youngstock, have declined in practically all land holding classes. In the very small holding (with less than 0.2 hectares) there has been a rise in the total bovines and adult males. There was also an exceptionally large change in the 0.4 to 1.00 hectare group in all categories. (This is so much at odds with the general pattern and the numbers for 1972 are so implausibly large as to raise doubts on the accuracy of this estimate.) In the remaining groups, it seems that the decline in total bovine stock and of adult females per household has been somewhat greater than average in the larger holding households, and lower than average among the smaller holdings. But the extent of decline in adult females and youngstock bears no relationship at all to size of holding.[1]

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1. In so far as averages for particular land holding classes are subject to larger margins of error than the average for the sample as a whole, all these conclusions should be treated cautiously.

Table 8 - Size and Composition of Bovine stock per 100 households by size class of operational holdings in Rural areas, 1961-62 and 1970-72.

Size class (in acres)	Total Bovines 1961-2	1972	Adult Males 1961-2	1971-2	Adult Females 1961-2	1972	Youngstock 1961-2	1972	Ratio of cattles to buffaloes 1961-2	1972
0.01 - 0.49	66.30	73.80	12.72	21.58	29.94	29.35	23.64	22.87	2.79	4.66
0.50 - 0.99	159.83	153.00	58.36	58.04	60.40	58.19	41.07	36.77	3.53	4.27
1.00 - 1.24	247.63	189.74	108.80	78.71	81.92	69.56	56.91	41.47	3.81	3.74
1.25 - 2.49		2520.54		1186.79		792.84		540.91		4.30
2.50 - 4.99	364.81	365.70	161.89	164.70	117.74	141.37	85.18	81.71	4.21	3.59
5.00 - 7.49	500.69	475.10	208.08	200.91	173.19	158.20	119.42	115.99	3.91	3.79
7.50 - 9.99	580.17	540.93	235.46	230.76	191.10	186.06	153.61	123.41	3.57	3.37
10.00 - 12.49	627.22	621.82	255.13	246.46	217.29	225.47	154.30	149.89	3.35	3.18
12.50 - 14.99	724.06	677.65	276.28	262.07	255.01	253.07	192.72	162.51	3.45	3.18
15.00 - 19.99	787.16	721.55	304.80	282.96	276.09	267.09	206.27	171.50	3.20	3.36
20.00 - 24.99	841.72	777.46	317.74	294.80	305.97	288.77	218.01	203.89	3.41	2.99
25.00 - 29.99	931.21	907.85	340.28	342.15	345.23	329.66	2450.70	236.04	3.07	3.42
30.00 - 49.99	1131.71	1003.15	460.48	376.83	385.86	372.20	263.09	254.06	2.45	3.26
Over 50	1636.19	1401.42	603.21	528.04	603.00	529.61	429.98	343.77	2.92	3.35
All sizes	307.64	278.22	121.61	111.94	107.62	98.86	78.41	67.43	3.51	3.47

Source: 1961-62, GOI, Cabinet Secretariat, National Sample Survey. Report No.144
Tables with notes on some Aspects of Land Holdings in Rural Areas, 17th Round September 1961 - July 1962, (Delhi, 1961)
1971-72, GOI, Department of Statistics, National Sample Survey Number 215, 26th Round, July 1971 September 1972, Tables on Holdings, All India, (February 1976).

20   The overall decline in cattle to buffalo ratio is largely concentrated
in the middle size holdings (from 1.00 to 10 hectares); holdings below
one hectare, and those above 10 hectares appear to have substantially
increased the share of cattle in their bovinestock. There is also a
pattern to the improvement in breeding efficiency. There has been
hardly any improvement in the small holdings; the extent of improvement
seems to increase with the size of holdings till about 10-12 hectares,
before tapering off in the largest 2-3 landholding class. A more
disaggregated state-wise analysis of the change in the pattern of bovine
stock by different classes of holdings would help understand whether
the patterns revealed by the all-India data are widespread or whether
they reflect shifts in the spatial distribution of bovinestock.

III

The Pattern of Mortality

21.   A closer examination of the sex composition of youngstock (see table 5)
reveals some rather puzzling features. Since the rearing of bovines
from birth to adulthood involves substantial costs, one would expect
the marked plurality of male cattle at the adult stage, and of
females among buffaloes, to be reflected in the sex ratios of young-
stock as well. This is indeed the case for buffaloes whose sex ratio
(mal s per hundred females) is below 100 in all three age groups for
which data are available and declines steadily from 0-1 to the 3+
age group. (Table 9) The latter suggests that the sex ratios are
progresively adjusted from birth to adulthood to achieve the desired
sex distribution of adult stock. The behaviour of sex ratios among

Table - 9

Sex Composition of Cattle and Buffaloes
in Different Age groups
All India, 1966

	Cattle			Buffaloes		
	0-1	1-3	3+	0-1	1-3	3+
Males (millions)	11.2	12.1	73.3	4.0	2.4	8.2
Females (millions)	11.1	13.6	54.7	5.9	6.3	24.1
Males/100 Females	100.7	89.6	136.2	67	39	32

Source:- G O I, Ministry of Agriculture, Diredtorate of Economics
and statistics, Indian Livestock Census, 1966, Vol. II
Detailed Tables, Part I, (mimeo. 1972)

cattle across age groups is very different and seems to be erratic.
The sex ratio is close to 100 in 0-1 age group, declines substantially
in the 1-3 age groups, before shooting up to over 1300 among the
adult animals. Prima facie, it is difficult to see why the sex
ratio among young cattle should be so far out of line, not just
in magnitude but directionally as well, with the ratio among adult
stock.

This pattern seems to prevail in most parts of India. It will be
seen from Table 10 that in most States, as in all-India, survival rates
of buffaloes calves from birth to age 1 and then on to adulthood,,
are considerably less than those of cattle. Most states also conform to
the all -India pattern in that, the survival rate for cattle calves
through the first year of birth are roughly the same for both males
and females, the major excertion being Gujarat and Kerala. Again,
in most States, as in all India, more females aged one year survive
to adulthood than males of the same age even though males are
predominant in the adult population. The significant exceptions to this
pattern are Gujarat, Punjab and Uttar Pradesh. In all these
cases, fewer females calves survive to adulthood compared to males
and this pattern is consistent with the observed sex ratios among
adults. In Kerala, again, the relative survival rates of male and
female cattle through the young age is consistent with the sex ratio
of adult stock. The deviations from the all-India pattern are
fewer in the case of buffaloes: In most cases the relative survival
rates in the young ages are consistent with the observed sex ratios
of adult stock which generally show a marked plurality of females.

Survival Rates of young Bovine Stock by States, 1966

| STATES | Cattle | | | Buffaloes | | | | |
| | 0-1 | | 1-3 | 0-1 | | 1-3 | | |
	Male	Female	Male	Female	Male	Female	Male	Female
Andhra Pradesh	.976	1.000	.472	.530	.601	.869	.227	.360
Assam	1.000	.931	.388	.437	.985	.932	.409	.451
Bihar	.943	1.000	.612	.752	.821	.997	.292	.594
Gujarat	1.000	.837	.581	.553	0.300	.963	.073	.580
Haryana	1.000	.906	.375	.504	.673	1.000	0.001	.572
Jammu & Kashmir	0.967	1.000	0.630	.629	.385	.860	.135	.461
Kerala	0.692	1.000	.245	.594	.514	.616	.372	.303
Madhya Pradesh	0.982	.996	.783	.962	.689	.873	.400	.706
Maharashtra	0.984	.988	.600	.633	.437	.750	.150	.386
Mysore	1.000	.986	.446	.494	.520	.805	.143	.322
Orissa	1.000	0.987	.490	.514	1.000	.944	.443	.492
Punjab	1.000	.998	.567	.533	.579	.865	.130	.565
Rajastan	0.993	.948	.497	.717	.708	.999	.214	.709
Tamil Nadu	.999	1.000	.455	.461	.695	.840	.203	.297
Uttarpradesh	1.000	.990	0.461	.424	.629	.987	.143	.372
West Bengal	.936	1.000	0.570	.508	.712	.737	.292	.345

Note: Computed from livestock Census data for 1966 using the same assumption as for all-India (See Table 3). In the case of cattle, the number of calves in C-1 group exceeds the number of cows in milk in most States. Therefore, the calculations are based on the number of males or females in 0-1 group, which ever is higher.

In the case of buffaloes, the number of calves born is, in all states except Orissa, taken as equal to the number of females in milk. In Orissa since the population below 1 year is greater than buffaloes in milk, the number of males below 1 year is taken as the starting point.

23.   Relative mortality rates, and therefore   sex ratios, follow this
        general pattern throughout the last 2 decades, with indications of some
        secular trends. (Table 11) Among cattle there has been a steady
        decline in the number of male to female calves below 1 year
        suggesting that the mortality rate of females has fallen relatively
        to that of males. The mortality rates in the 1-3 age group seems to
        have fallen for both sexes, but the fall is considerably greater and
        more sustained among females. While the number of males per female
        in the 0-3 group has steadily fallen between 1951 and 1966 (the
        data for 1972 are not yet available), the ratio has moved in
        the opposite direction among adult cattle. The apparently odd
        pattern of mortality as between sexes of cattle at different ages
        has been intensified over time.

24.   Among buffaloes, there has been some decline in the number of males
        per female in the 0-1 age group suggesting that a rise in male morta-
        lity in the first year of birth relative to female mortality. Female
        mortality has definitely fallen in the 1-3 age group; the decline
        of mortality among adult males is less pronounced and apparently
        not sustained. As a result, the sex ratio in this group moves
        rather erratically from census to census. In the adult age group,
        there was a slight rise in the number of males per female between
        1956 and 1966, but the ratio has since fallen rather sharply.

Table-11

Trends in Sex Ratio of Cattle and Buffaloes by Age Group
All India, 1951-1972

		1951	1956	1961	1966	1972
Cattle						
Sex Ratio	0-1	104.8	103.2	101.2	100.7	n.a.
	1-3	97.8	95.9	90.3	89.6	n.a.
	3+	124	131.8	135.6	136.2	132.1
Mortality Rate						
	1-3 Male	n.a.	.547	.441	.443	n.a.
	Female	n.a.	.423	.381	.378	n.a.
Buffaloes						
Sex Ratio	0-1	68.6	68.6	69.7	67.5	n.a.
	1-3	45.2	37.9	41.1	38.7	n.a.
	3+	31.0	29.9	31.5	32.3	27.6
Mortality Rate						
	1-3 Male	n.a.	.820	.790	.802	n.a.
	Female	n.a.	.524	.489	.488	n.a.

Source: Livestock Censuses.

Sex Ratio is defined as number of males per 100 females.

Assuming that at birth there is an approximate parity between

males and females, changes in sex ratios across age groups are

essentially a reflection of differential mortality (whether due

to natural causes or to slaughter). We have made rough calculations

of the average mortality rates in 0-1 and 1-3 age group on the

basis of data from the 1966 livestock Census. (Table 12) They

show that in both age groups, the overall mortality rate is much

higher for buffaloes than for cattle. It seems unlikely that this

is due to greater natural susceptibility of young buffaloes to

fatal infection and disease than cattle; more likely, it is a

reflection f delib rately greater neglect of buffaloe youngstock

by farmers. Of greater significance from the view point of the sex

ratio is the differential mortality of males and females. In the

case of buffaloes, the rate of male mortality is higher than that

for females in both age groups, the difference being particularly

pronounced in the first year of birth. In the case of cattle,

there seems to be little difference between the mortality rates of

the two sexes in the first year of their life. But between 1 and

3 years of age, the mortality rate among males is significantly

higher than among females. It seems highly implausible that this

change in the mortality pattern between 0-1 and 1-3 age groups could

be the result of any natural factors. If, on the othr hand, it

is the result of deliberate decision on the part of farmer, it

seems rather odd that they should let fewer males survive to adulthood

relative to females, when at the adult stage they have to carry

a lot more males than females.

Table-12

Rough Estimates of Survival Rates of Cattle
and Buffaloes in different age groups, All
India, 1966

		Cattle	Buffaloes
0-1	Male	1.0	.615
	Female	0.994	.912
1-3	Male	0.557	.198
	Female	0.622	.512

Assumption:

1. The number of calves born in any census year equal to twice the number of male and of female calves in the 0-1 age group or the number of breeding females in milk whichever is higher.

2. Number of calves born in the inter-censal years estimated by linear interpolation.

3. Mortality rate in the 0-1 age group does not change over time.

4. Surviving calves of 1-3 years age in year $t(pt-3)$ should have born in $t-1$ and t_{-2}

   Survival rate $= pt \dfrac{(1-3)}{b^o_{t-1} + b^o_{t-2}}$

Where, b^o refers to the number of calves born in year t.

Notes: a. Since the number of calves in 0-1 exceeds the number of breeding cattle in milk, we have taken the number of male calves in this age group as the basis for survival rate calculates.

   b. In the case of buffaloes, since the number of calves in 0-1 is very much lower than the number of breeding females in milk, the number of calves born is assumed to be equal to the latter, and divided evenly between male and female. Note that these are only crude approximations of the number of calves born.

26.   It is possible that the observed sex ratio at the adult stage
      does not reflect famer's perference so much as the differential
      mortality rates of the sexes at different stages of adulthoold.
      There is indeed some indication that the mortality rates of adult
      males and females follow divergent patterns. Dandekar has
      estimated (See Table 13) on the basis of data collect in 1950-51
      that, among adult cattle, females have a consistently higher
      mortality rate than males and that the difference increases
      sharply within age. Thus between 3 and 6 years, the average mortality rate
      for females is some o 40 per cent higher than for males; in the
      6-8 age group, it is over 300 per cent. Thereafter, the mortality
      rates of the two sexes seem to converge rapidly. By contrast,
      the mortality rate among adult buffaloes is consistently higher
      for males, the difference reaching a maximum inthe 5-6 age group,
      falling off quite rapidly thereafter.

27.   Since there is no strong reason to believe that the adult female
      cattle is inherently more prone to disease and death than the
      buffalo or the male cattle, the differential mortality pattern
      can only be explained in terms of differential care and attention
      given to different categories of animals. Dandekar's estimates
      suggest that the mortality rate among females cattle is not very
      different from that for female buffaloes in the 3-6 age group;
      but thereafter former rises sharply while the latter shows but a
      marginal rise till about 9 years. Neglect of the cow, which
      usually takes the form of indifferent or inadequate feeding and

Table-13

Annual death rate of cattle and buffaloes at different ages: All India, 1950-51

(Average death rate per 000 animals)

Age group	Cattle			Buffaloes		
	Bullocks	Cows	Calves	He-Buffaloes	She-buffaloes	Calves
Below 1			263.2			386.5
1-2			84.5			194.7
2-3			55.2			154.8
3-4	60.9	85.9		149.3	83.2	
4-5	60.9	85.9		149.3	83.2	
5-6	60.9	85.9		198.7	74.9	
6-7	41.0	94.1		151.8	88.6	
7-8	26.6	94.1		151.8	88.6	
8-9	26.6	126.0		151.8	88.6	
over 9	128.6	174.0		164.4	136.4	

Source: Dandekar V.M., Second Report on the Poona Schedule of the National Sample Survey, 1950-51, (Poona,1954) P.67.

Note: 1. The basis for these estimates are explained thus:

"Data on distribution by age of different animals as well as on deaths and slaughter in four weeks prior to the interview were collected. The latter related to the former gives four weekly death rates in different age groups. In order to derive annual death rates from the above data, the following procedure was adopted for the age groups 0-1 and 1-2: For the age group 0-1, the weekly death rates for successive 13 periods were obtained from the four weekly death rates for 0-1 and 1-2 (namely, 35.7 and 8.6 for cattle) by taking weighted averages, the weights being 13, 0; 1, 72; 2, 11; .... 12, 1. These death rates were then successively applied to survivals at the end of each to get annual death rates of the 0-1. This measures the proportion of calves below 1 year age which will die in the course of the year." (This is rather different from infant mortality rate as usually measured namely, the number of live-born calves which live to year 1) The death rate for 1-2 is derived on the basis of four weekly death rates for this age group successively 13 times to the survivals at the end of each four weekly period.(p.63)

2. The above estimates of mortality are based on sample data on age distribution which seem defective, especially in the young age groups; the ratio of youngstock aged less than one year to those of 1-3 years age derived from the Gohkale Institute data is much less than obtained from Livestock Census and subsequent NSS Reports. Also on the basis of data on birth rates given on PP 75-76 of the report, and the data on the population in the 0-1 age group, the infant mortality rates would seem to be very much higher than shown in the above table.

and makes it difficult for the animal to withstand the stresses of successive pregnancies, seems to become pronounced after the second lactation. Clearly at this stage the bullock is given much greater care and attention. One has to probe deeper into the reasons for this apparent difference in the care of cows and bullocks. Perhaps the milk yields of cow drops off sharply after the second/third lactation; perhaps the calving interval and/or the dry period increases with the age of the animal; perhaps the lack of specialisation across land holding classes intensifies the competition for limited feed resources in the smaller farms thus forcing them to choose the bullock in preference to the cow. As between the cow and the she-buffaloe, it is possible that the latter receives greater care partly because of it is more valuable as a milk animal and also because its biological character demands more careful attention. All this is, however, speculative and, even if true, still does not explain why farmer should not take better care of the young male cattle. For by reducing the male mortality rate in the 1-3 age group, the farmer in fact can make do, as far as reproductive function is concerned, with fewer cows than at present. This whole question needs to studied in greater depth using more recent data.

Draught Animals

28 At the time of the Livestock census of 1972, there were about 83
million working bovines in the country: 75 million of them were
cattle, the remain being buffaloes. Almost all (97 percent) of
working animals in both categories were males.[1] The number of
adult male bovines therefore provides a close approximation to the
size of the draught animal population.

29 The number of draught animals per hectare of cropped area varies a
great deal across states, as well as between land holdings of different
size. In general, states with relatively high density of rural popu-
lation relative to cropped area also tend to have more draught animals
per unit area; but the rate of increase in the latter falls off as one
moves up the scale of human density. The relation is much the same
when we view the dis-tribution of human and draught animal population
by size of holdings. These are summarised by the following regression
equation.

1. State Gross Section[a] 1972 $Y_1 = 0.5619 + 0.6796 \, X_1^* - 0.0697 \, X_1^2$
$$(R^2 = 0.75)$$

[a] State Regressions based on Population and Livestock Census Data

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[1] There were 2.1 million working cows and 0.4 million working she
buffaloes. The use of female cattle for work seems to be pronounced
in the three Southern States of AP, Karnataka and Tamil Nadu. They
accounted for over half of the total number of working cows in the
country. In all these States the ratio of working cows to working
cattle was considerably higher than the national average and reaches
a high 12 percent in Tamil Nadu.

3. Landholding [b/]
   Cross Section   1972 $Y_1 = .292201 + .157353^* X_2 - .002299^* X_2^2$

$$(.013925) \quad (.000266)$$

$$(R^2 = .95)$$

Notes: $Y_{1,2}$ = Adult Male bovines per hectare of cropped (operated) area; X_1 = Population per hectare of cropped area; X_2 = No. of persons per hectare of operated area in different size classes.

[b/] Based on NSS 26th round data

30. The more densely populated regions, like the relatively small holdings, are generally also areas where natural factors like soil and climate, and or the availability of man-made irrigation facilities permit intensive cropping involving higher inputs of both human and animal power. Over most of India, the soil is so hardened by prolonged dry spell and high temperatures of the summer that the preparation of land for sowing cannot be done by human labour alone. The use of animals or machines is indispensable. Animals are also used in other agricultural operations (like weeding and inter culture) as well as in transportation of inputs and outputs. Clearly more intensive cultivation is associated with larger input of human labour; but it is not obvious that there is any strong or inevitable technological reason compelling a higher level of animal power input along with higher human labour input. Animal power can be substituted by machines over practically the whole range of operations; and there is scope for using human labour in at least some of the operations currently being done by animals. In parts of Kerala where adequate pre-sowing rainfall is available, even land preparation is done wholly by human labour.[1] Thus one has to look for a complex of factors to explain the observed variations in the extent of draught

[1] This is one of the interesting findings of a survey conducted by Gangadhara Nair. He also found a well-developed bullock breeding system.

animal power in relation to cropped area.

31 The fact that more intensive cultivation generally associated, in
India, with relatively high population densities and small holdings—
may require a relatively high input of animal power does not explain why
small farms and farms in densely settled areas should carry relatively
large stock of draught animals per unit area. The usual explanation
in terms of the indivisibility of animal units is not wholly convincing
because this limitation can be, in principle, overcome by a system of
leasing of animal services. In fact if , as seems to be the case, the
available stock of animals is in excess of the requirements during the
critical periods, or periods of peak demand,[1] a leasing system should
lead to greater efficiency in the sense of meeting all the demand for
animal labour with a smaller stock of animals. The potential gain from
leasing or sharing is likely to be the greater because smaller farms
tend to use the draught animals less intensively.

32 As a matter of fact, however, the extent of leasing seems quite limited:
The ratio of hired to total bullock labour was less than 5 percent in
the Punjab and Orissa, 10 percent in Madhya Pradesh, and 10 percent
in Madras.[2] This is the more surprising because some recent surveys r
report that a sizeable proportion of farmers, especially those with
very small holdings, do not have any working bovines. Thus, the
NSS reports that in 1971-72, about a third of the rural households .

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[1] Farm Management Survey data show that bullocks are unemployed for
upwards of 40 percent of available time even during the peak season:
For instance in Orissa bullocks were employed only 57% of the time
in June-July (the peak season for that state); 60% of the time in
Gujarat (May) and 50-60% in Uttar Pradesh (April-May and October).
These data are all from surveys conducted in the mid-fifties.

[2] Figures relate to mid-fifties.

operating land did not have any working bovines; and 65 percent of farms with less than 0.40 hectares did not have any working bovines.[1]

The absence of well developed lease market could be an indication that the critical period when animal power is imperative may be much shorter than a month and that average utilisation rate over a month or two does not give a correct picture of the conditions during the critical season. If this were so, and the penalty in terms of loss of output of not getting the animals at the right time is large, the willingness farmers to carry an apparently excessive stock of draught animals, operated for only a fraction of the time, may be more explainable.

33 Since, prima facie animals and machines are substitutable, one would expect that as the intensity of machine input per unit area increases that of animal power per unit will fall. We tested this hypothesis as well as the relation between holding size and draught animal stock per hectare[2] on the data from the livestock census in respect of a

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[1] The proportion of households operating land but not owning any working bullocks or buffaloes varies widely. : It is around 15 percent in Punjab, 40-50 percent in AP, Karnataka and Tamil Nadu and close to 90 percent in Kerala.

[2] This is meant as a rough test of the indivisibility hypothesis. If, for whatever reason, farmers wish to hold some draught animals irrespective of size and given that these animals are indivisible units the no. of animals per hectare should increase as the holding size decreases. In this regression, the no. of animals in each size class of holdings were averaged over all holdings in that class (including those without any work animals). Since the proportion not owning any work animals is inversely related to holding size, this introduces a systematic bias in the estimated relations.

cross-section of states in 1961 and 1971) as well as on NSS data (in respect of a crosssection of holdings of different sizes for all India and for a few states). The only significant variable explaining the variations in draught animals per hectare, and that too not consistently, was the average size of holding. The coefficients for mechanical power had mostly the expected negative sign but were statistically insignificant in the inter-state cross-section as well as across land holding classes for all India and in three out of the five States for which the latter were tried.(Table 14)

34. Over time also, the relation between mechanical and animal power in agriculture remain clouded: At the all India level, the stock of the adult male bovines, has grown considerably slower than cropped areas consequently (except during 1951-56,) the number of adult male bovine per hectare of cropped area has been consistently falling; Over the same period there was a sharp rise in the quantum of mechanical power per hectare (Table 15) At first sight this would seem consistent with the hypothesis that animal power per hectare is being substituted with mechanical power mostly for irrigation and to a lesser degree for land preparation and, perhaps, transport.

35. But this neat picture withdraws when we look at State level data of the five selected States, all show a rapid and sustained rise in mechanical power per hectare, but only three recorded of decrease in the number of draught animals per unit area (Table 15). The latter

Table 14 Relation between Drought Animals per hectare (Y)
Average holding size (X$_1$) and Mechanical Power per
hectare (X$_2$)

All India

State Cross Section $Y = 139.07 - 26.8X_1^* - .066X_2 \quad (R^2 = .777)$

$(4.64) \quad (.321)$

Landholding classes: States

Punjab $\text{Log } Y = 4.95 - .069X_1^* - .883X_2^* \quad (R^2 = .90)$

$(.013) \quad (.405)$

Kerala $Y = 42.357 - 1.286 X_1 + 3.971X_2 \quad (R^2 = .250)$

$(.954) \quad (10.897)$

Karnataka $Y = 111.569 - 4.299 X_1^* - 297.302X^{**} \quad (R^2 = .561)$

$(1.27) \quad (152.82)$

Andhra Pradesh $\text{Log } Y = 4.434 - 0.056 X_1^* + .832X_2 \quad (R^2 = .548)$

$(.016) \quad (3.904)$

Tamil Nadu $Y = 231.26 - 2.527X_1 - 334.26X_2^* \quad (R^2 = .623)$

$(2.486) \quad (115.691)$

Sources: The data underlying these regressions are all from
the NSS, 26th round land holding survey.

Note: We tried 3 functional forms in all cases, namely linear,
semi-log and log linear. In general the R is lowest in
the linear from and largest in the log linear form. But
as a rule the change in functional form seems to increase
the value of the coefficient for landholding size, but
not that of the mechanical power which remains insignificant
except in a few cases. But in the case of Punjab either
coefficient for the linear from is significant, but both
are significant in the semi log form. In the case of AP;
both coefficients are insignificant in the linear form,
but one of the coefficients is significant in the semi
log form.

* Significant at 5%

Table- 15

Trends in animal and Mechanical power
Used in Agriculture, All-India, 1951-1972

	1951	1956	1961	1966	1972
Number of working animals 1/ (million)	67.3	70.7	80.4	81.4	82
Gross Sown area 2/ (10⁶ ha.)	127.9	145.7	155.2	158	164
Number of tractors (000)	8.6	17.73	27.3	54	148
Number of pumpsets (000)	108.6	169.2	300.1	686.	3176
Number of cane crushers (000)	21.3	23.3	33.3	45	87
Total House power3/ (000)	782	1227	2527	5465	18535
Working animals/ha	.526	.485	.518	.515	.500
Mechanical power (hp/ha)	.006	.008	.016	.035	.113

1. Including working adult females, and, hence not strictly equal to adult males.

2. Three year average centre around year at head of each column.

3. Assuming that a tractor has an average power of 15 hp. and all other equipment 5 hop. each.

Source: Livestock Census data.

index behaves quite erratically in Andhra while in Karnataka it has
shown a sustained rise from 1956 to 1972. And there is obviously
no consistent between the rate of increase in mechanical power per
hectare and the rate of change of draught animal per hectare.

Table 17

Trends in draught animal and mechanical
power in HP per ha. of cropped area,
Selected States, 1956-1972

	1956	1961	1966	1972
Andhra Pradesh				
Draught Animal	.469	.552	.548	.586
Mechanicall Power	.023	.025	.047	.116
Karnataka				
Draught animals	.369	.387	.391	.411
Mechanical power	.007	.013	.032	.113
Kerala				
Draught animals	.383	.355	.297	.206
Mechanical power	.009	.015	.027	.054
Tamil Nadu				
Draught animals	.679	.817	.783	.708
Mechanical power	.042	.102	.254	.402
Punjab				
Draught animals	.276	.282	.266	.245
Mechanical power	.013	.022	.048	.291

Notes: Computed from Livestock Census data. Draught animals include
working male and female animals: in computing the mechanical
power, we have taken the no. of pumpsets, power operated cane
crushers and Tractors and assumed the average horsepower per
unit of equipment and at 5 HP per pumpset and crush and 15 HP
per tractor. The per hectare calculations are based on the 3
year averages of gross sown area in each State centred around
each year indicated at the head of the column.

Milch Animals

.36 As noted earlier, the total number of adult female bovines relative to crop area is positively associated with the human population density; small holdings, which on the average have less land per capita than larger holdings, tend to carry on larger number of adult female bovines per unit area; and, during the last decade, the adult female population seems to have grown rather faster than the total. It is, however, difficult to interpret, and even more so to explain, the significance of the variations in numbers and density unless we also take account the variations in productivity of female animals in their dual role as producers of milk and of calves.

37 The reproductive efficiency of bovines, measured by the number of adult female stock required to meet a given demand for calves, depends on the age at first calving and the interval between successive calvings: The lower the age at first calving and the smaller the inter-calving interval, the greater the reproductive efficiency. The productivity of milk, on the other hand, is a function of the inter-calving interval, the length of lactation and the average daily yield per animal in milk. Nationwide data on inter-calving intervals are not readily available. But we do have considerable data on the proportion of adult females which are in milk[1] as well as on the average milk yields. These, set out in Table 17, show that (a) both in terms of lactating efficiency and of milk yields, the buffaloe is consistently

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[1] This index which we have called Lactating efficiency, approximates the ratio of lactation length to calving interval. Differences in reproductive efficiency are thus partially reflected in this index.

Table-17

Productive Efficiency of Cows and Buffaloes, all
India and States

State	Year	Cows		Buffaloes		Density of human populati- on. *
		Proportion in milk	Average daily yield kg.	Proportion in milk	Avera- ge dai- ly yield kg.	
Andhra Pradesh	1966-67	33	0.79	52	1.40	2.86
Bihar	1965.66	43	1.23	51	3.19	4.61
Gujarat	1963-64	46	1.67	61	3.08	1.94
Kerala	1964-65	45	1.11	59	2.01	5.92
Madhya Pradesh	1966-67	35	0.51	40	1.77	1.70
Tamil Nadu	1965-66	43	1.22	53	1.96	3.79
Maharash- tra	1964-65	32	0.61	53	2.26	2.00
Mysore	1965-66	46	0.72	51	1.32	2.23
Orissa	1960-61	42	0.50	n.a	n.a.	2.54
Punjab	1966-67	54	2.28	62	3.99	1.73
Rajastan	1962-65	34	2.12	52	3.02	1.23
East U.P.	1962-63	33	0.62	46	1.91	3.29 **

Source: Daroga Singh et.al, Monograph on estimates of milk Production,
Indian Council of Agriculture Research, New Delhi(undated),
pages, 16 and 21. Average milk yield relates to yield per
animal in milk.

* Rural population per ha of cropped area, 1972

** Relates to U.P.

superior to the cow, though the degree of superiority is by no means uniform; and (b) both indices of productivity for cows and buffaloes taken separately vary a great deal across states.

38 Livestock census data also show that the buffalo is more efficient in terms of the proportion of breeding females which are in milk in practically all states. This difference between cows and buffaloe has persisted throughout the last two decades and in fact seems to be somewhat greater now compared to 1951. Excluding 1956 (which shows an abnormal change from 1951) there would appear to be hardly any change in the proportion by cows which are lactating while there is some rise in the ratio for buffaloes. The patterns shows much variation between states: Again excluding 1956, the lactating efficiency of the cow seems in contrast to the all India pattern, to have increased appreciably at any rate in the southern states and Punjab. The index for buffalos shows, as in all India, a rise though of varying degrees. It is also apparent that the sustained reduction in the ratio of cows to she buffaloes observed at the all India level, has not occured in all parts of the country. While the reduction is marked in the Punjab, the ratio shows hardly any change in Andhra, and has actually increased in Kerala and Tamil Nadu. (Table 18).

indices of
39 In an attempt to explain the inter-state variations in the/efficiency of milch animals, we examined the relation between them and the extent
that
of human population pressure on land. One might expect/the less densely populated areas can afford to feed the animals better and, to the extent better feeding reduces the inter-calving interval and, or increases

Table: 18 : Trends in Ratio of Breeding Cattle to Breeding Buffaloes, India and selected states 1951 to 1972

		1951	1956	1961	1966	1972
Andhra Pradesh	a	1.29	1.26	1.20	1.23	1.21
	b	30.6	40.8	30.8	33.7	35.8
	c	47.2	57.2	50.0	49.6	53.3
Karnataka	a	2.70	2.94	1.89	1.87	2.07
	b	36.6	40.7	36.6	39.1	40.8
	c	43.0	54.2	47.4	50.1	54.7
Kerala	a	7.92	7.78	9.03	9.38	8.33
	b	35.6	40.7	37.6	39.9	47.1
	c	46.7	48.8	46.8	51.9	56.1
Tamil Nadu	a	1.85	1.92	2.42	2.32	2.46
	b	38.7	42.7	42.3	41.9	46.0
	c	51.2	56.1	54.3	55.9	58.4
Punjab	a	.91	.84	.74	.57	.55
	b	58.9	59.7	58.0	58.8	61.3
	c	55.4	62.0	55.4	57.9	64.7
All India	a	2.28	2.18	2.10	2.02	1.93
	b	40.9	42.5	40.5	40.5	40.5
	c	48.6	54.4	51.4	50.6	52.9

a = No. of breeding cows per breeding buffalo

b = Proportion of breeding cows in milk

c = Proportion of breeding buffaloes in milk

Source: Livestock Census Reports for various years

lactation period, this would imply that the ratio of animals in milk to total breeding females as well as average milk yields should be higher in such areas. As a matter of fact, however, there is no systematic relation between productive efficiency (defined as above) of either cattle or buffaloes on the one hand and population density on

the other. Nor is there a significant relation between population density and average milk yields.[1] This could well be a reflection of the defects in the data and, in particular, the inadequacy of cropped area per capita as a measure of relative pressure of population on land. Since land quality across states does vary a great deal on account of differences on soil, rainfall and irrigation, a proper measure of relative population pressure on land should make allowances for these differences.

40   The limitations of using per capita land area may be less severe when we compare holdings of different sizes. For, while larger holdings have on the average, poorer quality land, they also generally tend to have larger incomes both per family and per capita. One might therefore expect that larger holdings, by virtue of their superior command over resources relative to the human population they support, will be able to hold superior quality animals. If this were so, the calving efficiency,

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[1] It might be noted that W. Burns in his famous report entitled Technological possibilities of Agricultural Development in India (Lahore, 1944) claimed that the average animal milk yield per cow tended to be higher in areas with lower rainfall. The milk capacity per animal in regions of 30" or less rainfall being more than twice that of animals in areas with over 70 inches rain. Since there is a positive association between rainfall and population density, this could also imply an inverse relation between population density and milk yields. However, a more disaggregate analysis bring more recent data on milk yield do not support the hypothesis. (See Ashok V. Desai, "The Livestock situation", Economic Weekly, Annual Number 1965). The lack of such a relationship can also been seen from Table 14.

Table- 19

Size and breeding efficiency of Adult female stock by
class of holdings 1961-2 and 1971-2

Size Class (in acre)	No. of Adult Females per 00 households		Proportion of adult females in milk			
	1961-62	1971-72	Cows		Buffaloes	
			1961-2	1971-72	1961-2	1971-2
0.01-0.49	12.72	21.58	.508	.449	.529	.553
0.50-0.99	58.35	58.04	.423	.470	.620	.526
1.00-1.24		78.71	.355			.595
1.25-2.49	108.8	1186.79	.400	.490	.544	.610
2.50-4.99	161.89	164.70	.434	.495	.511	.612
5.00-7.49	208.08	200.91	.386	.511	.501	.647
7.50-9.99	235.46	230.76	.409	.512	0554	.617
10.00-12.49	255.13	246.46	.407	.500	.510	.632
12.50-14.99	276.28	262.07	.376	.493	.506	.631
15.00-19.99	304.80	282.96	.403	.531	.496	.625
20.00-24.99	317.74	294.80	.385	.610	.487	.671
25.00-29.99	340.28	342.15	.381	.582	.463	.654
30.00-49.99	462.46	376.83	.409	.537	.504	.648
Over 50	603.21	528.04	.385	.540	.502	.641
All sizes	121.61	111.94	.415	.505	.578	.619

Source: NSS, Report No. 144, Tables with notes on some aspects of Land-
        holdings in Rural areas, 17th Round, Sept. 1961, July 1962
        (Delhi-1961)

        NSS, No.215, 25th Round July 1971-Sept 1972
        Tables on holdings, all India (Feb. 1976)

the lactation length as well as milk yields of large holdings should be well above the average small holdings. In point of fact, (See Table 14) there seems to be no systematic relation between size of holding and the ratio of lactating to total breeding females.[1] Scattered data from the Farm Management Surveys also do not show any marked or consistent trend for milk yield to rise with holding size.[2]

41 The greater, and increasing, prominance of buffaloes among adult females than among adult males is **usually** to be explained in terms of / the superior efficiency of the buffalo as a milch animal. It should be noted however that the differences in efficiencies are not unifrom as been regions: In Tamil Nadu, for instance, the ratio of milk yield per cow in milk and that per buffaloe in milk is around 1.6 while in Maharashtra it is nearly 3.7. Similarly the lactating efficiency of the buffalo is only 10-15% better than that of the cow in M.P, compared to 65-70% in Maharashtra. Ecological conditions suitable for the rearing of buffalo and their use as work animals are not present in all parts of the country. Moreover higher milk yields of buffaloes also involve larger cost because they require higher feed inputs (especially concentrates) and buffaloes need greater care and attention. And finally the extent of reliance on buffaloes for milk is constrained by the limited demand for the species as a source of draught power.

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[1] It would however, seen from Table   that, while the overall breeding efficiency of both cows and buffaloes increased between 1961 and 1972, the increase was apparantly more in larger holdings. If true, this is a significant fact which needs to be explored further.

[2] We looked at FMS Data from the mid-fifties for Maharashtra, Madras, UP and Punjab. There is no systematic relation between holding size and milk yield per animal in 3 of the states. The Punjab data however show a strong positive relation between the two variables.

42   A satisfactory explanation of the factors determining the size

composition and productivity of adult female bovines clearly calls for

a more complex model.   Such a model will have to take cogninance of

the fact that, on the supply side, efficiency is partly determined

by inherent genetic characteristics of the animals, and partly by the

quality of management (as reflected in amount and type of feed, care

for animal health etc.).. The former as it were sets the upper limits

to be various parameters (such as calving interval, age at first

calving, lactation length, and efficiency in converting feed into

milk), while the latter determines their actual values. The quality

of management again cannot be viewed independently of the demand and

price conditions facing producers. And any model has to recognise that

the demand for milk and for calves are determined by quite different

sets of factors: the former by population and real incomes; the latter

by the requirement for replacement of animals lost by death or slaughter,

and for growth of the herd.

VI

Composition of the Bovine herd

43 Another important aspect of the bovine population relates to its age and sex composition. The review of available data in section 2 revealled large variations across states in the ratio of adult males adult females and young stock to bovine population. The data seem to suggest a systematic relation between age-sex composition of bovines and human density. More specifically, the proportion of adult male stock tends to increase, and that of adult females to fall, as one moves up the scale of human density. It is tempting to rationalise this by saying that as the pressure of population on land increases, and the competition between human and bovines intensifies, farmers tend to restrain the number of adult females in order to accommodate the requiste number of draught animals. But such an explanation could be an over-simplification because there are large differences in land quality, cropping patterns and the availability of alternate sources of power, and also because the proportion of different categories of animals reflect the net result of adjustments of herd composition to condition of demand, for different animal products and serries, costs of feed and maintenance, and productive efficiencies.

44 Interestingly, when one views the composition of bovine stock accross land holding classes, it is found that, for the country as a whole, the differences are no where near as striking. Of course, the very small land holdings do have a distinctly different pattern from the rest of the population: The bovine stock held by them consists of a smaller proportion of adult males and a noticeably larger proportion of adult

females than the average. Except for this, the percentage

distribution of total bovine stock as between adult males, adult -

females and youngstock, is surprisingly stable in different size

class of holdings,

45   It is possible that the all-India data, aggregating as they do regions

with very different agro-climatic and institutional conditions, give

a distorted picture. In order to check possible distortions on this

account, we have compared the size and composition of bovine population

by size of holdings in 4 selected States, viz., Maharashtra, Punjab,

Tamil Nadu and Uttar Pradesh. (Table   ). There are of course signi-

ficant differences in the average composition of bovinestock as well

as in the behaviour of the total bovine population per ha. and its

composition relative to the landholding size as between these States.

Thus, Tamil Nadu has 280 bovines per ha. of operated area, compared to

107 in Maharashtra; buffaloes comprise less than 15% of bovine stock

in Tamilnadu, and Maharashtra, compared to 53 per cent in Punjab; and,

while differences in the proportion of adult females to total are not

marked, there is a great deal of variation in the shares of adult

males and youngstock with Punjab having an exceptionally low pro-

portion of adult males and large proportion of youngstock.[1]

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[1] It is also noteworthy that while in all States, the overall bovine
density per ha. of operated area falls as holding increases, the
strength of the relation is by no means uniform: the fall is very
sharp and sustained in Punjab and Uttar Pradesh, somewhat less
pronounced in Maharashtra, and least pronounced and rather erratic
in Tamil Nadu.

46   The share of adult males in total stock is generally much lower than average, and that of adult females much higher, in the very small landholding class. (Tamil Nadu being an exception). The tendency for the proportion of adult males to fall as landholding increases is evident in Maharashtra, Punjab and Tamil Nadu but no clear trend is visible in Uttar Pradesh. The proportion of adult females shows a tendency to rise with holding rise in Tamil Nadu and to a lesser extent in Punjab. But in the other two States, the relation is erratic even if we exclude the smallest farms. The proportion of youngstock seems to be positively associated with holding size in Tamil Nadu, Uttar Pradesh and Punjab, but no clear trends are visible in Maharashtra. In none of the four States do we find any systematic relation between breeding efficiency of either cattle or buffaloes with holding size. These diverse patterns of relation between holding size and composition of bovine stock in different States clearly argue for a disaggregated analysis, by regions, in order to satisfactorily explain the variations. Even so, the State-level data do seem to broadly reinforce the conclusion based on all India data that, except for very small holdings, there seems to be no striking difference across landholding classes in terms of either the nature or the degree of specialisation.

47   This is prima-facie rather surprising in a situation where the availability of, and access to, resources needed for maintenance of animals is unequal as between different classes of farmers. A farmer with 1 acre has obviously much less home grown forage and feed compared to one with 10 acres. The latter being on the average much better off

in terms of per capita income and wealth is likely to have access to
much larger resources (by way of own savings or borrowings) for live-
stock rearing. Under these conditions, it would seem rational (in the
sense of securing maximum returns per unit of resources spent on live
stock husbandry) for the small farmer to maintain as high a proportion
of his bovine stock in the productive categories (like drought animals
or animals in milk) and keep the proportion of unproductive animals
(calves, dry cows or dry buffaloes) to a minimum. Indeed, since many
of them are not likely to have sufficient work for draught animals, it
would seem more economical for them to have as few of this category as
possible. On the other hand, a large farmer by virtue of his superior
                              (in terms of quantum and of terms)
command over resources/as well as high level of his own requirements
for animal products, and services, might be able to afford a larger
number of bovine stock, of better quality and of a more diversified
composition. But in actual fact there seems be no such specialisation:
on the contrary the remarkable similarity in the composition of bovine
stock across land holdings seems to suggest that farmers seek to be
self reliant in meeting their requirements of all major categories
of bovines.

46   Farmers could of course find it advantageous, or even necessary, to aim
at such self-reliance if there were no well developed markets for
animals. But this is evidently not the case in India. There is in
fact a widespread, and well organised, trade in bovines through out
the country. As early as 1950, Dandekar reported that the majority
of adult male bovines owned by farmers (60% of cattle and 72% of
buffaloes), over a fifth of cows and close to 40 per cent of she

buffaloes were purchased. On the other hand, the Survey showed that most (95%) of the youngstock were home-bred.[1]

49 Perhaps the data, which, by necessity are aggregated, conceal considerable degree of specialisation within different classes of farmers That this may be happening is suggested by the extra ordinarily high proportion of farmers, especially with small holdings, who do not own any draught animals. Another indication of this is given by the sample verification of the 1966 Livestock Census[2] which suggests that a little over half of the sample house holds had no cattle whatsoever, 65% had no working bullocks, and as many as 83 per cent had now cows in milk.

50 Another possible explanation could be that the availability of draught animals at the right time is so critical to the farming operations (which could be the case if the preparation and sowing operations have to be completed within a very short time during which animals can either not be leased at all or only at high cost), that even small farms find it worthwhile to maintain draught animals along with others. The possibility of getting some supplementary income from milk and of rearing calves for sale at maturity with little or no real cost (on account of the availability of surplus/family labour, combined with the possibility of finding free grazing on public lands) may also contribute to a more diversified pattern of bovine stock in small holdings. Again without

[1] V.M. Dandekar, op.cit. p.66

[2] CCI, National Sample Survey, No.163 Tables with Notes on Post Census Survey of Livestock Numbers 1966 (Rural Sector) Delhi 1971, Op.56, 59 & 62

more detailed data and further careful analysis, no definitive
conclusions can be hazarded.

VII

Conclusion

51 The purpose of this paper, as mentioned at the outset, is rather
modest: It has sought to marshalled some of the available
information on the structure of India's bovine population, and its
behaviour across regions and over time. In the process, certain
interesting patterns have been noticed and some of these are at odds
with expectation. The pattern of mortality by age and sex among
cattle, the lack of any strong substitutive relation between animal
and mechanical power, the seeming lack of pronounced specialisation
in the bovine economy of small and large farms and the existence of
a systematic relation between human density on the one hand and the
level and composition of the bovine stock on the other these are some
of interesting findings of this review. Our attempts to explain
these apparent puzzles are far too crude and simplified to provide
definitive answers. But they do raise several questions which deserve
to be pursued in greater depth inorder to better understand the factors
determining the size and productivity of a resource which next to
land and irrigation, is the largest resource of India's rural economy.

Size and composition of bovine stock in different classes of land holdings in 4 States-1972.

Size of holding (acres)	No. of bovine/100 ha.				Proportion of Adult Males				Proportion of Adult Females			
	Mah.	Punjab	Tamil Nadu	U.P.	Mah.	Punjab	Tamil Nadu	Uttar Pradesh	Mah.	Punjab	Tamil Nadu	Uttar Pradesh
1	2	3	4	5	6	7	8	9	10	11	12	13
0.01-0.49	464.35	1335.48	635.42	954.44	5.0	11.	53.7	3?.6	50.5	47.6	28.0	36.2
0.50-0.99	633.57	456.60	456.81	570.1?	36.0	–	53.8	47.5	29.0	51.1	33.1	34.1
1.00-1.24	323.21	1069.10	293.19	596.35	43.0	8.3	65.6	47.4	30.?	60.0	24.7	38.7
1.25-2.49	259.00	488.24	232.7?	393.37	43.4	36.4	60.2	50.4	34.5	36.2	24.9	31.5
2.50-4.99	200.41	235.?0	241.61	263.60	43.7	37.5	52.6	48.1	32.7	38.8	29.6	34.0
5.00-7.49	139.64	224.57	228.39	190.53	44.1	32.7	50.6	45.6	33.4	37.0	33.3	35.7
7.50-9.99	89.30	163.76	225.43	165.64	46.5	35.?	39.2	44.5	38.8	37.0	40.5	37.?
10.0-12.49	97.02	153.10	241.03	140.72	44.3	37.2	35.3	41.6	32.3	39.3	38.7	35.6
12.5-14.99	92.28	132.90	132.50	129.20	41.0	32.0	46.1	48.1	35.1	35.5	38.4	34.8
15.00-19.99	65.28	103.13	154.41	123.60	36.5	36.3	35.8	45.8	31.9	39.0	36.0	37.9
20.0-24.99	68.16	54.19	194.79	117.78	39.5	33.6	32.0	38.8	33.0	36.6	44.8	34.8
25.0-29.99	74.56	68.33	–	113.95	40.?	54.9	–	46.1	36.8	34.7	–	27.7
30.0-49.99	65.67	65.72	112.90	70.76	39.6	26.4	31.1	43.4	36.1	44.4	49.8	35.9
Over 50	119.73	41.88	26.82	21.9	35.8	–	45.8	53.2	35.8	–	42.0	11.9
All classes	106.70	203.50	282.10	243.49	44.0	25.6	53.4	44.5	35.3	35.0	31.7	35.5

Source: Government of India, National Sample Survey, 26th Round July 1971, September 1972, Tables on Holdings (State Volumes)

Table 20 contdd...

Size of holdings (Acres)	Proportion of Youngstock				Lactating Efficiency:Cattle				Lactating Efficiency:Buffaloe			
	Mah.	Punjab	Tamil Nadu	Uttar Pradesh	Mah.	Punjab	Tamil Nadu	Uttar Pradesh	Mah.	Pun.	Tamil Nadu	U.P.
	14	15	16	17	18	19	20	21	22	23	24	25
0.01-0.49	31.5	42.4	12.3	30.2	.29	.50	.54	.47	.54	–	1.00	.57
0.50-0.99	34.1	46.2	16.1	18.5	.77	1.00	.18	.55	.62	–	.88	.57
1.0-1.24	26.0	21.8	9.3	13.8	.89	.74	–	.34	.85	.14	–	.61
1.25-2.49	22.1	27.5	15.2	18.1	.54	.32	.64	.50	.00	.78	.79	.59
2.5-4.99	23.6	24.2	17.8	17.8	.63	.56	.42	.53	.82	.64	.55	.57
5.0-7.49	22.6	29.4	16.1	20.8	.64	.53	.34	.51	.78	.57	.81	.63
7.5-9.99	12.5	24.0	20.3	18.2	.61	.57	.29	.52	.72	.73	.47	.57
10.0-12.49	23.4	23.5	22.1	19.9	.57	.49	.25	.48	.90	.57	.57	.62
12.50-14.99	23.9	31.7	15.5	17.1	.53	.53	.18	.32	.74	.68	.36	.63
15.0-19.99	20.5	29.9	24.2	20.3	.53	.59	.32	.49	.58	.68	.69	.58
20.0-24.99	26.8	27.8	23.1	26.5	.59	.57	.29	.70	.73	.68	.18	.80
25.0-29.99	22.7	–	–	25.4	.58	.83	–	.52	.55	.83	–	.32
30.0-49.99	24.2	33.2	19.1	22.7	.52	.66	.76	.51	.63	.67	.67	.76
Over 50	11.9	33.2	–	12.1	.48	.18	–	1.00	.97	.53	–	.77
All Classes	24.2	38.5	17.9	20.0	.57	.54	.39	.50	.72	.61	.68	.59

Annex

The following are some of the principal contributors to the discussion, the main highlights of which are well summarised in SN Mishra. "Surplus Cattle in India: A Critical Survey Sociological Bulletin, Vol. 22, No.2., 1973.

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