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Vol XXXI
No. 1

ISSN 0019-5014

JANUARY-
MARCH
1976

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

RESEARCH NOTES

ESTIMATION OF DEATH AND BIRTH RATES OF CATTLE IN KERALA*

The quantitative and qualitative changes taking place in livestock population over the years would be due to the changes in demand for livestock products. The changes in livestock population and its components would be affected by changes in mortality rates, birth rates, and disposal rates of animals. Therefore, a study on the death and birth rates of livestock population over the years is of utmost importance for understanding the pattern of supply responses to variations in demand for services of livestock and livestock products. It is with this objective that we have undertaken a study on the death and birth rates of cattle population in Kerala. The paper is divided into two sections : Section I contains discussion of the methods and an attempt to estimate the death and birth rates and section II contains interpretation of the results.

I

Four methods have been used in India for estimating the death rate of cattle : (1) To use statistics of production and exports of skin and hides and average life span of cattle; (2) to use the number of cattle slaughtered and the life span of cattle; (3) to use information collected through sample surveys; and (4) to use the age distribution of animals obtained from livestock census.

The first method was used by the Indian Munition Board and the Imperial Veterinary Research Institute in the years 1922 and 1929, respectively. The second method was used by the Directorate of Marketing and Inspection of the Government of India (in the years 1948 and 1958, respectively). These methods provide some rough estimates of death rates of cattle and buffaloes in India.[1]

Detailed estimates of death rates and birth rates of cattle and buffaloes are available for the first time from the Poona Schedules of the National Sample Survey.[2] This survey gives for cattle and buffaloes respectively single age mortality rates upto 9 years of age and the mortality rates in the age group 9+. The all-India young and adult stock mortalities work out to be 12 and 9 per cent for cattle and 24 and 12 per cent for buffaloes.

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* Working Paper No. 29, Centre for Development Studies, Trivandrum. The author is grateful to his colleagues in the Centre for Development Studies for giving comments on an earlier version of this paper.

1. A review of the earlier attempts has been brought out in a paper by K. Seshagiri Rao and P. N. Chowdhary, "A Study on the Supply Position of Raw Hides in India," Central Leather Institute.

2. V. M. Dandekar: Second Report on the Poona Schedules of the National Sample Survey, Publication No. 29, Gokhale Institute of Politics and Economics, Poona, 1954.

Estimates of livestock mortality rates are available for a few States from the ICAR study on milk yield and other bovine and goat practices in India. The only estimate of mortality rate for cattle and buffaloes available for Kerala is from the survey carried out by the Institute of Agricultural Research Statistics (ICAR) in 1964-65 which covered 134 villages and a total of 4,308 households.[3] According to this survey, the mortality rates are as given in Table I.

TABLE I—MORTALITY RATES FOR CATTLE AND BUFFALOES ACCORDING TO THEIR CLASSIFICATION

(*per thousand*)

Classification	Cattle	Buffaloes
Young stock	119	480
Adult stock	22	33
Overall	52	72

Source : Indian Council of Agricultural Research : Sample Survey for the Estimation of Annual Production of Milk and Study of Bovine and Goat Practices in Kerala, 1964-65, Table No. 9·04.

According to this survey, the annual mortality rate worked out to about 2.2 per cent for adult stock cattle and 11.9 per cent for young stock cattle and 5.2 per cent for the entire cattle population. The mortality rate for adult buffalo population was about 3.3 per cent and the mortality rate for young stock buffalo population was around 48 per cent. The overall mortality rate for buffalo population was around 7.2 per cent. No estimates of birth rates are available from this survey.

The estimates of death rates obtained through the sample survey have the following limitations. In Kerala livestock trade is a well organized business involving a large number of livestock markets scattered over all the regions in the State. A significant proportion of the animals which moved from the rural to the urban areas is for slaughter. Since urban slaughter houses are situated at long distances from the sample villages from which the information is collected, the estimates of death rates obtained through the sample survey are likely to be under-estimates. Another drawback of the estimates of death rates by this method is that they cannot be used to estimate the death rates for future years. Death and birth rates are subjected to change depending on a number of factors like changes, from time to time, in the slaughter policies of government, in the demand for meat, etc. This calls for the development of a standard method for estimating mortality rates based on the size and age distribution of livestock population reported by the quinquennial livestock census.

3. Indian Council of Agricultural Research : Sample Survey for the Estimation of Annual Production of Milk and Study of Bovine and Goat Practices in Kerala, 1964-65, Institute of Agricultural Research Statistics, New Delhi (unpublished).

For the first time in India, Professor V.M. Dandekar tried to estimate the mortality rate for cattle in Maharashtra using the 1961 livestock census data.[4] This method was later modified and standardised by S. S. Srivastava and he estimated the birth rates and death rates of cattle and bufflaoes for 1960-61 for all the States in India.[5] We will be mainly using this method with a slight modification in one of the assumptions in the earlier approaches. Estimates of death and birth rates are made for the years 1960-61, 1965-66, and 1971-72. We had developed a method for estimating the birth rate of cattle in the State using the livestock census data and the data on the inter-State movement of cattle collected from the Renderpest Eradication Wing of the Animal Husbandry Department.

ESTIMATION OF DEATH RATES

Death Rate of Young Stock Cattle

The livestock census report gives population figures for cattle and buffaloes in the age groups (0-1) and (1-3) and 3 and above. The first two categories comprise the young stock and the third the adult stock. If there were no mortality of the young stock, the size of the young stock population comprising the age groups 1 to 2 and 2 to 3 will be exatcly twice the size in the single age group (0-1) in the State or at the district level if (1) there is a uniform flow of birth in cattle in consecutive years; (2) the annual survival rate is the same for the young stock; (3) there is no inter-State or inter-district cattle movements.

Generally the population in the (1-3) age group is found to be much less than (0-1) age group. This may happen due to different reasons like the high mortality rates, inter-district or inter-State cattle movements and annual fluctuations in birth rate, etc. In order to estimate the young stock mortality at the State level we may start with the following assumptions :

(1) the annual number of births remains unchanged in consecutive years;
(2) the annual survival rate is the same for the young stock in consecutive years;
(3) there is cattle movement into Kerala from the neighbouring States, but no cattle movement from the State to outside the State.

These assumptions then mean that if x is the number reported in the (0-1) age group and if r is the proportion that survives after a year, xr will be the number in the (1-2) age group and xr^2 will be the number in the (2-3) age

4. V. M. Dandekar, "An Economic Approach to Cattle Development in India," published in Nalin Mehta : Fiscal Policies and Economic Growth, Sarva Seva Sangh, New Delhi, 1965.
5. S. S. Srivastava, "Problem of Estimation of Mortalities in Cattle and Buffaloes," *Indian Journal of Agricultural Economics*, Vol. XXV, No. 2, April-June, 1970.

group. So the number reported in the (1-3) age group will be $xr+xr^2$. Let y be the size of the population in the age group (1-3) as reported by the census. If y_b is the (1-3) population moved into the State from outside the State then $(y—y_b)$ will give the number of young stock cattle born in the State. Therefore, the relationship $xr+xr^2 = y - y_b$ (1) will be valid and the solution of (1) will give the value of r, the survival rate of young stock cattle. It may be observed that the number of births in consecutive years may or may not be equal. Therefore, the size of the (0-1) population determining the value of r will be different for different years. Let x_1 and x_2 be the size of the (0-1) population in consecutive years and let R be the survival rate of young stock cattle. Then the value of R will be determined by the equation $x_1 R+ x_2 R^2 = y - y_b$ (2). But in the absence of any idea on the number of births in these years, it is not possible to obtain the value of R. The only method in this situation is to interpolate for x_1 and x_2 between the census periods assuming that (0-1) population will grow at a geometric progression. It can be shown that under this assumption the new survival rate will be $R = r (1 + g)$, where g is the growth rate of (0-1) population. If R is the survival rate of young stock cattle then (1—R) will give the mortality rate for young stock cattle.

Death Rate of Adult Cattle

A part of the adult stock at any point of time will be 2+ a year before. The balance are the survivors of the previous year's stock of adults. That is the (2-3) age group population joins the group of adults after a lapse of one year. The procedure here is the direct extension of the method we used for the estimation of the survival rate of the young stock, with the same kind of assumptions, namely, (1) the (2-3) population is the same in consecutive years; (2) the annual survival rate is the same for the adult stock in consecutive years; (3) there is movement of adult cattle into Kerala but no movement from the State to outside the State.

Let r_1 be the annual survival rate of the adult stock. Then r_1 of the population in the (2-3) age group will join the (3-4) group after a year. The population in the (2-3) age group has already been estimated to be xr^2. Therefore, the population in the (2-3) age group will be xr^2r_1. Similarly, the population in the subsequent age group will be $xr^2r_1^2$ $xr^2r_1^3$, etc. If Z is the size of the adult stock population reported in the census and if Zb is the size of the adult cattle population that is moved into the State, then the adult stock cattle population born in the State will be $(Z—Zb) = xr^2r_1 + xr^2r_1^2 + \ldots = \frac{xr^2r_1}{1—r_1}$ (3). The solution of (3) will give the value of r_1.

If we change the assumption of uniform flow of population in the (2-3) age group, the annual survival rate for the adult stock will be equal to

$R = r_1 (1 + g)$ where g is the growth rate of (0-1) population. Here R_1 is the average proportion of survival of animals in the age-group (2-3) onwards, *i.e.*, from the age group 2.5 and above. $(1—R_1)$ is the corresponding mortality in the years 2.5 and above.

The mortality rates for young and adult stock obtained through the above method are valid to cattle in the age group 0.5 to 2.5 and above 2.5 respectively. In the actual calculation of death rates, however, the young stock mortality rates are applied to the young and adult stock in the years 1960-61, 1965-66, and 1971-72 respectively. This can introduce some error in the estimate of the number of deaths for young and adult stock cattle. But this will not affect the total number of deaths of cattle in the State.

METHODS FOR ESTIMATING BIRTH RATES

Method I

In the total number of breeding cows in the State at any point of time, a certain number of cows will be in milk and the rest will be dry. The number of cows in milk and the number of cows that are dry will be reported in the livestock census. Let Y be the number of cows used for breeding and milk production and M be the number of cows in milk reported in the census. Let 'L' be the average lactation length of cows in the State. Then this M cows might have calved within the period L. In the year preceding the date of census some cows which had calved and were in milk might have gone dry. So the number of cows calved in the State in the year preceding the date of census=the number of cows calved within the period L +the number of cows that calved during the year but had gone dry (4).

The total number of births of cattle in the State is equal to the total number of calvings by breeding cows in the State. Since there are no data available regarding the number of cows which calved during the year it is not possible to use (4) for estimating the number of calvings by breeding cows in the State. In order to get over this difficulty we adopted the following method. Since M is the number of cows that might have calved over the period L, the average number of calvings per day by breeding cows in the period L will be (M/L). Since the lactation period of cows will be generally greater than two-thirds of a year, we have assumed that the average number of calvings per day over the lactation period as the average number of calvings per day per year. So the total number of calvings by breeding cows in the year will be (M/L) 365.

Since the calving of breeding cows is subjected to seasonal fluctuations, the validity of the above estimation method is questionable. Generally, the number of cows in milk is found to be the maximum from July to September

and minimum in the months of April and May and November and December. Since the census count is usually taken in the month of April, the number of calving over the period L will include cows calved both in the low and peak periods in the State. This fact suggests that our estimate will give at least the minimum number of births of cattle in the State.

Method II

In this method the number of births is estimated in the following way. If B is the number of births in a year, then the number of births in the period t and $t+\triangle t$ will be $B.\triangle t$. The number of calves born in the period will be exposed to the risk of mortality for a period $(1-t)$ if $\triangle t$ is sufficiently small. Hence $B.\triangle t\, r^{1-t}$ when $\triangle t \to 0$ will give the number surviving at the time of enumeration of birth $B.\triangle t$ and the integral of this from 0 to 1 will be the observed (0-1) population.

$\therefore \int_0^1 Br^{1-t}\, dt = x$ (5). The solution of (5) will give the value of $B = \frac{-x \log_e r}{1-r}$ where r is the survival rate of cattle in the age group (0-1).

This method of estimation will be valid only if the survival rate of young stock in the first year of life is known. In the absence of any idea on the survival rate of (0-1) population, the survival rate calculated for the young stock has been used as an approximation to arrive at the estimate of their birth rates. Howeverk, in Kerala the calf mortality in the first year of life is generally much lower than during the next two years because of the high incidence of slaughter of young stock cattle in the age group (1-3). Hence the survival rate used to estimate the number of births is likely to be lower than the actual rate and this will lead to an over-estimation of the birth rate.

The estimate of the birth and death rates for the years 1960-61, 1965-66, and 1971-72 are given in Tables II and III. Estimates of calf mortality rate are obtained by subtracting the observed (0-1) population on the date of census from the estimated number of births in the one-year period preceding the date of census.

TABLE II—ESTIMATED NUMBER OF DEATHS IN CATTLE IN KERALA

Census year	Calf				Young stock		Adult stock	
	No. of deaths (lakh)		Death rate (per cent)		No. of deaths (lakh)	Death rate (per cent)	No. of deaths (lakh)	Death rate (per cent)
	Estimate I	Estimate II	Estimate I	Estimate II				
1960-61 ..	0·07	1·31	1·3	19·8	3·03	37·7	1·52	8·1
1965-66 ..	0·52	1·47	8·4	20·7	3·52	38·8	1·88	9·8
1971-72 ..	1·08	2·48	14·2	27·6	5·01	49·4	1·94	10·4

TABLE III—TOTAL NUMBER OF DEATHS AND ESTIMATED NUMBER OF BIRTHS IN CATTLE AND PRODUCTIVITY OF BREEDING COWS IN TERMS OF NUMBER OF CALVES IN KERALA

Census year	No. of deaths (lakh)		Death rate (per cent)		No. of births (lakh)		Birth rate (per cent)		Productivity*	
	Estimate I	Estimate II	Estimate I	Estimate II	Estimate I	Estimate II	Estimate I	Estimate II	Estimate I	Estimate II
1960-61	4·62	5·86	16·2	20·6	5·35	6·59	18·5	23·0	46·9	57·8
1965-66	5·92	6·89	19·6	22·9	5·14	7·09	20·4	23·6	49·9	58·5
1971-72	8·03	9·43	25·8	30·3	7·57	8·97	24·3	28·8	58·8	69·7

Note : (1) Estimate I is obtained by using the estimated number of births by method I and estimate II is obtained by using the estimated number of births by method II.
(2) Birth rates and death rates are given as percentages to the total cattle population.
*(3) Productivity of breeding cows is given in terms of number of births per 100 cows used for breeding and milk production.

II

DISCUSSION OF RESULTS

According to our estimates, the number of deaths in the young stock cattle worked out to about three lakhs in 1960-61. By 1971-72 the number of deaths in young stock cattle increased to 5 lakhs. The number of deaths of adult cattle during 1960-61 was 1.52 lakhs and by 1971-72 it increased to 1.94 lakhs. The percentage of death of young stock cattle was about 33 during 1960-61 and 49 during 1971-72. The percentage of death of adult cattle was around 8 in 1960-61 and 10 in 1971-72.

According to method I, the number of births of cattle in the State worked out to nearly 5.35 lakhs during 1960-61, and according to method II it was 6.59 lakhs. The birth rate calculated by the second method was 23 per cent higher than that obtained through the first method. During 1971-72 the number of births according to the first method worked out to 7.57 lakhs and according to the second method to 8.97 lakhs. The number of births obtained by the second method during 1971-72 was 18 per cent higher than that obtained by the first method. Since the former gives only the minimum number of births, the actual number of births would lie between these two extreme values.

In 1960-61, the number of deaths of calves was 1.3 per cent of the total calf population according to the first method and it was about 19.8 per cent according to the second method. The death rate of calf in 1971-72 was around 14.2 per cent and 27.6 per cent according to the first and second method, respectively.

The main results obtained from the estimates of birth and death rates are summarised below :

(1) The death rate of young stock cattle is significantly higher than the death rates of calf and adult cattle in the State;

(2) Over the years the death rates of calf, young and adult stock have increased;

(3) The birth rates of cattle have been increasing in the 'sixties.

Reason for High Death Rate

Investigations carried out by the IARS survey into the causes of death of young cattle and calf in the State revealed that nearly 92 per cent of the deaths of young stock cattle was due to a variety of diseases. Around 70 per cent of the young stock cattle died due to slaughter and nearly 8 per cent of the calf and 3 per cent of young stock died due to accidents.

The high death rates of calf and young stock cattle due to different diseases as well as the differential pattern of mortality observed among cattle belonging to the different age groups suggest the possibility of very low levels of feeding of cattle in the State. An examination of the available data on feed intake of cattle might give some evidence to the extent of under-feeding.

In order to estimate the extent of under-feeding of cattle in the State, the actual per capita daily feed intake of cattle (data from the IARS survey) with different body weights and milk yield was converted into its energy equivalent and was compared with the recommended energy requirement as per Morrison's standard. The energy supplied by different feeds was expressed in terms of the total digestible nutrients (TDN) which is generally accepted as a unit of measuring energy. The results indicated that the extent of under-feeding was of the order of 35 per cent in milch animals, 40 per cent in draught animals and 50 per cent in young stock.

The low level of feeding of cattle in the State may be due to lack of sufficient feed resources in the State. But in a situation where the demand for beef and milk is increasing, one way of meeting the rising demand is by increasing the number of cattle. But an increase in the number necessarily means an increase in the demand for feeds which are limited in the State. An alternative method therefore will be to adopt selective growing of cattle by eliminating the non-functional categories of animals so that maximum benefit could be achieved out of the available feed supply. It seems that the high incidence of slaughter of young stock cattle and reduction in the life span of adult cattle due to an increase in the death rate by natural reasons is due to this consideration.

Increase in Birth Rate

Another important point emerging from our analysis is the increase in the birth rate of cattle over the years in the State. It implies an increase in the productivity of milch cows in terms of the number of calves born. During 1960-61, the number of births per 100 breeding cows was around 47 as per our estimate of the first method. During the period 1961-66 there was only a slight increase in the productivity of cows in terms of the number of briths. But between 1966 and 1972 a sharp increase is noticed in the productivity of breeding cows in terms of the number of calves. The number of calves per 100 breeding cows in 1971-72 was around 59, an increase in productivity of nearly 26 per cent. This increase may be primarily due to an increase in feed input of milch animals. Besides, there are a number of other factors which might have contributed to this increase in productivity, like the expansion of the size of the village markets for milk, improvement in the genetic quality of cattle due to an increase in the number of cross-bred cows and change in the organizational structure of the diary industry in the State.

K. NARAYANAN NAIR*

COST-BENEFIT ANALYSIS OF AFFORESTATION IN DEEP RAVINES OF GUJARAT

The ravines are the most advanced stage of soil erosion. The gullies which are neglected grow larger and deeper, divide the land into numerous pieces of humps and valley and render the land unfit for cultivation. A network of such gullies are called ravines. According to land capability classification, the ravines are classified into three categories, namely, shallow, medium and deep. Of these, deep ravines are considered as worst for agricultural production, remain unsown and are left for grazing as sub-marginal waste land. The Committee on Natural Resources (1968), Planning Commission reported that an area of about 9.88 lakh acres is covered by ravines in Gujarat State. This is fairly a large area wasted as against an area of about 101.87 lakh acres under the plough in the State. Since ravines constitute a part of national land resources, the primary concern of scientists has been to provide scientific support to ravine stabilisation by operational research and provide alternate and economical use of these neglected lands.

The Soil Conservation Research Centre at Vasad (ICAR) in Gujarat State has achieved considerable success in stabilising deep ravines by affore-

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