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INTER STATE DIFFERENCES IN MILK CONSUMPTION IN INDIA - A PRELIMINARY ANALYSIS

K. Narayanan Nair

A.Vaidyanathan

Centre for Development Studies
Ulloor, Trivandrum 695011

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and
A. Vaidyanathan

Introduction

1. In this paper an attempt is made to analyse some of the factors underlying the inter-regional variations in per capita intake of milk.[1/] According to the National Sample Survey data the average per capita consumption of milk in 1961-62 ranged from 0.44 kg. per 30 days in rural areas of Orissa to 11 kg. in Punjab; the range in urban areas being 2.1 kg. in Andhra Pradesh to 12.66 kg. in IUnion Territories.[2/] The existence of these variations was noted especially by Raj[3/] (1969).

2. In attempting to explain the large inter-regional differences in age, sex and species composition of bovine-stock, he suggested that, apart from the influence of per capita income difference, there seems to be tendency for per capita milk consumption to rise as one moves from,

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1/ Unless otherwise specified, "consumption of milk" refers to total fluid milk equivalent of the consumption of milk and milk products. The basis for conversion of the later into fluid milk is explained in Section I.

2/ Government of India, Department of Statistics, National Sample Survey, Draft Report No.200,(1961-62) Tables with Notes on Consumer Expenditure (New Delhi, mimeo,)

3/ See K.N.Raj, Investment in Livestock in Agrarian Economies: An Analysis of some Issues Concerning "Sacred Cows" and Surplus Cattle (Centre for Advanced Studies, Department of Economics, Delhi School of Economics, University of Delhi, 1969) and also Asok V. Desai "The Livestock Situation", Economic Weekly, Annual Number 1965.

areas exposed to heat and humidity through the year to areas exposed colder and drier weather. He went on to speculate that this is possibly due to the following factors:

> "(a) The milk yield of cattle declines when they are exposed to hot and humid weather making the cost of milk relatively high in these regions;
>
> (b) other substitutes (such as meat, fish and egg) are available in greater abundance to provide the necessary nutrition at a relatively lower cost; and
>
> (c) the need for fat in human diet is itself less in these climatic conditions." 4/

3. He further argued that "whatever be the precise explanations for the level of milk consumption in each region, it is obvious that the number of milch animals that has to be maintained would tend to rise with per capita consumption unless it is covered wholly by increased milk yields but which again would need larger feed inputs) and when intensive use of draught animals are also essential for agricultural production (i.e., in areas dependent on wells for irrigation) the two sources of demand would together exert considerable pressure on the available resources. One can also conceive of circumstances in which the pressure is so great that it becomes necessary to choose between the two." 5/

4. There has been, however, no systematic attempt so far to test the above hypothesis against facts. Any such attempt is beset with difficulties. In the first place some elements of the hypothesis, and in particular the factors determining the draught-milch animal mix and.

4/ Ibid, pp.25-26

5/ Ibid.

relative milk yields, are not formulated in sufficiently precise terms. Secondly, the explanatory variables cited by Raj includes some which deal with the demand for milk while others relate to supply. Since the available data on actual milk consumption necessarily reflect the combined effect of both demandand supply factors, we would need a much more rigorous formulation of the determinants of these two set of factors and of the interaction between them. In the absence of such a formulation we have tried to see whether the observed variation in milk consumption are systematically associated with the various elements influencing demand as identified by Raj. An attempt is also made to explore how far these variations fit the explanations based on supply factors. The analysis in this paper is confined to exploring the factors underlying variations in per capita milk consumption only in the rural areas. It should be further noted that since available hypotheses on supply behaviour are quite crude and since in any case we have not been able to explore the supply-demand interactions, our results are highly tentative and incomplete.

I

Demand Factors

5. On the demand side, Raj identified three major factors: (a) per capita income; (b) the availability of substitutes like fish and eggs; (c) the effect of clamatic factors on the level of fat consumption. The relevance of per capita income is obvious enough and does not need much comment. As regards (b), we need to define more precisely the items which can be deemed to be substitutes for milk. Milk is a source of fat as well as protein. Alternative sources of protein include vegetable proteins (from cereals and pulsoes) and other sources of animal

and other sources of animal protein (namely, meat, fish and eggs). Since the quality of protein from vegetable and animal sources are quite different, it seems reasonable to suppose thatother sources of animal protein are closer substitutes for milk than vegetable protein. Besides per capita total consumption expenciture, we have, therefore, considered (a) per capita consumption of meat, fish and eggs and (b) the relative price of milk and other animal protein as the variables which determine the level of per capitamilk consumption.

6. Milk is a source of fat which competes in principle with the edible oils. It would, therefore, seem appropriate to verify the relati between varitions in per capita consumption of milk fat on one hand and the consumption of edible oils and the relative prices of these two categories of fat on the other. There is, however, some question about the extent of substitutability between these two sources of fat. The doubt arises from the observation that while edible oils provide only fat, milk is a source of both protein and fat. Part of the animal fat is obtained from consumption of milk as such. Only the portion which is converted into ghee would seem to directly compete with edible oil. But even here, to the extent that ghee is used more as a food supplement rather than as a cooking medium (in contrast to edible oil which is used mostly as a cooking medium) the degree of substituability may be limited. These considerations, and the fact that milk is a joint product providing both fat and protein, are relevant to a proper specification of the demand relationships. However, this is an aspect which we have not been able to resolve satisfactorily yet. For the present, therefore, we shall treat fat from milk (including fluid milk) as a full potential substitute for

edible oils and include per capita consumption of edible oil and the relative price of ghee to edible oils among the candidate explanatory variables.

7. The relationships to be examined may be expressed symbolically as under:

$$M = f(C_p, C_f) \quad (1)$$

$$C_p = (y) \quad (2)$$

$$C_f = (y) \quad (3)$$

$$C_{pm} = (C_p, P_m, P_a) \quad (4)$$

$$C_{pm} = (C_p, P_{mp}, P_a) \quad (5)$$

$$C_{fm} = (C_f, P_e, P_g) \quad (6)$$

These can be reduced to the following composite relations. By combining (1), (2), (3), (4) and (6), we get

$$M = (y, P_m, P_a, P_g, P_c) \quad (7)$$

which can be further reduced to the form

$$M = (y, \frac{P_m}{P_a}, \frac{P_g}{P_c}) \quad (8)$$

similarly combining (1), (2), (3), (5) and (6) we get,

$$M = (y, \frac{P_{mp}}{P_a}, \frac{P_g}{P_c}) \quad (9)$$

Where,

M = per capita total fluid milk consumption (including fluid milk equivalent of products.)

C_p = Total per capita consumption of all animal protein.

C_f = Total per capita consumption of all fat.

C_f' = per capita consumption of edible oil plus ghee.

y = per capita total consumption expenditure

C_{pm} = per capita consumption of protein from milk and milk and milk products.

C_{fm} = Per capita consumption of fat from milk and milk products.

P_m = Price per kg. of fluid milk.

P_{mp} = Price per kg. of protein from milk.

P_g = Price per kg. of ghee

P_a = Price per kg. of protein from other animal sources

P_c = Price per kg. of edible oils and vanaspathi.

Data Sources

8. Our analysis is based on data from the 17th round of the National Sample Survey which relates to 1961-62.[6/] This is the only round for which detailed state-wise data of the quantities and value of the per capita consumption of fluid milk, ghee, butter, edible oils, meat, fish and eggs are available in published form.[7/] These data also permit calculation of State-wise average prices of different items.

6/ N.S.S. Report, No.200, op.cit.

7/ The Special tabulations for the National Commission on Agriculture (1970-71), as well as that done for FAO (1971-72) do not cover all the items involved in our analysis.

9. The estimated quantity of milk consumption includes milk consumed as such and the fluid milk equivalent of ghee and butter consumption. The latter has been estimated on the basis of (a) the per capita consumption of ghee and butter and (b) average fat content of milk in different States. The latter varies a great deal because of differences in the proportion of cow and buffaloe milk which have different fat contents. Since the NSS does not give the break up of cow and buffaloe milk, this proportion is estimated for each State on the basis of data from the milk production surveys conducted by the Institute of Agricultural Research Statistics (IARS).8/

10. The total animal protein intake is the sum of protein content of milk and milk products, meat, fish and eggs. Estimates of total milk protein take into account the significant differences in protein content of cow and buffaloe milk as well as the differences in their relative share in total milk consumption between States. The total fat consumption is the sum of fat content of milk and milk products and of edible oils (including Vanaspathi).

11. The price per unit of milk (ghee) is derived from the quantity and value of fluid milk (ghee) consumed in each State. Since the average protein content varies, we have estimated the price per unit of milk

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8/ The IARS milk production surveys conducted in 11 States duringthe Sixties. Estimates of the milk production in different States in the country are available on the basis of the output per milch animal, obtained from the milk production surveys and the population of milch animals avail ble from the Livestock Census. For details of the sampling procedure and estimation of the total milk production for different regions in the country, See Daroga Singh, etc. al. Monograph on Estimation of Milk Production (Institute of Agricultural Research Statistics, ICAR, New Delhi, undated).

protein by dividing the average price per unit of fluid milk in each State since the average protein content also varies, we have estimated the price per unit of milk protein. The price of other sources of animal protein is the average price per kilogramme of meat, fish and egg, taken together.[2/] Since the quality of the protein from these three products are not very different, this procedure would seem to be satisfactory.

Some Highlights of Inter-State Variations

12. The average monthly intake of milk in rural India in 1961-62 was about 2.68 kg. The total consumption of milk is highest in Punjab, Rajasthan and Gujarat and lowest in Assam and Orissa. About 60 per cent of the total rural milk consumption is in the form of liquid milk and the rest is converted into products like ghee and butter. This percentage varies 12 per cent in Assam, to nearly 65 per cent in Rajasthan. There are also significant variations in the average fat content of milk across States (ranging from 5.10 per cent in Kerala to 7.60 per cent in Andhra Pradesh) reflecting in the relative importance of cow and buffaloe milk.

2/ The protein consumption of meat, fish and egg are estimated on the basis of the standard rates suggested in C. Gopalan et al. Nutritive Value of Indian Foods (National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, 1971).

Table 1

Percapita Montly Milk Consumption (Kg.), Average Fat Content of Milk and Percentage of Milk Converted into Products (All-India, Rural, 1961-62)

States	Milk consumed as such (kg.)	Milk converted into products (Kg.)	Total milk consumption (Kg.)	Percentage of milk converted into products	Average fat content of milk (%)
Andhra Pradesh	0.727	0.537	1.262	43.00	7.60
Assam	1.250	0.173	1.423	12.10	5.39
Bihar	1.280	0.359	1.487	24.70	7.53
Gujarat	3.825	2.229	6.054	36.80	7.54
Jammu & Kashmir	3.069	1.626	4.795	34.70	7.44
Kerala	0.634	-	0.634	-	5.10
Madhya Pradesh	1.250	1.803	3.053	59.00	6.71
Tamil Nadu	0.709	0.145	0.854	17.40	6.42
Maharashtra	1.427	0.382	1.803	20.70	7.44
Karnataka	1.847	0.573	2.414	23.50	6.58
Orissa	0.298	0.150	0.457	33.30	6.21
Punjab	6.932	3.832	10.764	35.80	7.77
Rajasthan	2.684	4.547	7.167	63.80	5.52
Uttar Pradesh	1.968	1.450	3.418	42.40	7.72
West Bengal	1.250	0.033	1.283	2.50	4.75
Union Territories	1.959	1.049	3.008	34.90	7.11
All-India	1.632	1.050	2.681	39.50	7.11

Source: Government of India, Department of Statistics, NSS Report No.200, Tables with Notes on Consumer Expenditure (1961-62) Part II (mimeo, New Delhi,).

13. The per capita intake of animal protein in rural India is 0.133 kgs. (for 30 days) of which around 50 per cent is obtained from milk (Table 2) There are significant differences both in the size and composition of the animal protein basket across regions in the country. In Punjab milk alone contributed 90 per cent of the animal protein, while in Kerala 80 per cent is from fish. In Punjab, Rajasthan, and Gujarat milk is the main source of animal protein, while in Kerala, Assam, Orissa and West Bengal, fish contributes the bulk of it. Meat is found to be the second largest important source of animal protein in all States.

Table 2

Per Capita Consumption of Animal Protein (Kg.) from Milk, Meat, Fish and Eggs (All-India, Rural 1961-62)

State	Sources of Protein				Total animal Protein	Average protein content of the milk (%)
	Meat & Eggs	Fish	Sub Total	Milk		
Andhra Pradesh	0.047	0.042	0.089	0.037	0.126	3.44
Assam	0.052	0.154	0.206	0.050	0.256	3.52
Bihar	0.029	0.026	0.055	0.059	0.114	3.90
Gujarat	0.011	0.006	0.017	0.242	0.259	4.00
Jammu & Kashmir	0.058	0.023	0.081	0.183	0.397	3.90
Kerala	0.034	0.22	0.256	0.027	0.283	3.31
Madhya Pradesh	0.020	0.011	0.031	0.115	0.146	3.76
Tamil Nadu	0.051	0.057	0.108	0.031	0.139	3.66
Maharashtra	0.030	0.017	0.047	0.070	0.117	3.92
Karnataka	0.032	0.015	0.047	0.085	0.132	3.51
Orissa	0.024	0.091	0.115	0.017	0.132	3.69
Punjab	0.023	0.006	0.029	0.431	0.460	3.99
Rajasthan	0.014	-	0.014	0.268	0.282	3.75
Uttar Pradesh	0.020	0.017	0.037	0.137	0.174	4.01
West Bengal	0.025	0.078	0.103	0.043	0.146	3.28
Union Territories	0.036	0.070	0.106	0.118	0.224	3.98
All India	0.034	0.042	0.076	0.065	0.141	3.98

Source: Same as for Table No.1.

14. The price per kg. of protein from milk and other animal sources varies significantly in rural India. The protein from other animal sources is found to be much cheaper in rural India, while this general pattern holds in all the States, the difference is relatively smaller in Punjab, Rajasthan and Uttar Pradesh.

Table 3

Per Capita Total Monthly Rural Consumption, Price of Milk Price of Protein from Milk and Other Animal Sources

(All India - Rural, 1961-62)

State	Per capita total rural consumption (Rs.)	Price per kg. of milk (Rs.)	Price per kg. of protein from milk (Rs.)	Price per kg. of protein from 'other animal sources' (Rs.)
Andhra Pradesh	20.11	0.48	13.95	7.30
Assam	22.23	0.54	15.42	8.30
Bihar	19.00	0.51	13.78	6.72
Gujarat	24.38	0.47	11.75	9.41
Jammu & Kashmir	24.60	0.48	12.30	10.12
Kerala	21.07	0.71	21.45	3.35
Madhya Pradesh	21.46	0.57	15.15	8.80
Tamil Nadu	21.72	0.58	15.84	7.87
Maharashtra	19.91	0.58	14.87	10.21
Karnataka	25.33	0.49	14.07	8.93
Orissa	17.40	0.57	15.44	6.31
Punjab	32.76	0.51	12.78	10.31
Rajasthan	23.48	0.48	12.86	10.00
Uttar Pradesh	22.75	0.50	12.46	12.58
West Bengal	20.33	0.59	17.98	9.51
Union Territories	25.46	0.49	12.31	12.73
All India	-	0.52	13.06	7.23

Source: Same as for Table 1.

15. The per capita intake of fat from all sources, was 0.45 kg. for rural India, a little over 40 percent of it being contributed by milk and milk products (Table 4). The total fat intake ranges from less than 0.3 kg. in Bihar and Orissa to over 1 kg. in Punjab. Milk and milk products account for barely 6 per cent of total fat in Kerala while in the Punjab they account for over 80 per cent. The per capita consumption of edible oil is around 0.26 for all India and it ranges from 0.178 kg. in Bihar to 0.49 kg. for Kerala. The source of edible

intake varies from State to State. In Punjab 85 per cent of the edible oil consumed is in the form of vanaspati. However, the composition of edible oil consumption is not relevant to our analysis as to the fat content of different types of edible oil does not vary much.

Table 4

Per Capita Consumption (Kg.) of Fat from Milk and Edible Oil and Their Respective Prices (All-India, Rural 1961-62)

State	Consumption of fat from milk	Consumption of fat from edible oil	Total	Price per kg. of ghee	Price per kg. of fat from edible oil
Andhra Pradesh	0.105	0.252	0.357	4.04	2.18
Assam	0.077	0.278	0.355	8.57	2.95
Bihar	0.114	0.177	0.291	5.35	2.76
Gujarat	0.456	0.420	0.876	7.20	2.16
Jammu & Kashmir	0.380	0.364	0.744	6.03	2.58
Kerala	0.032	0.494	0.526	5.55	0.9
Madhya Pradesh	0.205	0.290	0.495	6.15	3.04
Tamil Nadu	0.085	0.308	0.393	5.35	2.30
Maharahstra	0.134	0.233	0.367	6.42	2.14
Karnataka	0.159	0.261	0.420	5.13	2.06
Orissa	0.078	0.149	0.227	6.66	2.61
Punjab	0.840	0.252	1.092	6.67	2.85
Rajasthan	0.394	0.278	0.672	6.60	2.69
Uttar Pradesh	0.264	0.233	0.492	6.07	2.70
West Bengal	0.134	0.289	0.423	6.66	2.80
Union Territories	0.214	0.204	0.418	6.75	2.84
All India	0.191	0.261	0.452	6.08	2.41

Source: Same as for Table 1

16. The price per kg. of edible oil in 1961-62 was Rs.2.40 for rural India and that of ghee around Rs.6. The range of variation in edible oil prices across States (0.90 kg. for Kerala to 4.50 in Union Territories) is however, much greater than in the case of ghee (Rs.4.10 in Andhra Pradesh to Rs.8.6 in Assam).

Regression Results

17. There is a strong positive association between the level of per capita total consumption of animal protein as well as of fat on the one hand, and per capita total consumption expenditure on the other. In both cases, the simple linear function gives the best fit to data.[10/] The estimated regressions are as under:

$$C_p = -0.267 + 0.0204\ y \qquad R^2 = 0.64$$
$$(0.094)\ (0.004)$$

'T' values -2.786 4.948

$$C_f = -0.722 + 0.541\ y \qquad R^2 = 0.68$$

'T' values -3.273 5.615

18. The consumption of milk protein and that of total animal protein are positively correlated, the former is significantly influenced by the price of milk protein relative to other animal protein. The cheaper the milk protein compared to meat, fish and eggs, the larger trends to be the consumption of the former. Much the same relationship is evident between the intake of milk fat, total fat and the relative price of ghee to edible oil.[11/] These are clearly brought out by the following regression:

10/ In all these cases, we tried four functional forms: linear, semi-log, double-log and log-linear. In general, the estimated regressions presented in the paper relate to the functions which give the highest R^2. It may be noted that in the case of total fat, all forms seem to give similar R^2; but in the case of animal protein, the R^2s for all the other functional forms are significantly lower than in the case of the linear function.

11/ We also tested the relation between per capita intake of edible oil and ghee on the one hand and per capita total consumption expenditure on the other. Though the regression coefficients are statistically significant the R^2 values are much lower (0.38 to 0.44) compared to the regression for total fat.

$$1 \qquad C_{pm} = \underset{(0.0321)}{-0.00092} + \underset{(0.128)}{0.997}\, C_p - \underset{(0.0093)}{0.041}\, P_{mp}/P_a \qquad R^2 = [illegible]$$

'T' value -0.029 7.756 4.428

$$C_{fm} = \underset{(0.048)}{-0.0272} + \underset{(0.061)}{0.832}\, C_f - \underset{(0.014)}{0.061}\, P_g/P_c \qquad R^2 = [illegible]$$

'T' value -0.559 13.593 -4.208

19. While these partial relationships confirm our apriori expectati the hpothesis underlying the "reduced" form (equation 8 above) is o partially corroborated. As can be seen from the estimated regressio given below, the per capita total milk intake is an increasing functi of per capita total consumption expenditure, and shows a significant inverse relation to the price of milk protein relative to other anim proteins.[12/] However, the price of ghee (i.e. milk fat) relative to edible oil prices is apparently not a significant influence on total milk consumption; moreover, the sign of the coefficient is positive w is contrary to our expectation and contrary to estimated relationship ( ) above. This apparent anomaly remains to be explained.

$$\text{Log } M = \underset{(.899)}{-2.304} + \underset{(0.0375)}{0.140}y - \underset{(0.100)}{0.498}\, P_{mp}/P_a + \underset{(0.418)}{0.312}\, P_g/P_c \qquad R^2 = [illegible]$$

'T' values 2.616 4.495 -12.771 0.618

12/ A regression using relative price of milk to other animal prote instead of the relative prices of milk protein to other animal' protein, gave the following result:

$$\text{Log } M = \underset{(1.007)}{-1.968} + \underset{(0.040)}{0.146}y - \underset{(10.622)}{17.063}\, P_m/P_a + \underset{(2.831)}{2.422}\, P_g/P_c \qquad R^2 = [illegible]$$

'T' value -1.955 3.663 -1.606 0.856

In this formulation, the coefficient for relative price of milk to other protein is not statistically significant.

20. If the variable P_g/P_c were omitted on the ground that its coefficient is statistically insignificant, we get the following relationship.

$$\text{Log } M \quad \underset{(0.899)}{-2.351} + \underset{(0.0375)}{0.1607}\, y - \underset{(0.100)}{0.2723}\, P_{mp}/P_a \qquad R^2 = 0.74$$

'T' values -2.616 4.404 -2.711

II

SUPPLY FACTORS

21. As pointed out in para 4, the inter-State differences in per capita milk consumption which we observe from NSS and other surveys reflect the net effect of demand and supply factors. Having reviewed some of the factors which operate on the demand side, we now consider the factors which determine supply. Our discussion is essentially exploratory in character. The quantitative analysis is limited to testing the degree of association between inter-State differences in per capita production levels and some factors which prima facie would appear to be important in determining these levels.

Sources of data on supply

22. Statewise estimates of total milk production have been made by the Institute of Agricultural Research Statistics (IARS), on the basis of the yield rates of cows and she buffaloes obtained from sample milk production surveys and the population of milch animals as obtained from the Livestock Censuses.[13/] Even though IARS milk production surveys are conducted both in rural and urban areas, only

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13/ See, op.cit. 8. Monograph on Estimation of Milk Production.

the overall average yield rates of milch animals have been published; separate estimates of yield per animal for rural areas are not available. One could estimate rural milk output on the basis of the overall average yield rates for cows and buffaloes in each State and the corresponding population of these animals in rural areas. But, since the relative yield rates of cows and she buffaloes in rural and urban areas varies from State to State, the estimate may not be wholly reliable. Moreover, the IAHS Surveys were carried out in different States at different points of time which makes it difficult to get comparable data for all the States for the same years. We have therefore not used IAHS data.

23. The All India Rural Debt and Investment Survey, 1961-62 (AIDS) gives the estimated average value of output of milk and other milk products per household.[14/] It does not give quantity estimates. We have obtained the latter by dividing the value of output as shown by the AIDS with the average unit price of fluid milk in each State as shown by the NSS Consumption Survey Data for the same year.

24. In view of the possible defects of the estimates based on AIDS and difficulties of assessing the accuracy of the underlying data, we have also used the consumption estimates derived from the NSS (1961-62) as an alternative measure of relative production are given in Table 5. In general, the AIDS estimates imply a level of consumption (obtained by deducting cash sales from total output), which is considerably higher than that shown by NSS. However, the relative rankings of States by per capita production estimated from AIDS and by per capita consumption are more or less the same. The two surveys were done independently of each other, the use of consumption data for reflecting the relative positions of States in terms of productions seems to be justifiable.

14/ See, Reserve Bank of India, Department of Statistics, All India Rural Debt and Investment Survey, 1961-62 (Mimeo) Bombay, undated

Table 5

Total and Percapita Rural Milk Production (All India, 1961-62)

State	Total Milk Production		Per Capita Milk Production	
	AIDS	NSS	AIDS	NSS
	(000 tonnes)		(Kg.)	
Andhra Pradesh	825.40	545.20	15.35	22.94
Assam	221.00	205.50	17.31	18.61
Bihar	1197.70	859.00	18.49	25.78
Gujarat	1988.70	1519.40	73.65	96.60
Jammu and Kashmir	209.20	204.00	57.31	58.72
Kerala	197.20	130.30	7.71	11.67
Madhya Pradesh	1082.20	1202.20	37.14	33.45
Madras	623.20	350.00	10.39	18.50
Maharashtra	1104.20	867.30	21.93	27.92
Mysore	692.60	692.90	29.37	29.36
Orissa	149.20	97.40	5.55	18.80
Punjab	3444.00	2674.60	131.69	169.57
Rajasthan	1964.40	1753.00	86.95	97.44
Uttar Pradesh	3666.10	3066.50	41.58	49.71
West Bengal	579.80	545.00	15.60	16.61

Sources: 1. Same as for Table 1.

2. Reserve Bank of India, Department of Statistics, All India Rural Debt and Investment Survey, 1961-62 (mimeo) Bombay, undated.

25. Differences in per capita milk output can be viewed as a function of differences in (a) the number of milch animals per capita (b) the average yield per milch animal. The number of milch animals per person ranges from 0.07 in Kerala to 0.347 in Rajasthan. Output per milch animal is found to be the lowest in Orissa and Andhra Pradesh and highest in Gujarat and Punjab.

Table 6

Number of Milch Animals per person, Average Annual Milk output per milch animal, output of Foodgrains and Oil Seed per adult equivalent of Bovine Population, Ratio of Milch Animal Stock to total Adult Equivalent Population, and Ratio of Cows/She Buffaloes (1961-62)

State	Number of milch animal per person	Milk output per milch animal (kg.)		Output of foodgrains and oil-seeds per animal (kg.)	Ratio of milch animal stock to total adult equivalent population	Ratio of cows/she-buffaloes
		AHDS	NSS			
Andhra Pradesh	0.183	146.34	90.00	583.00	0.348	1.21
Assam	0.180	109.90	95.78	341.00	0.340	11.06
Bihar	0.122	224.72	153.43	706.00	0.267	2.30
Gujarat	0.199	615.71	369.20	680.00	0.391	0.89
Jammu & Kashmir	0.265	367.05	162.90	410.00	0.503	-
Kerala	0.072	155.29	107.00	442.00	0.400	8.33
Madhya Pradesh	0.121	119.28	115.50	438.00	0.372	3.19
Tamil Nadu	0.117	189.44	83.40	661.00	0.249	2.46
Maharashtra	0.178	205.55	123.10	578.00	0.337	2.45
Karnataka	0.206	175.35	142.10	382.00	0.338	2.07
Orissa	0.147	60.40	37.60	481.00	0.245	9.16
Punjab/Haryana	0.217	925.80	603.40	812.00	0.377	0.94
Rajasthan	0.347	324.31	250.30	432.00	0.432	1.85
Uttar Pradesh	0.169	328.50	244.70	570.00	0.352	1.02
West Bengal	0.132	189.21	176.87	534.00	0.309	18.57

Source: Human Population, Census of India, 1961, Bovine Population, Livestock Census 1961, Output of Foodgrains and Oilseeds are estimated from (a) Estimation of Area, and Production of Principal Crops in India 1961-62, (b) Estimation of Area and Production of Commercial Crops in India, 1961-62 and 1964-65, Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi.

Note: (a) The output per milch animal is obtained by dividing the total milk production by population of milch animal, (b) conversion of youngstock into adult stock is made under the following assumptions: (1) youngstock below 0-1 year is equal to one-fourth of an adult stock; (2) youngstock between 1-3 year is equal to half of an adult stock.

26. Our analysis shows that per capita milk production (X1) is positively correlated both with the number of milch animals per capita (X2) and with the yield per milch animal (X3). The total correlation coefficient between X3 and X1 is higher than that between X2 and X1 which suggests that the variations in per capita production are affected by variations in productivity per animal more than by the number of animals. (See Table below). There is no systematic or significant association between the number of milch animal per head and productivity of milch animal. This is true whether we specify (X1) in terms of per capita output as obtained from AIDS or of per capita consumption as shown by NSS. This result suggests that the factors which determine the variations in per capita milch animal stock and those accounting for variations in output per animal are quite different.

Table 7

Relation between per capita milk production (X1), number of milch animal percapita (X2) and the average yield per milch animal (X3)

	AIDS	NSS
$r_{1.2}$	0.51	0.66
$r_{2.3}$	0.16	0.24
$r_{1.3}$	0.86	0.89
$r_{1.23}$	0.92	0.99

27. In order to explain the large variations in the number of milch animals per person between different parts of India one would need to understand the factors responsible for variations in the total bovine-stock relative to human population as well as variations in the composition of the bovine herd. This raises rather complex questions which have

barely began to be examined systematically. However, for the purposes of the present enquiry, it is significant that the number of milch animals per capita tends to be high for States where the production of foodgrains is more abundant relative to population. In other words, where the per capita of foodgrains production is high, the rural population as a whole is also likely to be more prosperous and the competition between humans and animals on the product of land is apt to be less intensive, thereby enabling farmers to maintain more animals, including milch stock. There is however, no apriori basis for predicting the relation between the rate of milch to total bovine stock and the level of per capita foodgrain output. The data suggest that these two variables are not systematically related.

28. As regards the variations in output per milch animal across regions in the country W.Burns suggested an inverse relation between rainfall and output per milch cow.[15/] Ashok V.Desai, who examined the Burns hypothesis in some detail, found the relation to be rather more complex.[16/] He found that the Burns hypothesis holds for the plains but breaks down for the Deccan Plateau. He concluded that "our analysis of milk yield is not exhaustive, but they seem to depend on the availability of feeding stuff per animal and particularly on the supply of leguminous fodder. This relation between fodder supply and milk yield is clearer in the case of buffaloes than cows."[17/] On the basis of more recent data we find a weak (and statistically non-significant inverse relation between rainfall and outpur per animal (r = -0.45).

15/ W. Burns, Technological Possibilities of Agricultural Development in India (Lahore 1944).

16/ Ashok V.Desai, "The Livestock Situation", Economic Weekly, Annual Number, 1965.

17/ Ibid.

29. Since in general the buffaloes are more productive than cows, differences in the species composition of milch stock will naturally affect the overall average output per milch animal. Buffaloes are supposed to be best suited for relatively wet and humid environments. The rainfall and the ratio of cows to the she buffaloes are inversely related, the correlation coefficient (0.37) is not statistically significant. The relation between the ratio of cows to she buffaloes and average yield per milch animal has the expected negative sign, but again the coefficient (-0.29) is not significant.

30. We hypothesise that the output per milch animal will be primarily a function of the availability of feed (and in particular, concentrates) per animal. This depends on two factors: (a) the amount of foodgrains and oil seeds output per bovine and (b) the proportion of milch animals in total bovine stock. Since the age composition of bovine herd varies across regions, and since the feed requirements of youngstock is much smaller than of adults, we have expressed total bovinestock in adult equivalent units. 18/ The correlation coefficients between output per animal on the one hand and feed availability per bovine stock and ratio of milch stock to total adult equivalent bovine population taken individually are positive though weak. There is little relation between feed availability per head and the sex composition of bovine herd. However, the combined effect of both the explanatory variables on the output per milch animal is statistically significant accounting for approximately half the observed variations.

18/ In order to convert youngstock into adult equivalent units we have used the following conversion rates:

(a) one youngstock in the (0-1) age group is equal to $\frac{1}{4}$ of an adult animal;

(b) one youngstock in the age-group (1-3) is equal to $\frac{1}{2}$ of an adult stock.

Table 8

Relation Between Output per Milch animal (X1) Percapita feed Availability per bovinestock (X2) and the ratio of milch stock to total adult equivalent bovine population (X3)

	AIDS	NSS
$r_{1.2}$	0.43	0.58
$r_{2.3}$	0.02	0.13
$r_{1.3}$	0.46	0.43
$r_{1.23}$	0.66	0.72

31. As mentioned earlier, these results are neither defenitive nor complete. A fuller analysis of the supply factors will require satisfactory explanation of the factors responsible for the large variation in the cow/buffalde ratios; the reasons for differences in the proportion of milch animals which are in milk at any given point of time; the impact of cropping pattern (especially paddy monoculture) on the quality of milch animals; the extent of competition between humans and animals for available supply of protein; and, not the least important, the influence of the cost of feed (especially protein relative to the price of milk. We hope to undertake further studies on these questions in the future.