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ESTIMATION OF DEMAND FOR COARSE CEREALS: A NEW APPROACH

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The role coarse cereals play in the diet of Indians has not been brought into focus sufficiently. Maize, bajra, jowar, *ragi*, barley and a host of millets, all of them of the coarse cereal class, have been generally dubbed as 'inferior', perhaps, by the better off. The inadequate attention paid to the function of coarse cereals in the food basket of many of the poorer sections may be based on the notion that economic development resulting in a sustained growth of income will substitute them for finer cereals like rice and wheat. Here, an important assumption being made is that a significant growth of economy results not only in pushing up the income but also affects its equitable distribution very rapidly. The past experience and the future prospects for the attainment of such a goal in India belies these beliefs. The apparent neglect of coarse grains may also be due to the social and political structure which dominates the economic decision-making in the Government. Let us remember that most of the coarse grain producers (many of them themselves are consumers) are generally poor, illiterate, socially and economically downtrodden and engaged in subsistence farming in the arid and semi-arid areas of the country.

The consequences have been appalling. Coarse grains did not receive due governmental support both in the spheres of production and consumption compared to rice and wheat.[1] Economic studies on coarse cereals have also contributed to this state of affairs by covering up, unintentionally, some of the important issues. The estimation of income elasticities of consumption seems to be a case in point. The National Council of Applied Economic Research[2] and Food and Agriculture Organization,[3] among others, found negative elasticities for coarse cereals. The policy implications of such inferences are bound to be disastrous for the consuming sections who are the poorest of the country. Bapna[4] showed that, in fact, the National Sample Survey (NSS) data used in most studies depict an increasing trend of consumption with respect to expenditure (hereinafter called income) in the case of relative low income groups in the rural areas which cover a large proportion of population. The higher income segment of the consumption curve, of course, was falling. We have, therefore, given a fresh look at the NSS consumption

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We have benefited from the comments of Prof. S. L. Bapna on this paper. However, the errors are ours.

1. Barbara Harriss: Coarse Grains, Coarse Interventions, Overseas Development Studies, London, 1979 (draft).
2. National Council of Applied Economic Research: Demand and Supply Projections of Agricultural Commodities, New Delhi, 1962.
3. Food and Agriculture Organization, Agricultural Commodity Projections, 1979-80, Vol. II, Rome, 1971.
4. S. L. Bapna: Production of Coarse Cereals in India: Past Performance and Future Prospects, Economics Program, ICRISAT, Hyderabad, A. P., 1976.

data with the following objectives: (1) to evolve a method to derive the income elasticities of consumption of coarse cereals in general, and (2) to test this method to estimate the elasticities for jowar, *ragi* and barley and forecast the demand for them in the case of important consuming States of the country.

DATA AND METHODOLOGY

The data from the 27th Round consumer expenditure survey (1972-73)[5] of the NSS were used for demand estimates. Notwithstanding the shortcomings,[6] the NSS data seem to be the only source for the purpose. The bias of over-estimation shown by it can be an important handicap in demand forecasting. But as we are interested here primarily in evolving a methodology and then use it to forecast the demand in respect of different States, an equal estimation bias of data can be assumed in the analysis.

For the purpose of this study we have selected eight States where these cereals are important in the food. These States are Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu and Uttar Pradesh. The data reported for both the rural and urban areas of these States were used. Although the data of the 28th Round of the NSS were the latest available, we did not use it because of smaller sample size than in the 27th Round.

The behaviour of the consumption curves of rice and wheat, on the one hand, and jowar, *ragi* and barley, on the other in response to changes in income is shown in Figure 1. The figure is drawn for the rural consumption data of Uttar Pradesh, as it was the only State which showed consumption of all the three commodities as also the slopes of the curves much more sharply over income groups. While rice and wheat consumption functions rise almost monotonically, those of the coarse grains increase at an increasing rate initially and then decline rapidly after a certain point. If one is to estimate the elasticity of consumption by regressing the values of income on the quantities consumed, it is almost certain that he may obtain negative income coefficients. But if we infer that when income increases, consumption falls, it can be quite misleading. The figure clearly shows that this may happen only after a point and as the time taken for reaching it can be very long for the lowest income groups, the opposite of this contention is the real situation. The way to get around this problem is, perhaps, to fit two separate functions to the data. But the number of observations we can have in each group will cause a very serious drain on the degrees of freedom. In the case of urban areas, the problem is worse as only a few expenditure classes will be falling into the lower group. Exclusion of the urban areas on the ground that, in general, they account only a small amount of aggregate consumption of coarse cereals may only be side-tracking the issue.

5. National Sample Survey Organisation, "Some Results of Survey on Consumer Expenditure: NSS 27th Round (October 1972-September 1973)", and "Survey Results", *Sarvekshana*, Vol. II, No. 3, January 1979.

6. M. S. Ahluwalia: Rural Poverty in India: 1956-57 to 1973-74, India: Occasional Papers, World Bank Staff Working Paper No. 279, Washington, D.C., 1978.

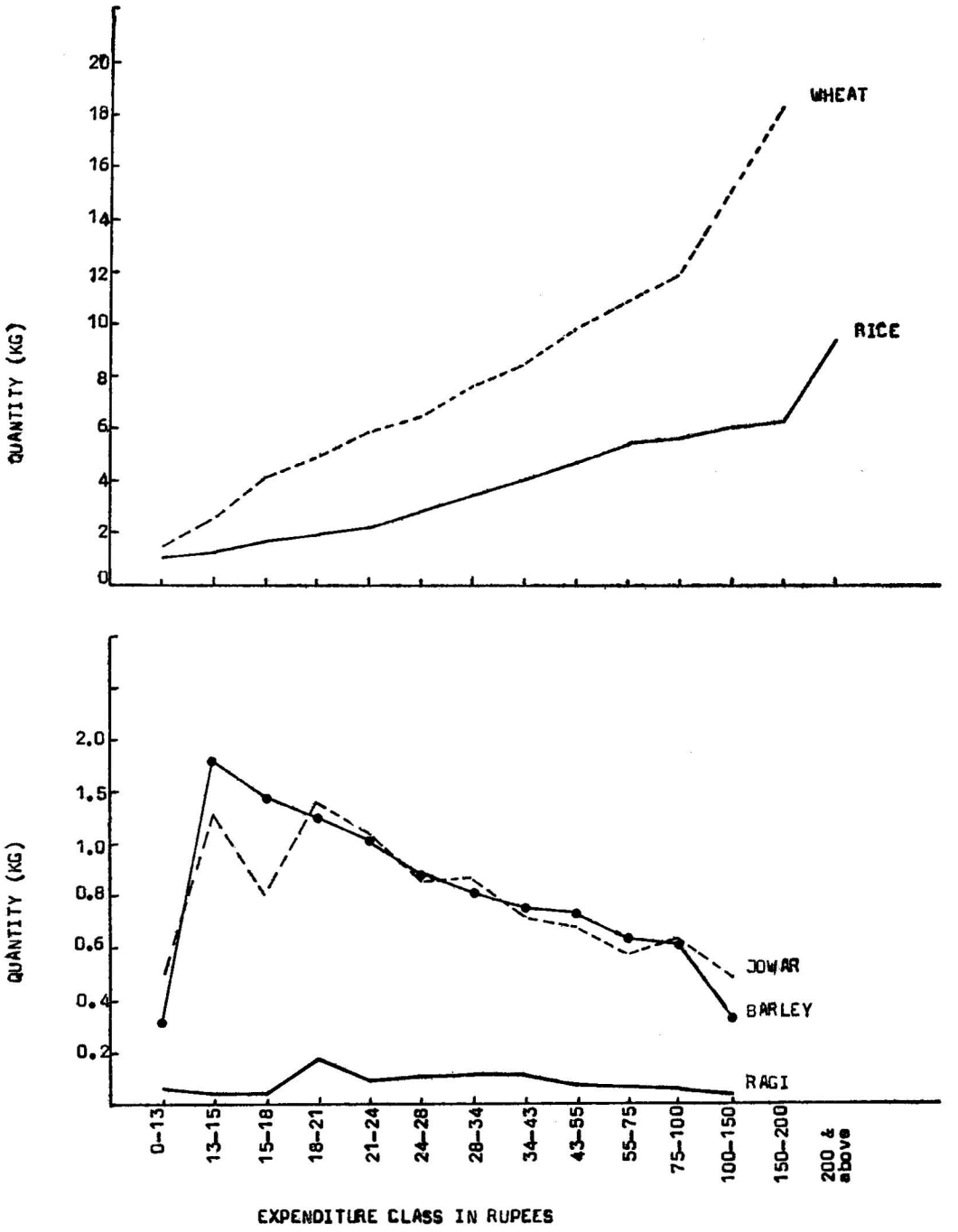

Figure 1—Monthly Per Capita Consumption of Selected Commodities by Different Income Groups—Uttar Pradesh (Rural)

The meaning of the lower and higher income groups as used in this paper is only relative. It varies from commodity to commodity, rural to urban and State to State. Again the determination of the point of inflexion at which the slope of the curve changes has been done by mere inspection and not by any mathematical curve fitting.

We specify a linear demand function as follows:

$$C = b_0 + b_1 Y + b_2 D_1 + b_3 D_2 + b_4 D_3 + b_5 D_4$$

where C = consumption per capita in kg. per month;

Y = per capita total consumption expenditure per month in rupees;

D_1 = 1 for rural areas, 0 for urban areas;

$D_2 = D_1 \times Y$;

D_3 = 1 for low income, 0 for high income, and

$D_4 = D_3 \times Y$.

Here D_1 and D_3 are intercept dummies whereas the slope dummies are indicated by the variables D_2 and D_4.

Linear, semi-log and double-log functions were estimated for each commodity and each State separately. We set up several computer runs beginning with the equation having all the dummy variables and then dropping one or more of them in the context of the data. From the selected functions, the equations for various groups were culled out.[7]

The estimated equations were used for predicting the demand for 1975-76, 1978-79, 1981-82, 1985-86 and 1989-90. The future values of the independent variable (Y) were estimated from the past behaviour of the growth of per capita State income at constant prices.[8] This information was taken from only 1968-69 and the simple annual percentage growth rates were worked out. This was done due to the absence of reliable data to calculate the growth rates of real per capita income of different States.

RESULTS AND DISCUSSIONS

Linear equations turned out to be the best fits in the case of jowar while both semi-log and double-log were relatively better for *ragi* and barley (Tables I to III). All the coefficients have the correct signs and the 't' values are significant at 5 per cent level in most of the cases. The income intercept dummy (D_3) was insignificant, meaning that the average propensity to consume does not change when income changes. But this is not true when the region is different. Note that the region intercept dummy is an important variable, indicating a shifting down of the average propensity to consume in the course of urbanisation.

The R^2 is very high for almost all the States. But the D-W statistics show autocorrelation in a few cases in respect of jowar. The income slope dummy (D_4) is significant for most of the States. The slope dummy for region (D_2) is

7. J. Johnston: Econometric Methods, McGraw-Hill, New York, 1972, and A. Koutsoyiannis: Theory of Econometrics, Macmillan, London, 1978. Also refer to P. S. George: Some Aspects of the Structure of Consumer Demand for Foodgrains in India, Working Paper No. 292, Indian Institute of Management, Ahmedabad, 1979 (mimeo.).

8. Central Statistical Organisation: National Accounts Statistics: 1970-71 to 1978-79, Ministry f Planning Government of India, New Delhi, January, 1981.

TABLE I—SELECTED DEMAND EQUATIONS—JOWAR

State	Intercept/ constant	Regression coefficients of					R^2	$\bar{R}^2$	D-W	N	Functional form
		Y	D_1	D_2	D_3	D_4					
1. Andhra Pradesh ..	1·190	—0·004** (—1·71)	1·628*** (4·87)	0·003† (1·07)		0·0016* (1·55)	0·75	0·71	1·64	28	Linear
2. Gujarat	0·730	—0·002† (—0·81)		0·014*** (4·95)	0·584* (1·77)		0·80	0·78	2·02	26	Linear
3. Karnataka	2·568	—0·008*** (—2·90)	1·227*** (3·12)			0·015*** (4·00)	0·71	0·67	0·97	28	Linear
4. Madhya Pradesh ..	0·742	—0·011*** (—8·70)		0·010*** (5·51)		0·010* (1·48)	0·81	0·79	2·03	28	Semi-log (log c)
5. Maharashtra	1·868	—0·006** (—2·15)	2·127*** (5·35)	0·010*** (3·45)		0·029*** (6·15)	0·91	0·90	0·83	28	Linear
6. Rajasthan	0·982	—0·002* (—1·37)		0·005*** (2·63)		0·042*** (3·28)	0·46	0·40	1·94	28	Linear
7 Tamil Nadu	0·403	—0·004*** (—3·65)	0·736*** (8·46)			0·008* (1·47)	0·86	0·84	0·92	24	Linear
8. Uttar Pradesh ..	0·406	—0·0018** (—2·26)	0·320*** (3·30)	0·0009* (1·44)		0·026*** (3·04)	0·70	0·64	1·51	26	Linear

Note:—Figures in parentheses indicate 't' statistics.
*** Significant at 1 per cent level of significance.
** Significant at 5 per cent level of significance.
* Significant at 10 per cent level of significance.
† Significant at 20 per cent level of significance.

TABLE II—SELECTED DEMAND EQUATIONS—RAGI

State	Intercept/ constant	Regression coefficients of				R^2	$\bar{R}^2$	D-W	N	Functional form
		Y	D_1	D_2	D_4					
1. Andhra Pradesh	0·495	—0·002** (—1·79)	0·414** (2·03)	0·004*** (2·61)	0·012** (2·50)	0·76	0·72	1·87	28	Linear
2. Gujarat	0·661	—0·927** (—2·15)	—	—	—	0·40	0·31	3·36	9	Double-log
3. Karnataka	0·255	—0·003* (—1·63)	0·263† (0·89)	0·007*** (2·93)	0·015*** (2·55)	0·65	0·59	1·33	28	Semi-log (log c)
4. Madhya Pradesh	1·046	—1·115*** (—3·47)	—	—	—	0·60	0·55	1·01	10	Double-log
5. Maharashtra	—0·092	0·155** (2·43)	—	—	—	0·35	0·29	1·53	13	Semi-log (log c)
6. Tamil Nadu	0·647	—0·006*** (—9·66)	1·470*** (19·90)	—	0·036*** (4·69)	0·96	0·95	1·31	27	Linear
7. Uttar Pradesh	—2·383	—0·0075* (—1·66)	—	—	—	0·22	0·14	1·30	12	Semi-log (log c)

TABLE III—SELECTED DEMAND EQUATIONS—BARLEY

State	Intercept/ constant	Regression coefficients of				R^2	$\bar{R}^2$	D-W	N	Functional form
		Y	D_1	D_2	D_4					
1. Madhya Pradesh	—0·587	—0·023*** (—4·69)	—	—	0·031* (1·46)	0·83	0·80	1·75	12	Semi-log (Log c)
2. Maharashtra	0·0727	—0·00018† (—0·86)	0·0497* (1·24)	0·001* (1·20)	—	0·45	0·37	2·70	23	Linear
3. Rajasthan	1·074	—0·0023† (—1·14)	—	0·006** (2·50)	0·019*** (3·85)	0·59	0·53	1·61	26	Linear
4. Uttar Pradesh	—2·343	—0·0056*** (—2·70)	2·442*** (7·36)	—	—	0·74	0·71	1·97	24	Semi log-(Log c)

TABLE IV—EXPENDITURE ELASTICITIES FOR JOWAR, RAGI AND BARLEY

State	Jowar				*Ragi*				Barley			
	Rural		Urban		Rural		Urban		Rural		Urban	
	LIG	HIG	LIG	HIG	LIG	HIG	LIG	HIG	LIG	HIG	LIG	HIG
1. Andhra Pradesh.. ..	0·036 (99)	—0·021 (1)	—0·085 (6)	—0·142 (94)	1·197 (95)	—0·173 (5)	0·861 (1)	—0·164 (99)	—	—	—	—
2. Gujarat	0·585 (100)	—	—0·092 (2)	—0·092 (98)	—0·927 (19)	—0·927 (81)	—	—	—	—	—	—
3. Karnataka	0·150 (100)	—	0·150 (28)	—0·169 (72)	1·333 (97)	0·297 (3)	0·833 (8)	—0·203 (92)	—	—	—	—
4. Madhya Pradesh ..	0·705 (93)	—0·023 (7)	—0·066 (3)	—0·794 (97)	—1·115 (25)	—1·115 (75)	—	—	0·0017 (17)	—0·0065 (83)	—	—
5. Maharashtra	0·741 (99)	—0·097 (1)	0·514 (21)	—0·130 (79)	0·003 (99)	0·003 (1)	—	—	0·470 (1)	0·470 (99)	—0·101 (4)	—0·101 (96)
6. Rajasthan	2·643 (41)	0·167 (59)	2·336 (1)	—0·139 (99)	—	—	—	—	1·119 (99)	0·181 (1)	0·825 (11)	—0·112 (89)
7. Tamil Nadu	0·345 (39)	—0·285 (61)	0·345 (2)	—0·285 (98)	1·541 (4)	—0·326 (96)	1·541 (2)	—0·326 (98)	—	—	—	—
8. Uttar Pradesh	2·486 (9)	—0·084 (91)	2·393 (1)	—0·117 (99)	—0·294 (9)	—0·294 (91)	—	—	—0·372 (99)	—0·372 (1)	—0·372 (12)	—0·372 (88)

LIG = Low income group. HIG = High income group.

Note:— Figures in brackets indicate the percentage of people in the respective income groups.

TABLE V—DEMAND FORECAST FOR JOWAR, RAGI AND BARLEY

(*thousand tonnes*)

State	Jowar					*Ragi*					Barley				
	1975-76	1978-79	1981-82	1985-86	1989-90	1975-76	1978-79	1981-82	1985-86	1989-90	1975-76	1978-79	1981-82	1985-86	1989-90
1. Andhra Pradesh	1,405 (1,020)	1,481 (1,418)	1,561	1,676	1,799	906 (370)	987 (343)	1,073	1,198	1,335	—	—	—	—	—
2. Gujarat ..	625 (554)	632 (577)	743	833	932	21 (55)	21 (39)	22	22	22	—	—	—	—	—
3. Karnataka ..	1,456 (1,695)	1,556 (1,767)	1,663	1,818	1,990	646 (1,222)	691 (1,661)	740	811	910	—	—	—	—	—
4. Madhya Pradesh	1,175 (1,349)	1,256 (1,280)	1,344	1,472	1,616	24 (6)	25 (5)	26	28	30	234 (213)	246 (209)	259	278	298
5. Maharashtra ..	3,500 (3,455)	3,794 (4,881)	4,109	4,567	5,071	748 (188)	793 (201)	841	908	979	91 (8)	97 (7)	104	115	126
6. Rajasthan ..	763 (190)	871 (331)	984	1,152	1,345	—	—				854 (1,006)	1,022 (547)	1,157	1,361	1,597
7. Tamil Nadu ..	437 (716)	452 (636)	467	489	511	706 (479)	725 (421)	743	769	784	—	—	—	—	—
8. Uttar Pradesh ..	845 (462)	901 (481)	960	1,045	1,139	88 (186)	93 (170)	98	105	113	1,074 (1,374)	1,134 (1,001)	1,199	1,292	1,392

Note:—Figures in brackets indicate the production of crops in respective years.

also significant in many cases. It can be seen from the tables that in some cases, the coefficients of income have positive signs. This is because of the increasing consumption of the concerned items with the increase in income. *Ragi* is not consumed in the urban areas of Gujarat, Madhya Pradesh, Maharashtra and Uttar Pradesh and the results pertain only to the rural areas of these States. Similarly, jowar consumption was an increasing function of income in the rural areas of Gujarat and Karnataka.

Elasticities for both low and high income groups are given in Table IV. They are positive for the low income group of the rural areas in the case of jowar and barley (except for Uttar Pradesh). A large percentage of population in the rual areas of all the States is in the low income class, signifying the fact that the positive elasticities influence the overall behaviour of the demand for coarse cereals. The upward shift of the real income will push up the per capita demand for coarse cereals. But it is also true that once the income of the poor starts rising rapidly, a stage may come at which the demand may turn negative.

Forecast demand for jowar, *ragi* and barley is shown in Table V. We estimated the exponential growth rates of both the rural and urban population of various States between 1971 and 1981 and assuming that they will not change till 1991, the figures for the forecast years were arrived at. The consumer expenditure tables in the NSS reports give the number and size of sample households in each expenditure class. We estimated the percentages of persons falling in the low and high income groups for jowar, *ragi* and barley and assumed that they were true for the particular State as a whole. Further assuming that those proportions may not change during the forecast period, the population falling in the different income groups was worked out. The per capita projected demand was multiplied by the population figures to get the aggregate estimates. If Tables IV and V are read together, it will be evident that the falling per capita demand of high income groups is overtaken by the rising demand of the low income groups who form a large segment of the population.

There is no direct way in which the forecast figures can be verified for their consistency. We worked out the net exports and imports of jowar (data for *ragi* and barley are not available) among different States on the basis of data on inland movements given in the Bulletins on Food Statistics of Directorate of Economics and Statistics, Ministry of Agriculture, Government of India. These figures were adjusted against the production data and the demand forecasts were compared. The figures for 1975-76 were consistent for all the States except for Rajasthan and Uttar Pradesh. In these two States, the consumption demand far surpassed the net availability, indicating heavy imports of jowar, perhaps, by road, which are unaccounted for in published statistics.

CONCLUSIONS

The method employed in this paper has a few weak points. Instead of the OLS, a weighted form of it should have been the appropriate one to estimate demand equations from grouped data. We could not use this as it was quite

involved. The hyperbolic forms of the functions, perhaps, might have been better suited for the purpose. Our effort has been mainly to show that the negative income elasticity of demand for coarse cereals derived by many studies is based on the erroneous assumption of the monotonous decline of the consumption curves for coarse cereals. Avenues for improving the measurement of consumption function and its precision exist and need to be utilized for formulating more informed policies.

IMPROVED TECHNOLOGY FOR COARSE GRAINS: SOME CONSTRAINTS

P. Rangaswamy*

Technical change which is a major source of growth has been, in general, slow in the case of coarse cereals, pulses and oilseeds compared to superior cereals. The fact that the former are largely grown on drylands subject to the vagaries of monsoon has been partly responsible for the slower impact of even available innovations on these crops. Other constrainsts to growth like the low value of coarse cereals, the low income and price elasticities of demand and restrictions of their markets to the specific areas where they are grown, have also been mentioned.[1] Under such conditions, technological change and the consequent expansion of output may depress prices and this may act as a disincentive for further spread of the technology.[2]

However, this is true only of inferior grains and not pulses and oilseeds. Hence, if research effort is directed towards these crops, "the terms of trade may not turn significantly against such (dry) regions, in the wake of a technological change in respect of millets."[3]

Research in dry farming technology received a new impetus with the launching of the All India Co-ordinated Research Project for Dryland Agriculture (AICRPDA) under the Fourth Five Year Plan. This Project has 23 co-ordinating centres in different agro-climatic regions of the country. Experiments are being conducted on a wide range of crops including jowar, bajra, *ragi*, maize, gram, *moong*, groundnut, castor, etc., and proven results are carried on to the farmers through the agency of Integrated Dryland Agriculture Development Project (IDADP) in each area. This paper will confine itself to an economic analysis of some experimental and survey results in two centres, *viz.*, Hissar in Haryana and Kovilpatti in Tamil Nadu, with respect to three crops—jowar, bajra and gram. It will focus on the profitability of the technology, its adoption rates and constraints.

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1. N. S. Jodha, "Prospects for Coarse Cereals: Permanent Constraints of Jowar and Bajra", *Economic and Political Weekly*, Vol. VIII, No. 52, December 29, 1973; Dharm Narain, "Growth and Imbalances in Indian Agriculture", *Economic and Political Weekly*, Vol. VII, No. 13, March 25, 1972.

2. For example, this is what happened in Rajasthan and Gujarat during 1969-70, when bajra prices crashed due to glut and adversely affected the adoption of hybrid bajra. See Jodha, *op. cit.*

3. C. H. Hanumantha Rao: Technological Change and Distribution of Gains in Indian Agriculture, Macmillan Co. of India Ltd., New Delhi, 1972, p. 197.