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Agricultural Development and Calorie Consumption in Rajasthan: An Analysis through Econometric Modelling

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Abstract: The agricultural development is linked with calorie-consumption as it makes available the subsistence production and generates income to buy sufficient food. The calorie consumption, was studied in two districts, Jodhpur (with inadequate agricultural development) and Jaipur (with adequate agricultural development). Using econometric models it is found that marginal propensity to obtain a calorie intake in relation to household income is only 0.083 in case of Jodhpur and tends to be negative in case of Jaipur with agricultural development. However, raising subsistence production by one unit, the calorie intake is almost doubled in Jodhpur. The local food preferences are of paramount importance here. The results suggest that in order to check calorie-inadequacy in desert population through agricultural development, the strategies should be to promote more the subsistence production of local calorie-rich crops.

Key words: Malnutrition, consumer unit, household income, subsistence production, agricultural development, econometric analysis.

Malnutrition (calorie inadequacy) is a major cause of child mortality in developing countries. Agricultural development is linked with the problem of malnutrition. The agriculture not only makes available subsistence production (agricultural produce not sold, but consumed by the farmer), but also generates income through the sale of its produce. The problem of malnutrition in the community, therefore can be viewed through the development of agriculture in such a way that every household is in a position to produce or to purchase the required food. The development strategies may even aggravate the situation of malnutrition in a community if they are aimed at capital formation and maximization of per capita income (WHO, 1976). A tendency to accumulate income, results in a non-linear relationship of increased food availability with its intake (Beaton, 1982). In this situation, the role of subsistence production becomes important as it affects the income elasticities for food. Therefore, it is important to study the malnutrition in a community through the role of the two components of agricultural development, income generation and subsistence production.

The paper reports one such study from Rajasthan considering the role of the two components on calorie consumption across different size class of farmers.

Materials and Methods

A cross-sectional survey in the year 1991 was carried out in Jodhpur, a typical desert

district with inadequate agricultural development and Jaipur, a district with adequate agricultural development.

According to Statistical Abstracts, Rajasthan (Anonymous, 1987), the cropping intensity was 102 in Jodhpur and 128 in Jaipur. In Jodhpur around 70% of the area was occupied by pearl millet and kharif pulses. In Jaipur it was only 40%, due to cultivation of 'cash crops'. In Jodhpur per hectare calorie production was only one-tenth of that in Jaipur district.

Based on population size all the villages in each district were divided into four strata. From each stratum, four villages were selected by simple random sampling without replacement (SRSWOR). A list of household (H/H) was prepared and stratified as per the categories of farmers, viz., marginal, small, medium and large in each district. Farmers having less than 1 ha land were classified as marginal, those having 1 to 4 ha as small, between 4 to 10 ha of land as medium and above 10 ha as large farmers. A sample of 30 H/H from each category was selected at random, constituting a sample of 120 H/H from each district. Administering the pre-tested schedules, the relevant H/H level data was obtained so as to record the values of the following variables:

Yearly income per CU: The total yearly expenditure per Consumer Unit (CU), as used by National Institute of Nutrition (NIN, 1980), was taken as proxy to the yearly income per CU of a household. The variable was denoted by M_T.

Yearly expenditure on food per CU: The total yearly expenditure on food, as recorded at H/H level and converted in CU, was denoted by M_f. Its complement variable, (M_T-M_f), i.e., yearly expenditures on non-food items was denoted by $M_{\bar{f}}$.

Expenditure on calorie consumption per CU: Using 24 hours recall method of dietary surveys conducted by National Institute of Nutrition (NIN, 1982), calories consumed per CU per day at household level were calculated and converted to money equivalent by the worked out fraction of 0.52, depending upon the prevailing prices in the region. Thus, if at a household level, c calories were consumed per CU per day, then (0.52)c was the amount in rupees spent on it. This was our variable, expenditure on calorie consumption per CU and was denoted by Mc. Its complement variable, $[M_{\bar{T}}-(0.52)c]$, which relates to other expenditures on similar scale was denoted by $M_{\bar{c}}$.

Subsistence production per CU: During the survey the land possessed and the average agricultural produce retained for home consumption by each H/H was recorded. Based on average production of cereals per ha, as per the statistical Abstracts, Rajasthan (1987), the annual produce was multiplied by the Houehold's average produce retained for home consumption. The entity, when scaled as per the CU, and expressed in terms of its money equivalent, based on the prevailing prices; determined the study variable, subsistence production. The variable was denoted by the symbol S.

Econometric analysis

In order to study the calorie consumption as influenced by the two components of agricultural development, under consideration, use of econometric analysis was made, as the explanatory variables here are themselves governed by the other variables.

Analysis 1: *Household income and calorie consumption*

To study the relationship between income (total expenditure taken as income proxy) and calorie consumption at household level, the following simultaneous equation model was proposed:

Model (I)

$$M_T = M_c + M_{\bar{c}} \quad \ldots (1)$$

$$M_c = \beta + \alpha M_T + U \quad \ldots (2)$$

where,

The constant α represents marginal propensity to spend on calorie intake,

β is also a constant to be estimated,

M_T is total expenditure per CU,

M_c is expenditure to obtain c calorie intake, both M_T and M_c are endogenous variables,

$M_{\bar{c}}$ relates to other expenditures on similar scale and is an exogenous variable, and

U is random error term.

Partitioning the total expenditure in two parts, viz., expenditure towards calorie intake and all other expenditures, the model (I) assumes that expenditures towards calorie intake are influenced by the total income.

To make Model (I) complete, the following assumptions are made:

(a) $E(U) = 0; \; E(U^2) = \sigma^2$

U's are serially uncorrelated, i.e.,

$E(U_i \; U_j) = 0 \qquad i \neq j$

(b) $M_{\bar{c}}$ is autonomous in relation to M_c and M_T, i.e.,

$E(M_{\bar{c}} \; U) = M_{\bar{c}} \; E(U) = 0$ by (a)

In order to obtain reduced form equations, we put M_c from (2) in (1) and M_T from (1) in (2). The reduced form equations are:

$$M_T = (\beta/1-\alpha) + (1/1-\alpha) \; M_{\bar{c}} + (1/1-\alpha)U \quad \ldots (3)$$

$$M_c = (\beta/1-\alpha) + (\alpha/1-\alpha) M_{\bar{c}} + (1/1-\alpha)U \quad \ldots (4)$$

Let the least square estimates of

$$(\beta/1-\alpha) = \alpha_0; \; (1/1-\alpha) = \alpha_1, \; (\alpha/1-\alpha) = \alpha_2$$

The estimates of α and β are then given by:

$$\alpha = \alpha_2/\alpha_1 \text{ and } \beta = \alpha_o/\alpha_1 \quad \ldots (5)$$

Estimates given by (5) are consistent estimates of α and β.

Analysis 2: *Subsistence production, expenditure on food and calorie consumption*

As subsistence production plays an important role in studying the calorie consumption in the community, the study of the subsistence production, expenditure on food and calorie consumption, was made through the following structural model,

Model (II)

$$M_c = \alpha_0 + \alpha_1 S + \alpha_2 M_f + U_1 \quad \ldots (1)$$

$$M_f = \beta_0 + \beta_1 M_c + \beta_2 M_{\bar{f}} + U_2 \quad \ldots (2)$$

where,

S is money equivalent of subsistence production,

M_f is expenditure on food,

$M_{\bar{f}}$ is expenditure on non-food items,

M_c is expenditure incurred to obtain c calorie intake,

U_1 and U_2 are random error terms,

$\alpha_0, \alpha_1, \alpha_2, \beta_0, \beta_1, \beta_2$ are model parameters.

The structural model (II) assumes that the expenditure on calorie intake is influenced

Table 1. The estimated values of parameters of model (I) for the different categories of farmers in two districts

Categories of farmers	Estimated values of α and β			
	Jodhpur		Jaipur	
	α	β	α	β
Marginal	0.065	669.81	-0.042	216.87
Small	0.142	938.46	-0.207	779.12
Medium	0.067	438.84	0.174	412.22
Large	0.059	1603.31	-0.078	1353.83
Overall	0.083	1085.22	-0.038	689.05

by the available subsistence production and the expenditure incurred on food. Expenditure on food is assumed to be a function of expenditure on calorie and expenditure on other less calorie rich food items. Substituting M_f in (1) from (2) and M_c in (2) from (1), the reduced form equations are given by:

$$M_c = r_{11} + r_{12} S + r_{13} \overline{M_f} + V_1 \quad ...(3)$$

$$M_f = r_{21} + r_{22} S + r_{23} \overline{M_f} + V_2 \quad ...(4)$$

where,

$r_{11} = (\alpha_0+\alpha_2 \beta_0)/(1 - \alpha_2\beta_1)$;

$r_{12} = \alpha_1/(1 - \alpha_2\beta_1)$;

$r_{13} = \alpha_2\beta_2/(1 - \alpha_2\beta_1)$;

$r_{21} = (\beta_0+\beta_1\alpha_2)/(1-\beta_1 \alpha_0)$

$r_{22} = \beta_1\alpha_1/(1-\beta_1 \alpha_2)$

$r_{23} = \beta_2/(1-\beta_1 \alpha_2)$ ...(5)

V_1 and V_2 represent random error terms. They are functions of U_1 and U_2.

The estimates of r_{11}, r_{12}, r_{13}, r_{21}, r_{22}, r_{23} are obtained by applying ordinary least square (OLS) technique to the reduced form equations (3) and (4) of model (II). The estimates of model parameters α_0, α_1, α_2, β_0, β_1, β_2 are then worked out using relation (5).

In order to make the model complete, again the similar assumptions are made, viz., $E(V_j) = 0$; $E(V_j^2) = \sigma^2$; $j = 1, 2$ and V_j are serially uncorrelated, i.e., $E(V_jV_k) = 0$; $j \neq k$.

Following the method of substitution, the estimates of the parameters of model (II) obtained in terms of the parameters of reduced form equations (3) and (4) are:

$\alpha_0 = r_{11} - r_{21} r_{13}/r_{23}$;

$\alpha_1 = r_{12} - r_{22} r_{13}/r_{23}$;

$\alpha_2 = r_{13}/r_{23}$;

$\beta_0 = r_{21} - r_{11} r_{22}/r_{12}$

$\beta_1 = r_{22}/r_{12}$

$\beta_2 = r_{23} - r_{13} r_{22}/r_{12}$

Results and Discussion

The estimated values of the parameters of model (I) and (II) are given in Tables 1 and 2, respectively. It can be seen from Table 1 that the marginal propensity to obtain calorie intake in relation to household income is very low in case of Jodhpur and takes negative value in case of Jaipur. The overall value of $\alpha = 0.083$, in case of Jodhpur signifies that increasing the household income

by one unit, there is increase in obtaining the calorie intake by only 0.083 units. However, in case of Jaipur there is a decrease by 0.038 units. The trend is observed more or less the same, in all the categories of farmers within the two districts.

From Table 2, on comparing α_1, it can be seen that in case of Jodhpur, if the subsistence production is raised by one unit, the calorie intake is enhanced by 1.83 units (almost double); whereas; in case of Jaipur, the enhancement of calorie intake is just by 0.140 units. The value of α_2, in case of Jaipur, is 5.26. It means that with an unit increase in expenditure on food, there is a sharp rise of (more than 5 units) calorie intake. This trend is not observed in case of Jodhpur.

The higher value of β_1, in case of Jodhpur; indicates that for an increase in unit calorie intake, the expenditure on food is to be raised by 0.76 units for Jodhpur while by 0.22 units for Jaipur.

The low value of marginal propensity to obtain a calorie intake in relation to household income, signifies less effectiveness of increase in household income in enhancing the calorie intake. The picture becomes worse with agricultural development, as the value is negative in case of Jaipur. The reason appears to spend more on other items than on calorie intake. The findings thus contradict the fact that to address the malnutrition in a community in the study area, adequate income generation is must. Perhaps, due to insecurity; the inherent characteristics in the farming community in the area are to accumulate the income, or to spend it more on items of secured living, e.g., gold purchase, construction of house etc.

Table 2. Estimated values of the parameters of model (II) for the two districts

Model parameters	Estimated values of model parameters	
	Jodhpur	Jaipur
α_0	-1917.13	-2478.98
α_1	1.83	0.14
α_2	-0.51	5.26
β_0	-1086.58	405.80
β_1	0.76	0.22
β_2	1.38	0.20

It is observed, however, from Table 2 that the subsistence production is more effective in enhancing calorie intake in Jodhpur. For unit increase in subsistence production, the calorie intake increased substantially.

The local food preferences are of paramount importance, as is noted by the values of α_2 in both the districts. The increase in food expenditure not accompanied by suitable increase in expenditure on calorie-rich food (as indicated by higher β_1) results in the prevalence of malnutrition (Shah, 1980).

The analysis thus indicates that with the agricultural development, the tendency is towards income accumulation and/or to spend it more on less calorie-rich food items. The local food preference, however, plays an important role in enhancing the calorie intake.

More emphasis on adequate income generation through agricultural development may therefore, yield little useful results. As the subsistence production is found more effective than the income, this should be promoted, keeping in view of the local food

preferences, as they are of paramount importance. Hence, in order to increase the calorie consumption in Rajasthan, through agricultural development, strategies should be directed to promote the cultivation and consumption of locally preferred, calorie-rich crops.

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