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Labour Decomposition Analysis under Different Soil and Land Irrigability Environments in the Kakrapar Left Bank Canal Irrigation Project in Gujarat State

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Abstract: An attempt has been made to decompose the change in labour demand between irrigation classes and between soil degradation levels into technological component and complementary input components. The employment decomposition model was employed. Two stage random sampling technique was used to select the farm households. At the first stage, 18 villages were randomly selected from the Kakrapar Left Bank Canal (KLBC) command in a way that it represented all the irrigability classes. The KLBC is having only II, III and IV classes of land irrigability. Ten farmers who had benefited from the canal water were randomly selected from each of the selected villages. Finally, the selected farmers were stratified according to soil degradation perceived by them. The Cobb-Douglass production was fitted to establish the relationships with land irrigability classes and soil degradation, which revealed that land irrigability class and soil degradation levels had negative relationship with yield of the crops. The use of other inputs had positive effects on yield. The results revealed that magnitude of change in labour demands depends upon the change in irrigation classes and soil degradation levels. The complementary inputs like family labour and fertilizers used had a direct positive effect.

Key words: Land irrigability class, environment.

A positive effect of technical change on employment has been reported (Billings and Singh, 1969; Bisaliah, 1978; Hanumantha Rao,1976; Singh, 1976) if associated with irrigation and cropping intensity. However, Raj Krishna (1976) reported that the direct effect of new technology on employment was negative. The combined effect of labour-saving technology on change for individual crops has been either stagnant or may have fallen in absolute terms. The introduction of labour-saving technologies in agriculture was reported to enhance income. Vaidyanathan (1978) explained inter-regional variation by arguing that: (i) bio-chemical technology and soil moisture had an intrinsic capacity to raise land yields, (ii) physical (including human) energy inputs contributed to yields, not through biotechnology application, and (iii) human labour use was governed by land yields and relative prices of different inputs. None of these studies indicated the effect of different land irrigability classes and also accounted for the impact of soil degradation on the employment. Different land irrigability classes and soil degradation levels do contribute to the decline in crop yields.

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This decline in yield would result in a notable reduction in employment generation and also in use of other inputs. An attempt has been made to examine changes in employment attributable to land irrigability classes and soil degradation levels.

Concept

Land irrigability classes

The production performance of any crop is primarily guided by soil parameters like texture, slope, soil depth, water-holding capacity, internal drainage, etc., as these parameters define the land capability or sustainability to different crops. Generally there are eight recognised land capability classes. The class I to IV are suitable for crop production with negligible to moderate obstacles while class V to VIII are completely unsuitable for crop production, with very severe obstacles, like topographic, drainage or others soil conditions (Donald,1980). Artificial drainage is only required where natural drainage is poor (Benoit Lesatfre, 1992). For agricultural production, land capability class III is marginally economical and thereafter, reduction in yield starts (Sehgal *et al.*, 1989). Under irrigation conditions, land capability class is called as Land Irrigability Class.

Water logging and salinity

The suitability of soils for irrigation in arid and semi-arid regions is mainly influenced by the seven factors, viz., soil depth, calcium carbonate content, gypsum status, texture, slope, internal drainage and water holding capacity (Sys and Verheye, 1974). The status of soil internal drainage systems is responsible for water logging. The water applied to the crops also percolates deep in profile of the soils. Due to imperfect and poor internal drainage of soils, the water accumulates in the soil profile. Gradually water level reaches the root zone of the crops. Sometimes, it may be on the surface. Such soils are prone to water logging and salinity (Sehgal *et al.*, 1989). Due to the brackish ground water, the salts come to the surface through capillary rise. Water will evaporate leaving salts on surface. Artificial drainage is required only where natural drainage is poor (Benoit Lesatfre,1992). Such soils are classified as land irrigability class III, IV and V.

Materials and Methods

Sampling

The Kakrapar is one of the largest irrigation projects in the Gujarat state with a capacity to irrigate 2.04 lakh hectare area. The project has two main canals, Kakrapar Right Bank Canal Command (KRBC), and Kakrapar Left Bank Canal (KLBC). For the present study, the KLBC was purposefully selected. Two stage random sampling technique was used to select the farm households. At the first stage, 18 villages were randomly selected from the KLBC in a way that it represented all the irrigability classes. The KLBC is having only II, III and IV classes of land irrigability. Ten farmers who had been benefited from the canal water were randomly selected from each selected village. Finally, the selected farmers were stratified according to soil degradation perceived by them. The sampled farmers were distributed according to irrigability classes and soil degradation levels, which is based upon the farmers' perception about the problems.

The Cobb-Douglas production function of following form was used:

$$\text{Ln } Y = \text{Ln } A + a_1 \text{ Ln } HL + a_2 \text{ Ln } FERT + a_3 \text{ Ln } FL + a_4 \text{ Ln } OWN + U1 \quad ...(1)$$

where,

Y = yield of crop measured in q ha^{-1} for paddy and t ha^{-1} for sugarcane,

FERT= expenditure on fertilizers and manure (Rs. ha^{-1}), (FERT),

HL = hired labour in mandays ha^{-1} (HL),

FL = family labour in mandays ha^{-1} (FL), and

OWN= other expenses including seed, irrigation, chemicals, and ploughing charges, etc. (Rs. ha^{-1}) (OWN).

Following a UOP Profit Function in logarithmic form was used as specified below:

$$\pi = \text{Log } A^* + b_1 \text{ Log } W + b_2 \text{ log } PERT + b_3 \text{ Log } FL + b_4 \text{ Log } OWN \quad ...(2)$$

where,

$$A^* = A^{\theta} (1 - a_1) a_1^{a} 1^{\theta}$$

$$b_1 = a_1^{\theta} < 0; \; b_2 = a_2^{\theta} > 0, \; b_3 = a_3^{\theta} > 0; \; b_4 = a_4^{\theta} > 0$$

$$\text{Let } \frac{1}{1-a_1} = \theta$$

Definition of FERT, FL, OWN are the same as in equation (1) and π is defined as per hectare profit.

It was evident from the way the parameters of profit function (2) were defined that production function (1) and the UOP profit function (2) were closely related. The crucial feature of the function (2) was that it assumed firms to behave according to some decision rules like profit maximization, given the price for output and labour, and given the quantities of other inputs. The employment decomposition model was formulated with the help of labour demand function, which in the UOP Profit Function was worked out as follows:

$$\frac{W.HL}{\pi} = (-b_1)$$

Taking logarithms and rearranging the terms:

$$\text{LogHL} = \text{Log } (-b_1) - \text{Log } W + \text{Log } \pi$$

Substituting the value of Log π and LogW from equation (2)

$$\text{Log } HL = \text{Log } (-b_1) + \text{Log } A^* + (b_1 - 1) \text{ Log } W + b_2 \text{ Log } FERT + b_3 \text{ Log } FL + b_4 \text{ Log } OWN \quad ..(3)$$

An employment decomposition model was formulated by using the labour demand function. The final equation was:

$$\frac{dHL}{HL} = \frac{\theta\, dA}{A} + \frac{\theta\, da_1}{a_1} + [\theta^2 (\log A + \log a_1) da_1 - \theta^2 (\log w) da_1 + \theta(\theta^2 (1-a_1) da_2 + a_2\, da_1) + a_2\, da_1) \log FERT + (\theta^2 (1-a_1) da_3 + a_3\, da_1) \log FL + (\theta^2 (1-a_1) da_4 + a_4\, da_1) \log OWN - (\theta a_1 + 1) \frac{dW}{W} + \frac{\theta a_2\, dFERT}{FERT} + \theta a_3 \frac{FL}{FL} + \theta a_4 \frac{dOWN}{OWN} \quad ...(4)$$

Equation (4) allows to decompose per hectare change in employment $\frac{dHL}{HL}$ into three components:

Technology effects: The effect of shifts in scale parameter (A) and slope parameters (output elasticities) in production function (1), given W, FERT, FL and OWN as under old technology. This effect was captured by adding the values of first two bracketed expressions of employment decomposition equation (4).

Normalized wage rate effect: Denoted by third bracketed expression in employment decomposition model (4).

Complementary inputs effect: Denoted by last bracketed expression and includes employment effects of difference in quantities of inputs, given the new technology output elasticities.

The employment decomposition model (4) measured the sources of change in employment between different land irrigability classes and also between soil degradation levels for sugarcane and paddy. The output elasticities with respect to various inputs are the same for different irrigability classes and soil degradation levels due to existence of Hicks-neutral type technical change. This was indicated by $da_1 = da_2 = da_3 = da_4 = 0$. Substituting these values in equation (4), the decomposition model becomes:

$$\frac{dHL}{HL} = \frac{\theta\, dA}{A} + (\theta\, a_1 + 1)\frac{dw}{W} + \theta a_2 \frac{dFERT}{FERT} + \frac{\theta a_3\, dFL}{FL} + \frac{\theta a_4\, dOWN}{OWN} \quad ...(5)$$

Normal wage rate $W = \frac{P_n}{P_y}$

where,
P_n = money wage rate, and
P_y = price of output per unit.

Since the price of Pn and Py was the same in the command area under all the irrigation classes and soil degradation levels, the change in normal wage rate was zero.

The final decomposition equation therefore was: .

$$\frac{dHL}{HL} = \frac{\theta\, dA}{A} + \theta a_2 \frac{dFERT}{FERT} + \theta a_3 \frac{dFL}{FL}$$

$$\theta a_4 + \frac{dOWN}{OWN} \quad ...(6)$$

Equation (6) is the final decomposition equation for employment change. To estimate employment change, the parameters of production function and per hectare input levels were needed. For managing constant returns to scale and Hicks-neutral technical change, a pooled least square regression model was estimated. It has been argued that ordinary least square applied to the UOP Profit Function and the Labour Demand Function separately were consistent. However, these estimates were argued to be inefficient because b_1 appeared in both the equations. So a more efficient approach was to estimate (2) and (3) jointly, imposing the conditions that b_is were equal. Zellner's Method provided an efficient estimate as it would reduce the standard errors than those of single equation least squares. So the estimation procedure in the present study is likely to have some bias in the values of coefficients.

Results and Discussion

Estimated regression model

The estimated results of log-linear function showing the effects of the selected factors on productivity along with their standard errors and coefficients of determination (R^2) for sugarcane and paddy (Table 1). The input variables included in the production function explained 94 and 88% variation in the productivity of sugarcane and paddy, respectively. The observed 'F'