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Labor Decomposition Analysis Under New Technology of Legume Crops in Arid Zone of Rajasthan

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Abstract: The paper attempts to define the factors showing the effects on output and use of labor in case of old and new technology along with complementary input components. The new technologies are supposed to increase economic growth by increasing productivity, efficiency and profitability. It was found that increases in labor employment due to adoption of new technology of moth bean and clusterbean were 57.44 and 47.61%, respectively. It was further observed that the increase in employment was mainly due to technical changes which were 42.02 and 25.18% in moth bean and clusterbean, respectively. Therefore, it can be concluded that modern technology adopted for cultivation of moth bean and clusterbean is supposed to increase the employment generation and agricultural production in the arid zone of Rajasthan.

Key words: Impact, decomposition, labor.

India is an agrarian country and about 70% population lives in rural areas. Inspite of the Government efforts to promote development program over 50% of the rural people are still living in poverty. Rural poor have to migrate with their families in search of daily wages, which is not assured. Therefore, reliable techniques need to be developed to assess a strategy for high agricultural production and employment generation. The effects of increase in production and productivity on rural employment has received considerable attention during past decade. Vaidhyanathan (1978) explained inter-regional variation in agricultural production by arguing that (i) biochemical technology and soil moisture have intrinsic capacity to raise yields, (ii) physical (including human) energy inputs and (iii) human labor use governed by yields and relative prices of different inputs. Billings and Singh (1969), Bisaliah (1978), Hanumantha Rao (1976) and Singh (1976) have reported that labor employment in agricultural sector can be increased if modernization process is associated with increase in irrigated areas, HYV and cropping intensity. On the contrary, Rajkrishan (1976) found that effect of modern technology on employment generation was negative in Punjab. It was due to combined effect of labor saving technological change for individual crops. The total labor absorption has either been stagnant or may have fallen in absolute terms in several technologically dynamic states. State level analysis suggested that the development is associated with rapid mechanization and increased use of chemical fertilizers and pesticides.

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The introduction of labor saving technology in agricultural sector promises increase in income (Bhalla, 1987). Scanty informations are available in dry land agriculture, particularly in arid zone of India. Arid zone is characterized by wind erosion, low and erratic rainfall, high temperature and high wind velocity, poor soil fertility status with moisture stress during kharif season. These factors lead to low and unstable crop yields.

Socio-economic status of the farmers as well as communication and transport infrastructure is very poor. Therefore, these areas are still agriculturally backward and agriculture is practiced in traditional ways with negligible inputs like fertilizers and plant protection measures. In moth bean and clusterbean a value addition has been attempted. The new technology increased the use of inputs crop productivity and employment generation. What is the source of employment change? How much of additional employment generation is due to modern technology? What proportion of change in employment can be attributed to other complementary inputs? The specific objective of this paper is to decompose the change in labor employment under new technology of legume crops in arid zone of Rajasthan.

Materials and Methods

The moth bean and clusterbean together occupied nearly 30% of total cropped area during 1996-97. The study is based on the data collected from two villages Lakhusar and Beru adopted under DDP/TOT project of Central Arid Zone Research Institute, Jodhpur. Twenty farmers were selected under new technology demonstrated and works undertaken by CAZRI. The new variety of moth bean and clusterbean were RMO-40 and RGC-936, respectively. The data collected were for 1996-97. The objective was to evaluate the primary data collected from a field survey of 20 farmers in the adopted villages.

The Cobb-Douglass per hectare production function of the following form was used:

$$\text{Log } Y = \text{Log } A + a_1 \text{ Log HL} + a_2 \text{ Log FERT} + a_3 \text{ Log FL} + a_4 \text{ Log OWN} + U \quad \ldots (1)$$

where,

Y = Output of crop (q ha^{-1})

HL = Hired labor employed (man-days ha^{-1})

PERT = Expenditure on fertilizers and manure (Rs. ha^{-1})

FL = Family labor employed (man-days ha^{-1})

OWN = Value of other expenditures (Rs. ha^{-1}), it includes ploughing, irrigation, pesticides, depreciations and interest on working capital, etc.

A = Constant term of scale parameter

a_1, a_2, a_3, a_4 = Partial output elasticities of hired labor, fertilizer, family labor and other expenses.

The method of Lau and Yotopoulos (1971), a UOP Profit Function in logarithmic form was used as specified below:

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

where,

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

$b_1 = a_1^{\phi}<0$; $b_2 = a_2^{\phi}>0$; $b_3 = a_3^{\phi} > 0$ and $b_4 = a4^{\phi}>0$

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

Definition of FERT, FL, 0WN are the same as in (1) and π and W are defined as per hectare profit and normalized wage rate Bisaliah (1978) defined normalized wage rate is the ratio of Pn and Py, respectively.

Normal wage rate W = Pn/Py

where, Pn = money wage rate, and
Py = price of output per unit.

It is evident from the way in which 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 labor, other inputs. The employment decomposition model was formulated with the help of labor demand function, which in the UOP Profit Function was worked out as follows:

$W*HL/\pi = (-b_1)$

Taking logarithms and rearranging the terms:

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

Substituting the value of Log π and Log W 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 labor demand function. The final equation was of the following form (Bisaliah, 1978):

$$\Delta HL/HL = [\phi \Delta A/A] + \{\phi \Delta a_1/a_1 + \phi^2 [\text{Ln } A + \text{Ln } a_1) \Delta a_1] - \phi^2 (\text{Ln } w) \Delta a_1 + \phi_2 [(1-a_1) \Delta a_2 + a_2 \Delta a_1] \text{ Ln FERT} + \phi^2 [(1-a_1) \Delta a_3 + a_3 \Delta a_1] \text{ Ln FL} + \phi^2 [(1-a_1) \Delta a_4 + a_4 \Delta a_1] \text{ Ln OWN}\} - [\phi a_1 + 1) \Delta W/WL] + [a_2 \Delta \text{FERT/FERT} + a_3 \Delta \text{FL/FL} + a_4 \Delta \text{OWN/OWN}] \quad ...(4)$$

Equation (4) permits to decompose per hectare change in employment HL into three components:

Technology effects: This includes 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: This effect is denoted by third bracketed expression in employment decomposition model (4) which captures the effect of difference in normalized wage rates confirming old and new technology. Due to Government policy the normalized wage rates are same for both technologies. Hence its effect is zero.

Complementary inputs effect: This effect (last bracketed expression), includes employment effects of difference in quantities of inputs, given the new technology output elasticity for the purpose of decomposition analysis:

$$\Delta HL/HL = \phi\Delta A/A - (\phi a_1+1)\ \Delta W/W + \phi a_2\ \Delta FERT/FERT + \phi a_3\ \Delta FL/FL + \phi a_4\ \Delta OWN/OWN \quad \ldots (5)$$

$$\Delta HL/HL = \Delta A/A - (\phi a_1+1)\ \Delta W/W + \phi a_2\ \Delta FERT/FERT + \phi a_3\ FL/FL + \phi a_4\ \Delta OWN/OWN \quad \ldots (6)$$

Since the price of Pn and Py was the same in the villages selected under arid zone, the change in normal wage rate was zero. The final decomposition equation therefore was:

$$\Delta HL/HL = \phi\Delta A/A + \phi a_2\ \Delta FERT/FERT + \phi a_3\ \Delta FL/FL + \phi a_4\ \Delta OWN/OWN \quad \ldots (7)$$

Equation (7) is the final decomposition equation for employment change. To estimate employment change we need, the parameters of production function and per hectare input levels. 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 labor demand functions separately were consistent. However, these estimates were argued to be inefficient because bias appeared in both the equations. So a more efficient approach was to estimate (2) and (3) jointly, imposing the conditions that these were equal. Zellners' method provided an efficient estimate. The Zellners' restricted method would reduce the standard errors than those of single equation least squares. So study is likely to have given rise to some bias, in the values of coefficients.

Results and Discussion

The pooled data of moth bean and clusterbean were used with dummy variable for new technology and the results are presented in Table 1. The dummy variable is significant at 1% level indicating structural break in productivity of moth bean and clusterbean (Table 1). All other explanatory variables were statistically significant at 1% level. The values of coefficient of determinantion for moth bean and clusterbean were 94.13 and 94.98, respectively. The 'F' value for coefficient of determinant for both the crops was found to be significant at 1% level.

Decomposition of labor employment required the estimates of production function

Table 1. Estimated production function parameters, standard error and coefficient of determination (R^2) for moth bean and clusterbean

Variables	Moth bean	Clusterbean
Intercept	0.1889	0.1779
Dummy	0.2744** (0.0533)	0.1862** (0.0417)
Fertilizers and manures (Rs. ha^{-1})	0.0937** (0.0232)	0.0956** (0.0391)
Labor (man-days ha^{-1})	0.3469** (0.1133)	0.2603** (0.0999)
Other expenses (Rs. ha^{-1})	0.2063** (0.0877)	0.2086** (0.0913)
No. of observation	40	40
R^2	0.9413	0.9498

** Statistically significant at 1% level; * Statistically significant at 5% level.

Table 2. Geometric mean levels of inputs used in moth bean and clusterbean

Inputs	Moth bean		Clusterbean	
	RMO-40	Local	RGC-936	Local
Fertilizers and manure (Rs. ha^{-1})	204.39	144.6	277.69	159.49
Labor (man-days ha^{-1})	41.25	26.20	47.87	32.43
Other expenses (Rs. ha^{-1})	1036.75	833.80	902.35	689.87
Yield (q ha^{-1})	4.18	2.49	9.39	4.62

parameters (Table 1) and geometrical mean levels of per hectare inputs (Table 2). Higher levels of inputs were used in new technology in both the crops under study. The observed increases in labor employment due to new technology of moth bean and clusterbean cultivation were 57.44 and 47.61%, respectively (Table 3). The increase in labor employment was mainly due to technical changes, which was 42.2% in moth bean and 25.18% in clusterbean. The changes in level of inputs from traditional to modern technology contributed 13.62% in moth bean and 18.27% in clusterbean. This indicated that additional employment could be generated by 14% in moth bean and 18% in clusterbean due to increase in inputs used.

From the above discussion, it is clear that labor requirement increased due to introduction of modern technology. The decomposition model indicated that maximum change (73.5%) in labor requirement in moth bean is due to modern technology. The complementary contribution of technical change was 38% in clusterbean. This further indicated that increment in complementary inputs also played an important role in increased labor demand.

Table 3. Decomposition analysis of change in labor employment between new and traditional technologies of moth bean and clusterbean crops

Items	Per cent attributes	
	Moth bean	Clusterbean
Observed change	57.44	47.61
Source of change		
Technical change	42.02	25.18
Complementary inputs		
Fertilizers and manures	5.93	9.58
Other expenses	7.66	8.69
Total change due to inputs	13.62	18.27
Total change due to technology	55.64	43.45

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