LABOR ABSORPTION IN TAMIL NADU AGRICULTURE: A MICRO ANALYSIS

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A. *The Problem*

WITH THE introduction of the high yielding varieties technology (HYVT), it was expected that the HYVT would increase not only total production, but also employment opportunities, especially for hired labor. After one and a half decades, earlier expectations of increasing employment have now been questioned by some recent empirical evidence in a few South and Southeast Asian countries.[1] This negative effect, however, has not been observed uniformly and consistently in these countries. Observing historical patterns of change in labor absorption in Japan's and Taiwan's agriculture, Ishikawa [20] concluded that the countries of South Asia are likely to be adopting the technology in its labor-saving phase rather than its labor-using phase. The question addressed in this paper is whether Indian agriculture has reached a labor-saving phase of technology. We seek to examine in detail, only the labor-absorptive capacity of Indian agriculture with particular reference to rice production in a progressive rice growing region of Tamil Nadu, and not the labor allocation among various activities of rice production. With a greater need to understand the overall impact of recent technological innovation on the demand for hired labor (Hirashima [19]), this study specifically examines the extent to which the present modern technology of rice production in Tamil Nadu absorbs hired labor.

B. *Labor Absorption*

Labor requirements in agriculture depend on the type of technology used, distribution of landownership, socio-economic-institutional and political conditions. The conventional technocratic approach to increasing agricultural labor absorption has been through the dissemination of labor-intensive technology. However, as Hayami [18] noted recently, in the Indian context, this may not succeed because of the high transaction costs involved in employing labor due to the often hostile relationship between farmer operators and landless laborers. This is due in part to the prevailing caste antagonism.

While Hayami contends that the friction between the farmers and landless laborers will lead to greater labor displacement, in fact, under certain situations

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[1] See, for example, Smith and Gascon [34] and ARTEP-ILO [4].

the opposite may occur. Rudra and Mukhopadhya [31], Khusro [23], and Mehra [27] have similar views that the technocratic approach will make a significant contribution in enhancing employment opportunities, if it is achieved through a larger contribution from small farms. Dantwala [12] also observed an inverse relationship existing between farm size and labor input per hectare.

Though it is still controversial, some of the empirical evidence derived from the Indian context by Johl [21], Desai [14], Bisaliah [10], Sharma [32], and in the Philippines by Cordova [11], show that the labor-saving effects of mechanization are largely offset by the labor-increasing effects of high yielding varieties, multiple cropping, and high level of usage of modern inputs.[2] Further, the influence of agrarian structure, labor market, and the sociopolitical environment prevailing in any particular area cannot be underestimated in offsetting the negative effects of the technocratic approach on farm employment. For example, in the case of Thanjavur District, which is well served with irrigation and paddy varieties, farmers are not able to introduce mechanization fully into their rice fields.[3] This is not because of a shortage of capital, but is mainly a consequence of strong labor unions,[4] controlled by political parties that oppose mechanization because of the lack of alternate employment opportunities.

In view of the debate which is now under way, empirical studies of the labor-absorptive capacity of modern technology are needed to examine some of these issues. Otherwise, the debate is likely to continue on a purely speculative phase. In this paper the results of such an empirical study are reported.

Given the importance of market forces, which indirectly reflect the influences of other factors such as agrarian structure and socioeconomic and institutional factors on labor absorption, the present study examines the question of labor absorption in terms of estimated parameters explaining market behavior.

C. *Study Area and Sample*

Coimbatore District (Figure 1) is one of the few districts in India where the performance of the HYVT is very extensive in terms of area coverage and input usage.[5] The study area selected is favorably placed in terms of irrigation, administration, and distribution of inputs. Of the total population, about 18 per cent are landless agricultural workers, and 19 per cent are engaged only in nonagricultural activities such as teaching and business. The remaining 63 per cent are farmers, of whom about 81 per cent are owner operators, 12 per cent are owner-tenant cultivators, and 7 per cent are pure tenants. This total population of farmers consists of about 55 per cent with operational holdings of one

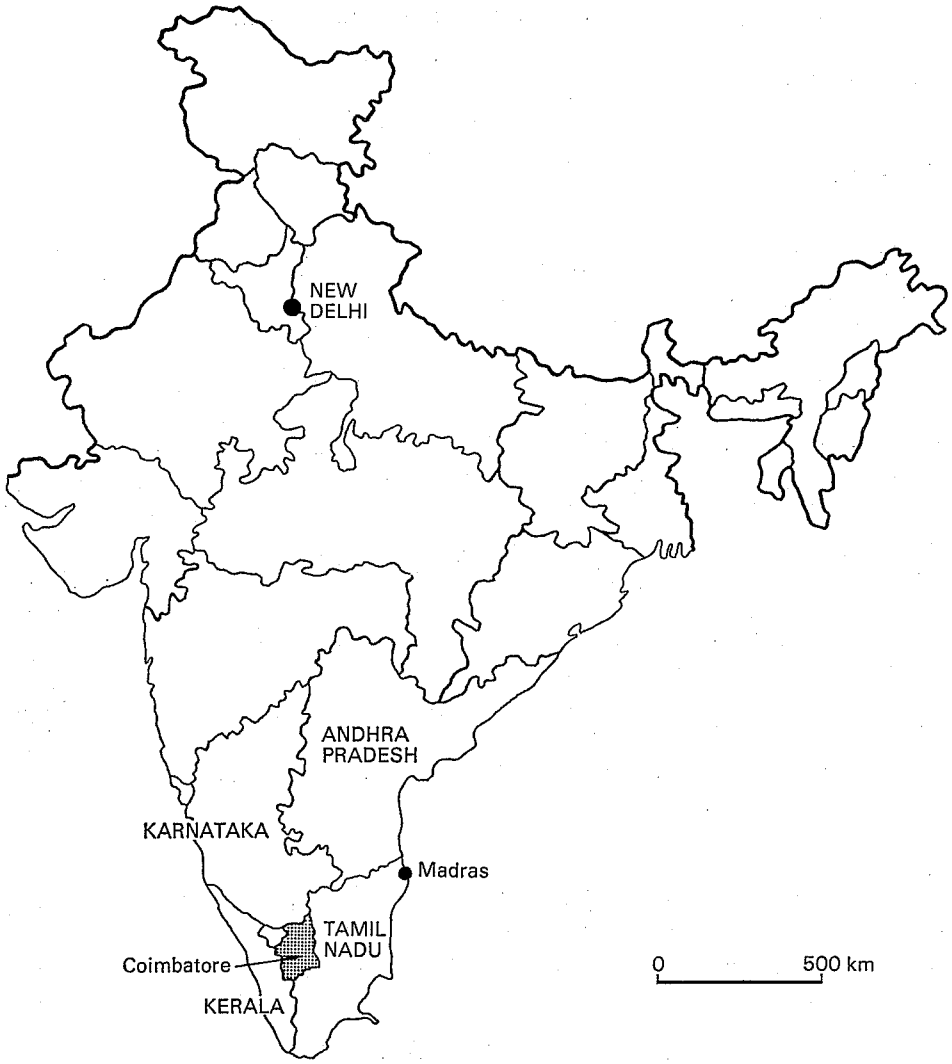
[2] Raj Krishna [29], Binswanger [9], and Bartsch [8] have provided empirical evidence which are in sharp contrast with these conclusions.

[3] Only recently, a few tractors were introduced which, as Johl [21] argued anyway, are bullock-displacing rather than labor-displacing.

[4] These labor unions are comparable with those observed by Bardhan [5] in Kerala. To substantiate this, it may be noted that the real income of landless laborers increased by 13 per cent between the crop years of 1965–66 and 1970–71 which was higher than the increase in real income of most operator groups (Swenson [35]).

[5] For more details, see PEO-ANU [28] and Adams et al. [1].

Fig. 1. India: Coimbatore District



hectare or less (with an average of 0.64 hectare), and 45 per cent who have operational holdings of above one hectare (with an average of 2.79 hectares). An average farmer in this area retains about one-eighth of total production for his family consumption and for seed, and markets the rest.

There is an active labor market for agricultural labor. Agricultural laborers regularly come in groups from nearby villages to work in the study area. Other nonagricultural employment opportunities around the area are limited. In the study area, generally, agricultural workers are able to find work throughout the year, in paddy, sugarcane, turmeric, and cotton cultivation. Thus, there is a kind of job mobility of workers, in terms of expansion of employment opportunities

TABLE I

AVERAGE DAILY WAGE RATE PAID BY SAMPLE FARMERS FOR HIRED LABOR

Full Operation	Daily Wage per Worker (Rs.)		
	Male	Female	Child
Field preparation	6.00	4.00	2.00
Ploughing	10.00	—	—
Nursery raising	5.00	3.00	—
Transplanting	5.00	4.00	—
Weeding	5.00	4.00	2.00
Fertilization	10.00	7.00	—
Pesticide application	10.00	7.00	—
Watering		(in kind)	
Harvesting		(in kind)	
Threshing and bundling		(in kind)	

within the area. More notably, the relationship between employers and employees appears to be harmonious rather than antagonistic. To summarize, the study area may be described as commercialized in the sense that a large proportion of total production is marketed and that there is a competitive labor market.

Random samples of fifty and seventy rice farmers growing ADT-31 and IR-20, respectively, in the *kharif* and *rabi* seasons of 1977–78 are selected for the present study. Eighty per cent (*kharif*) and 84 per cent (*rabi*) of sample participants are owner-operators, and the rest are tenants. It is worth noting here that sample family members are involved in farming only in finalizing management decisions and in supervising field operations.[6] On average, most of the sample farmers have two attached workers for both domestic and agricultural activities.[7]

D. *Conceptual Model*

A number of recent studies of labor market have argued that the competitive model[8] can adequately explain market behavior and labor absorption (Sidhu [33], Lau and Yotopoulos [25], and Rosenzweig [30]). The assumption of wage rates being determined competitively seems to hold good in the study area for the reasons mentioned earlier.[9] As necessary in profit function analysis, however, differences were found in the prices paid and received by different survey participants. These price differences do not imply that competitive markets did not exist in the area or that there were major impediments in factor and product markets. Rather, differences in rice and input prices between farmers are largely due to differences in location and in transport costs to market and to some extent by price movements brought about by seasonality of demand and supply for goods and services.

[6] Unless otherwise indicated, labor refers to hired labor throughout this study. Dasgupta and Laishley [13] give some probable reasons for reduction in the supply of family labor.

[7] Generally these attached workers are distant poor relatives of farmer operators.

[8] Criticisms of the competitive labor market model can be seen in Bardhan [6], Hart and Sisler [17], and Arndt and Sundrum [3].

[9] It is worth mentioning here that there was no labor unrest reported at any time in the survey area in relation to the wages paid to hired labor (Table I).

The growth of agricultural employment to a large extent depends on the elasticity of the real wage rate and the relative change in real wage rate for a given level of output. Following Bardhan and Srinivasan [7], it is assumed that the wage rate is exogenous and is competitively determined in the study area. It is further assumed that all sample farmers attempt to maximize profits, i.e., the difference between current revenue and current variable costs. Using the duality between the production function and profit function, we can estimate the "real" profit (profit divided by the unit of output price) as a function of "real" prices of the variable factors of production and quantities of fixed factors of production.[10] The advantages of using this model based on competitive principles to explain labor absorption are manifold:

(a) By partially differentiating the "real" profit function with respect to the real wage rate we obtain a theoretically and economically efficient demand function for labor.

(b) The profit maximization assumption can be tested by jointly considering the variable factor demand functions and the profit function.

(c) The assumption of a competitive model explaining the labor market behavior can be statistically verified by examining the equality between the marginal product of labor and wage rate. (This is done in the present study.)

(d) Own and cross price elasticities of labor and other variable inputs can readily be obtained.

(e) Above all, demand for labor is not derived independently but jointly, as a system of output supply and factor demand equations which incorporates the interdependent nature of output and input decisions reached by farmers.

E. *Empirical Model*

The estimating stochastic profit and variable factor demand functions assuming a Cobb-Douglas type of relationship[11] in this study respectively are:

$$\ln \pi^* = \alpha_0 + \beta^*_1 \ln W + \beta^*_2 \ln F + \beta^*_3 \ln P + \beta^*_4 \ln B + \alpha^*_1 \ln A + \alpha^*_2 \ln C + \alpha^*_3 \ln L + u_1. \quad (1)$$

$$\frac{-Wx_1}{\pi^*} = \beta^*_1 + u_2. \quad (2)$$

$$\frac{-Fx_2}{\pi^*} = \beta^*_2 + u_3. \quad (3)$$

$$\frac{-Px_3}{\pi^*} = \beta^*_3 + u_4. \quad (4)$$

$$\frac{-Bx_4}{\pi^*} = \beta^*_4 + u_5. \quad (5)$$

[10] For further details on theoretical aspects and empirical application of the profit function, see Yotopoulos and Lau [37].

[11] Limitations of the Cobb-Douglas form are recognized (Anderson and Jodha [2]). However, a number of empirical studies have used this form with apparent success (Lau and Yotopoulos [25], Sidhu [33], Bisaliah [10]). It has the additional advantage of operational simplicity.

where

π^* = "real" profit in rupees defined above;
W = "real" wages for labor (man-days);
F = "real" fertilizer price;
P = "real" pesticides price;
B = "real" bullock pair day price;
A = total area cultivated (acres);
C = capital flow which is calculated as the sum of depreciation, maintenance, and opportunity costs of capital stock;
L = family labor man-days used in the field in supervision and in making management decisions;
x_1 = total labor man-days utilized;[12]
x_2 = total amount of fertilizer used;
x_3 = total amount of pesticides used;
x_4 = total bullock pair days; and
u_i = random disturbances with "normal" properties correlated across equations.

The fact that β^*_i's appearing in equations (1) and (2) to (5) are equal should be taken into account in estimating these systems of equations jointly and efficiently. These restrictions are directly incorporated into the estimation process through the Lagrange multiplier (λ), and the system (1) to (5) is estimated using restricted Aitken's least squares estimation method.[13] The insignificance of the estimates of the Lagrange multiplier λ, means that the null hypothesis that the individual restrictions are valid cannot be rejected at the appropriate confidence level. The estimate of χ^2-statistic is used to verify the hypothesis that overall restrictions are valid. The results are presented in Table II for both *kharif* and *rabi* seasons.

F. *Results*

In the case of the *kharif* crop ADT-31, the χ^2-value is not significant, so the restrictions are valid, which implies that the assumption that farmers growing ADT-31 attempt to maximize profit cannot be rejected. In the case of the *rabi* crop, with IR-20, the χ^2-value is significant at the 5 per cent level, which means that farmers are not absolutely maximizing profit.

In the case of ADT-31, none of the Lagrange multipliers are significant. The insignificance of λ_1 means that the restriction that the price elasticity β^*_1 estimated from the profit function (1) and the labor demand function (2) is equal, cannot be rejected statistically. This implies that the marginal value product of labor is equal to real wage rate. It may be inferred from this result that the assumptions of a competitive labor market in the study area need not be rejected. In the case of IR-20, it is evident from the Lagrange multipliers that this result is also valid.

Own and cross price elasticities of demand for labor, and elasticities with

[12] Here, labor refers to hired labor only.
[13] Details of this estimation method are given by Kalirajan [22].

TABLE II

JOINT ESTIMATION OF REAL PROFIT FUNCTION AND VARIABLE FACTOR DEMAND FUNCTIONS WITH STATISTICAL TESTS

Variable	Parameter	Restricted ALS Estimates	
		Kharif	*Rabi*
Profit function:			
Constant	α_0	6.8003	5.7432
		(1.3102)	(0.1356)
ln W	β^*_1	−0.4583	−0.5820
		(0.1149)	(0.1935)
ln F	β^*_2	−0.7335	−0.9100
		(0.1971)	(0.4605)
ln P	β^*_3	−0.0613	−0.0603
		(0.0278)	(0.0425)
ln B	β^*_4	−0.0667	−0.1108
		(0.0303)	(0.0564)
ln A	α^*_1	0.8589	0.8855
		(0.1336)	(0.1620)
ln C	α^*_2	0.0604	0.0320
		(0.0156)	(0.0121)
ln L	α^*_3	0.0712	0.0901
		(0.0201)	(0.0310)
Labor demand:			
	β^*_1	−0.4583	−0.5820
		(0.1149)	(0.1935)
	λ_1	1.6659	1.0375
		(1.3485)	(1.5623)
Fertilizer demand:			
	β^*_2	−0.7335	−0.9100
		(0.1971)	(0.4605)
	λ_2	1.2047	1.0730
		(1.3857)	(1.0820)
Pesticides demand:			
	β^*_3	−0.0613	−0.0603
		(0.0278)	(0.0425)
	λ_3	1.9275	5.9689
		(1.5346)	(1.3204)
Bullocks demand:			
	β^*_4	−0.0667	−0.1108
		(0.0303)	(0.0564)
	λ_4	1.8695	0.3009
		(1.7902)	(0.5206)
χ^2 test $\lambda_1=\lambda_2=\lambda_3=\lambda_4=0$		7.1082	10.8234

Note: Figures in parentheses are standard errors of estimates. Critical χ^2-values: χ^2 0.10 (4)=7.78.

respect to the supply of rice, which are computed with the formula given in Table III, are reported in Table IV.[14]

The output supply elasticities for *kharif* and *rabi* rice with respect to rice price

[14] As the wage elasticity is the most important estimate of this study, it alone is reported along with the output supply elasticity.

TABLE III

FORMULA TO ESTIMATE OUTPUT SUPPLY AND INPUT DEMAND ELASTICITIES FROM A COBB-DOUGLAS REAL PROFIT FUNCTION

Description	Parameter of Profit Function
(a) Supply elasticities:	
1. With respect to real price of *i*th variable input, x_i	β^*_i
2. With respect to fixed input, Z_j	α^*_j
3. With respect to output price, P_y	$-\Sigma\beta^*_i$
(b) Input demand elasticities:	
1. Own price elasticity of x_i	β^*_i-1
2. Cross price elasticity of demand for x_i with respect to real price P_j	β^*_j
3. Variable input x_i with respect to fixed factor Z_j	α^*_j
4. Demand elasticity of x_i with respect to output price	$-\Sigma\beta^*_i+1$

Source: Lau and Yotopoulos [25, p. 17].

TABLE IV

OWN AND CROSS PRICE ELASTICITIES OF DEMAND FOR LABOR AND OUTPUT SUPPLY

Exogenous Variable	Fndogenous Variable			
	Output Supply		Labor Demand	
	Kharif	*Rabi*	*Kharif*	*Rabi*
Rice price	1.3198	1.6631	2.3198	2.6631
Real wage	−0.4583	−0.5820	−1.4583	−1.5820
Real price of fertilizer	−0.7335	−0.9100	−0.7335	−0.9100
Real price of pesticide	−0.0613	−0.0603	−0.0613	−0.0603
Real price of bullock	−0.0667	−0.1108	−0.1667	−0.1108
Land	0.8589	0.8855	0.8589	0.8855
Capital assets	0.0604	0.0320	0.0604	0.0320
Family labor	0.0712	0.0901	0.0712	0.0901

are 1.3198 and 1.6631 respectively. Hence, a 1 per cent increase in rice price would induce more than a 1 per cent increase in rice supplies, and means that sample farmers are very responsive to changes in rice prices. The effect of rice price changes on the demand for labor is also important, and the elasticities for *kharif* and *rabi* seasons respectively are 2.3198 and 2.6631. These elasticities are quite high and show that a 10 per cent increase in rice price, would result in increases in demand for labor of about 23 per cent and 26 per cent in *kharif* and *rabi* seasons respectively.

The demand elasticities for labor are highly elastic in both seasons—a result that is in sharp contrast to the findings of Evenson and Binswanger [15]. These elasticities indicate that a 10 per cent increase in the real wage rate will lead sample farmers to reduce employment by about 15 per cent in *kharif* season and by 16 per cent in *rabi* season. The elasticity of these labor demand curves with respect to real wages further means that demand for labor is not solely constrained by biophysical considerations. This finding is in contrast with the views of Vaidhyanathan [36]. Within the range of sample farm sizes, an increase in irrigated area mutatis mutandis would have a substantial impact on both output

TABLE V
INDIRECT ESTIMATES OF PRODUCTION ELASTICITIES

Variable	Indirect Estimates	
	Kharif	*Rabi*
Labor	0.1976	0.2185
Fertilizer	0.3162	0.3417
Pesticides	0.0264	0.0226
Bullock pair	0.0288	0.0416
Area	0.3703	0.3325
Capital	0.0260	0.0120
Family labor	0.0307	0.0338

supply and labor absorption which emphasizes the influence of irrigation on labor absorption.

The indirect production elasticities derived from the "real" profit function are listed in Table V.[15] Constant returns to scale seem to prevail with respect to rice production in both seasons in the study area. The production elasticities of labor are 0.20 for *kharif* season and 0.22 for *rabi* season. With the assumption of equilibrium, the functional shares of factors of production can be inferred from the production elasticities. Accordingly, labor's share in total output is approximately 20 per cent, which seems to be reasonable (Kikuchi and Hayami [24]).

G. *Conclusions*

The environment of sample farmers, no doubt, is not typical of all farmers growing rice in Tamil Nadu in the sense that the farmers use advanced rice production technology. Nevertheless, their situation provides an example of what the rice economy may come to look like as technological change and the prevailing patron-client relationship between employers and employees spread to other parts of Tamil Nadu. Thus, it may provide a demonstration effect for other less developed areas and encourage them to participate in the process of technological and institutional transformation of the economy.

This study showed that a modernized rice crop enterprise has the capacity to absorb a considerable amount of hired labor. This result is in conformity with findings of other recent studies of Tamil Nadu rice production (North Arcot District) by Farmer [16]. These empirical evidences, in contrast to Hayami's observation, show that there is scope for an optimistic view of the possibility of introducing new agricultural technologies with a labor-absorbing capacity. However, this depends heavily on price policy measures. This study showed that demand for hired labor is highly elastic to wage changes, and that a rightward shift in the supply function of labor may easily be absorbed with only a slight decrease in wage rate. As Lipton [26] suggested a decrease in wage rate in this context can be controlled by the laborers organizing themselves into cooperative associations,[16] and preventing undue wage falls.

On the other hand, if these associations shift supply curve of labor to left,

[15] For details of derivation, see Yotopoulos and Lau [37, p. 21].

[16] We prefer this term to labor unions so as to avoid political connotations.

then a lot of jobs will be lost in response to wage increases. Wage increases for landless laborers will result in large increases in unemployment. However, the results show that an increase in rice price induces considerable labor absorption which is encouraging. Thus output price policy appears to be an important tool in absorbing labor into agriculture. However, we agree with Hirashima [19] that output price policy is not the only policy measure that policymakers can use to increase labor absorption in agriculture. Policy measures dealing with improving the noneconomic factors such as social structure, the inheritance system, and labor organizations can also have positive effects on labor absorption. The appropriateness of any policy instrument should, however, be judged by its overall social and economic consequences. This study, though limited in terms of sample size, suggests that modernization or commercialized agriculture need not worsen the absorptive capacity inherent to the traditional communities. The results would have been more valuable if labor absorption is studied with the actual derivation of supply curve of labor, and considering different agricultural crops and other interlinked institutional aspects. These were unfortunately assumed to be constant in this study due to data constraints.

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