NATURE OF NEW FARM TECHNOLOGY AND ITS IMPLICATIONS FOR FACTOR SHARES—A CASE STUDY IN TAMIL NADU

V. Rajagopalan and S. Varadarajan*

The process of economic development can be viewed as an ordered sequence of changes in technology. Then the typical instrument for inducing this process is a deliberate attempt to inject elements of new technology in the system. Inasmuch as it is new to the rural scene, for successful innovation of technology in the farm sector it must be consistent with human and other resource conditions of the target groups and be sufficiently reliable and predictable in use, because uncertainty contributes to risk aversion of farmers, majority of whom are small and marginal farmers and tenant cultivators. With multiple paths to technological development as Hayami and Ruttan1 point out, the ability of an economy to achieve rapid growth in agricultural productivity and output depends in large part on its ability to choose among the alternative paths available to it. More specifically, it must economise on scarcer resource and facilitate its substitution with other less scarce resources. They refer to new biological-chemical farm technology as land-saving and farm mechanization as labour-saving. In the land scarce and labour abundant Indian agriculture, this new technology thus provides opportunity for significant productivity gains and rapid economic development in turn.

A DIGRESSION

In discussing economic development in general, and agricultural transformation in particular, the behaviour of two indicators is stressed. First, the secular decline in the share of agricultural sector in the growing national product. This not only highlights greater levels of investment in the non-agricultural sector as the general argument could be but also implies intersectoral linkages and their important determinant, technology. In the process of modernization of agriculture, input components of agricultural production such as seeds, fertilizers, chemicals and energy undergo radical changes; more of them being produced outside and supplied to agriculture. This would ultimately result in changes in the product-mix aggregatively and consequent changes in the sectoral shares.

Second, the decline in the proportion of work force employed in agriculture. There is considerable amount of evidence to show that in the course of growth of an economy, labour moves out of agriculture.2 Thus, agricul-

---

* Director and Professor, respectively, Centre for Agricultural and Rural Development Studies, Tamil Nadu Agricultural University, Coimbatore.
ture will face the need for increasing its labour productivity through investment for the development of human skills, and through substitution of labour by capital. The source and pattern of capital substitution should be considered in terms of labour-saving and labour-augmenting through land and water resource development. This process is not, however, unidirectional, it is something like an inverted U, revealing that labour-using strategies of sectoral development, linkages and transformation would increase the quantum of labour used in agriculture up to a point, beyond which factor substitution and increasing labour productivity would go with a reduction in labour use. Given this paradigm, one can expect the factor shares to be favourable to labour to start with and to capital at later stages of development.

Nevertheless, one is not certain that this would happen unless conditions which induce such a process of transformation exist. Our experience with Indian agriculture shows that the proportion of work force employed in agriculture remains almost invariant over a period of five decades; and it is so even in spite of recent reduction in the share of agriculture in the Gross Domestic Product. Has this contributed to the widening spectre of poverty, deprivation, malnutrition and alienation? Has the share of labour in the output declined? Does it not then imply a declining wage income in contrast with rising profit? The answers can be simply 'yes' and misleading. The point at issue is about the role of technology in determining factor proportions and factor shares in income, given the factor prices relative to product prices. In other words, the hypothesis emerging from the above discussion is that the factor proportions are determined by the nature of technology, choice of which is based on the relative price structure. This is not new, nor exiting. Nevertheless, the key concept is the choice of technology, consistent with the present stage of development of the economy and the goals perceived. In aid of this choice, attention is paid to the consequences of the green revolution for their implications for sustaining and supporting desired trends in the growth process.

An attempt to interpret the implications of new technology for economic development has to pay attention to four questions: (i) the distributional consequences of slower rise in food prices; (ii) the regional income distribution effects; (iii) the effects of possible biases of technological change on factor shares in income; and (iv) the distributional impact of secondary effects of green revolution on non-agricultural sectors. This paper pays attention to the third of the four questions.

**METHODOLOGY**

The analysis is based on the simple proposition that the new biological chemical technology is essentially an input designed to facilitate the substitution of fertilizer for land. Thus the technology plays a catalytic role. The new high yield variety seeds themselves are not substitute for land. Rather

---

they facilitate the substitution of the cheap input, fertilizer for scarce input, land. It is therefore expected that land productivity improves. Evenson has shown that all factors will lose if the price elasticity of the final demand for the commodity experiencing technical change is inelastic with relative losses being dependent on the supply elasticities of factors. Conversely, all factors gain if final demand is elastic. Rice, the reference crop for the present study has an inelastic demand and the continuing unfavourable terms of trade for rice producers is not surprising. But among the factor inputs, land being relatively inelastic in supply, can be expected to gain in its share of income, while relatively abundant labour may lose. The net result will be a change in factor proportion and factor shares. The basic question to be answered by the present study is whether the new technology is also labour-saving, by substituting fertilizer not only for land, but also for part of labour input? In other words, is there a bias in technical change for labour-saving? There are a number of definitions of technological bias and a number of different ways of measuring it. The present study uses Hicks’ concept which measures the bias along a constant capital-labour ratio.

The study was confined to rice—the staple crop of Tamil Nadu, with more than 75 per cent of area under high-yielding varieties. A sample of 200 rice farmers selected randomly in two blocks of Thanjavur district. viz., Kumbakonam and Pattukkottai blocks, consisted of 150 observations for high-yielding varieties and 50 for local varieties. With this cross-section data, an attempt was made to measure bias, if any, in the new high-yielding variety technology. Assuming Cobb-Douglas form of production function and constant returns to scale the production function was defined* as:

\[
\left( \frac{Q}{L} \right) = a \left( \frac{K}{L} \right)^{\beta} + \gamma D e^\mu
\]

where
- \( Q \) = production of rice in kg. of grains per hectare,
- \( L \) = labour used, in man-days per hectare,
- \( K \) = capital non-labour cost in rupees per hectare,
- \( D \) = a dummy variable to represent the nature of technology with
  - \( D = 1 \) if it is high-yielding variety,
  - \( D = 0 \) if it is local variety.

Taking log, the function is written as:

\[
Y = a_0 + b_1 X + b_2 DX + u
\]

where
- \( Y = \log \left( \frac{Q}{L} \right) \), \( a_0 = \log a \), \( b_1 = B \), \( b_2 = \gamma \),
- \( X = \log \left( \frac{K}{L} \right) \) and \( D \) as defined above.
- \( u \) = random error term.


* The authors wish to thank Dr. U. Shankar of University of Madras for his suggestions in the formulation of the function.
Then neutral technology (absence of bias) implies $\gamma = 0$ or $\sigma = 1$ and where $\sigma$ is the elasticity of substitution in the Hicksian sense. A bias is indicated when $\gamma \neq 0$.

**RESULTS**

With price-inelastic demand for rice and relatively inelastic supply of land, as discussed earlier, a priori expectation was that land price would depend on the nature of new farm technology, viz., the strength of bias in technology causing labour-using or labour-saving decisions in production. To verify this expectation, available time-series of cross-section data were collected and studied. The index numbers of rent for land, wages and price of fertilizer, as a proxy for price of capital, were worked out, with 1971-72 as the base. Estimated index numbers and parity indices between rent and wage, rent and fertilizer cost and wage and fertilizer cost are presented in Table I.

**Table I—Temporal Changes in Rent, Wage and Fertilizer Cost during the Seventies**

<table>
<thead>
<tr>
<th>Year</th>
<th>Index number (1971-72 = 100) of Rent/ha.</th>
<th>Wage/hr.</th>
<th>Fertilizer cost per kg.</th>
<th>Parity between</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rent/ha.</td>
<td>100·00</td>
<td>100·00</td>
<td>100·00</td>
<td>Rent/wage</td>
</tr>
<tr>
<td></td>
<td>124·51</td>
<td>95·34</td>
<td>120·98</td>
<td>Rent/Fertilizer</td>
</tr>
<tr>
<td>1972-73</td>
<td></td>
<td></td>
<td></td>
<td>cost</td>
</tr>
<tr>
<td></td>
<td>224·79</td>
<td>113·95</td>
<td>90·63</td>
<td>Rent/100</td>
</tr>
<tr>
<td>1973-74</td>
<td>214·56</td>
<td>148·84</td>
<td>180·80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>215·36</td>
<td>148·83</td>
<td>192·52</td>
<td></td>
</tr>
<tr>
<td>1975-76</td>
<td>148·23</td>
<td>153·49</td>
<td>181·25</td>
<td></td>
</tr>
<tr>
<td>1976-77</td>
<td>268·65</td>
<td>160·46</td>
<td>172·32</td>
<td></td>
</tr>
<tr>
<td>1977-78</td>
<td>379·11</td>
<td>154·38</td>
<td>164·91</td>
<td></td>
</tr>
<tr>
<td>1978-79</td>
<td>256·38</td>
<td>179·07</td>
<td>165·54</td>
<td></td>
</tr>
<tr>
<td>1979-80</td>
<td>367·59</td>
<td>158·13</td>
<td>182·59</td>
<td></td>
</tr>
<tr>
<td>1980-81</td>
<td>182·59</td>
<td>232·46</td>
<td>201·32</td>
<td></td>
</tr>
</tbody>
</table>

*Source:* Estimated from data available for the sample farmers of the Scheme for Estimating Cost of Cultivation of Principal Crops in Tamil Nadu.

As could be seen in Table I, there was a clear uptrend in rent per hectare of land leased in for cultivation of rice. At 1971-72 = 100, the index went upto 379 in 1978-79. Exceptional years 1976-77 and 1979-80 followed drought years of 1975-76 and 1978-79. Low returns from land in the drought years had its impact in the following year through a fall in demand for leasing land and consequent fall in rent. A similar but lesser rate of increase was observed in wage rate. While the highest index of 179 (in 1979-80) was an exception, it had definitely reached the level of about 155-160, with 1971-72 = 100. The fertilizer price indicated year to year fluctuation—largely policy induced—but it was well above 160 with 1971-72 = 100. Indices of parity would show the changes in relative factor shares more sharply. Rent/wage and rent/fertilizer cost parity indices showed steeper rise than wage/fertilizer cost parity index. It would imply that the new technology had brought significant gains
to landowners, it had remained rather neutral in the use of labour and capital with no appreciable change in their relative share in income. In other words, new high-yielding variety technology was neutral in the use of labour and capital. Emerging hypothesis was \( \gamma = 0 \) or \( \sigma = 1 \). This was tested by fitting the Cobb-Douglas production function specified above. The estimated value of coefficients and the relevant test statistics are presented below:

\[
\begin{align*}
    b_1 &= \beta = 0.335913^{**} & t &= 10.9474 \\
    b_2 &= \gamma = -0.013542^{NS} & t &= -1.30808 \\
    a &= \log \alpha = 1.14631^{**} & t &= 34.77 \\
    R^2 &= 0.3788 & F &= 60.055^{**}
\end{align*}
\]

** Statistically highly significant.

The results of functional analysis thus proved the hypothesis that the new high-yielding rice variety represented a neutral technology in the use of labour and capital. Neutrality implied unchanging factor proportions and factor shares for labour and capital and it agreed with the empirical observation of parity between wages and fertilizer cost. With 1971-72 = 100, wage-fertilizer price parity index varied between 77.71 and 125.73, the upper value becoming an exception because the next highest value was just 108.17.

CONCLUSION

In a labour surplus economy of Tamil Nadu, a labour-using (hence biased) technology would directly contribute to solve the problem of unemployment through larger absorption in agriculture, provided the problem of high transaction cost in employing labour was solved by a policy of better farmer-labour relationships. However, if the technology was not labour-using, it was at least not labour-saving and it could not be a cause for growing unemployment and under-employment in the farm sector. Incidentally, the results would also imply that increasing use of labour in rice farms would depend on increasing application of capital. Then policies on agricultural credit and fertilizer prices would emerge as important determinants of diffusion of new technology and consequent gains in employment potential on farm.

---