INTRODUCTION

The size of the rural non-farm economy depends primarily on agricultural demand. As farm income grows, it generates spillover growth in the rural non-farm economy, since rising farm income increases rural purchases of non-farm goods and services. The well-known debates on agricultural growth linkages revolve around how powerful these demand linkages are (Mellor, 1975; Johnston and Kilby, 1975; Bell and Hazell, 1980). Yet agriculture affects the supply of non-farm goods and services as well. Operating primarily through the labour market, these supply-side linkages have been largely overlooked in the growth linkage discussions. This is unfortunate, because a focus on the labour market alters conclusions about the magnitude of farm–non-farm linkages. It also highlights how agriculture affects not only the size but also the composition of the rural non-farm economy.

This paper explores the relationship between agricultural growth, the rural labour market, and the size and composition of rural non-farm activity. It begins by reviewing what is known about the rural non-farm economy in developing countries, followed by a review of empirical evidence on the relationship between agriculture, labour markets and the transformation of the rural non-farm economy. The paper then introduces a simple price-endogenous model that projects the non-farm employment, wage and income effects of alternative forms of agricultural growth. The model highlights the labour market interactions that contribute importantly to a shifting composition of rural non-farm activity.

PROFILE OF THE RURAL NON-FARM ECONOMY

Static profile

Non-farm activities form an important and integral part of the rural economies of developing countries. They provide 20 to 45 per cent of full-time employment and 30 to 50 per cent of rural household income (Chuta and Liedholm, *Bodija Associates and Michigan State University, USA, respectively.*

STEVEN HAGGBLADE AND CARL LIEDHOLM*

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1979; Haggblade and Hazell, 1989; Liedholm and Kilby, 1989). Amid wide variation, the composition of rural non-farm employment typically includes one-third manufacturing and one-third commerce, with services, mining and construction making up the remainder (Chuta and Liedholm, 1979). Most non-farm enterprises are quite small. Self-employed, one-person firms predominate. Unlike the case of the formal wage labour force, women constitute 40 per cent or more of those engaged; frequently they account for the majority of the rural non-farm entrepreneurs. Because of extremely low capital requirements and seasonal demand, most businesses operate with excess capacity (Liedholm and Mead, 1987).

**Dynamic profile**

Employment data, the only indicator routinely available, suggest that rural non-farm activity has generally increased across continents and over time (Anderson, 1982; Chuta and Liedholm, 1979; Haggblade and Hazell, 1989; Liedholm, 1990), yet employment growth can signal good news or bad. In prosperous regions, where rising wages and buoyant demand stimulate growth in increasingly productive non-farm activity, non-farm employment growth signals prosperity. But in stagnant rural regions, a surge in non-farm employment may reflect the bad news that population growth is forcing non-farm activities to act as a sponge, soaking up excess workers in marginal, low-paying jobs (Shand, 1986). Differences in wage rates and the composition of non-farm activity help in interpreting the employment data to distinguish between the two.

In prosperous regions, employment growth concentrates increasingly in rural towns and in full-time enterprises with hired employees. The composition of activity also changes, with a decline in very labour-intensive, often household-based activities and an increase in higher-investment, higher-productivity enterprises. Transport, food preparation, repair and other services normally grow, while household manufacturing industries decline. A great deal of churning accompanies this aggregate growth; 10 per cent or more of total enterprises disappear each year, while other, new firms emerge. Among the deceased, one-person firms predominate (Liedholm, 1990).

Women typically bear the brunt of this adjustment. They predominate in weaving, basket making, pottery and many of the household-based activities that generally decline. While many growing non-farm services – milling, food preparation and many domestic services – normally employ women, the necessary capital investment in mechanical milling, transport, some food processing and manufacturing can form an intimidating barrier preventing them from participation in this transformation and growth. Although rural transformation offers improved opportunities, for non-farm labourers and for the rural poor in general, women’s access to the larger, full-time, higher-investment and higher-productivity non-farm businesses is not assured. Access to investment funds and education combine with child rearing and other household obligations to constrain women as they try to respond to new opportunities.
TRANSFORMATION OF THE RURAL NON-FARM ECONOMY

A complex interaction of forces drives the evolution of the rural non-farm economy. On the demand side, growth in agricultural income, changes in urban and foreign preferences, and income transfers from urban areas all influence the growth and composition of demand for non-farm goods and services. On the supply side, natural resource availability, technological change, the supply of investment capital as well as physical and institutional infrastructure all influence the magnitude and shape of the rural non-farm economy.

Agriculture, however, plays a central role in this process. As the principal source of rural income, agriculture generates the principal source of demand for rurally produced consumer and intermediate goods. Through the rural labour market, agriculture also affects the supply side of the rural non-farm economy. As farm production and income grow, they generate increased demand, not only for more production inputs, but also for rurally produced consumer goods. Recent estimates suggest that agricultural growth multipliers generally lie in the range of 1.3 to 1.8, which means that every dollar of technologically induced agricultural income generates an additional 30 to 80 cents in rural non-farm income (Haggblade and Hazell, 1989). Irrigated rice regions in Asia growing high-yielding varieties (HYVs) generate the largest multipliers, while traditional smallholder regions in Africa and Latin America produce the smallest. About two-thirds of the total agricultural growth multipliers stem from the consumption linkages, with the production linkages providing the remainder.

Rapid agricultural growth also affects the composition of rural non-farm activity in two important ways. First, where agricultural income growth outpaces population, rising per capita agricultural income leads to consumption diversification into a broader array of non-foods, many of which are produced in rural areas. Second, on the supply side of the rural non-farm economy, agricultural growth affects the rural wage and hence the opportunity cost of labour available for non-farm activities. This induces a movement away from many low-return non-farm activities towards those that are more remunerative. In contrast, in regions where agricultural growth lags and employment prospects in agriculture cannot keep pace with population growth, low-return non-farm activities proliferate, with no increase in wage rates. In these cases, the rural non-farm economy becomes an employer of last resort, a sponge, absorbing by default labour force increments unemployed in agriculture. Whether buoyant or lagging, agriculture plays a key role in the structural transformation of the rural non-farm economy.

Recent evidence from Bangladesh describes this combined effect of agricultural growth on the composition of rural non-farm activity (Table 1). Employment in services, the highest-return non-farm activities, increase dramatically in prosperous agricultural regions. In contrast, villagers reduce time spent in low-return cottage industries, in earth hauling and in petty trading. Within cottage industry and trading, the doubling and tripling of labour returns suggests a considerable shift in the composition of activity.

Labour market interactions are of major significance. Green revolution farm technology has typically increased demand for farm labour. In its early
TABLE 1  Differences in the size and composition of rural non-farm activity in agriculturally developed and under-developed\textsuperscript{a} regions of Bangladesh, 1982

<table>
<thead>
<tr>
<th></th>
<th>Income per hour in under-developed regions (taka/hour)</th>
<th>Per cent by which agriculturally developed regions exceed under-developed areas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Income/hour\textsuperscript{b}</td>
</tr>
<tr>
<td>Agriculture</td>
<td>5.14</td>
<td>29</td>
</tr>
<tr>
<td>Non-agriculture</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td>11.41</td>
<td>4</td>
</tr>
<tr>
<td>Cottage industry</td>
<td>4.35</td>
<td>90</td>
</tr>
<tr>
<td>Wage labour\textsuperscript{c}</td>
<td>2.82</td>
<td>6</td>
</tr>
<tr>
<td>Trade</td>
<td>2.30</td>
<td>195</td>
</tr>
<tr>
<td>Total non-agriculture</td>
<td>4.35</td>
<td>59</td>
</tr>
</tbody>
</table>

Notes:  
\textsuperscript{a}Agriculturally developed and under-developed regions are distinguished by a number of criteria: access to irrigation, use of modern rice varieties, and fertilizer consumption, among others. In the agriculturally developed regions, modern varieties cover 60 per cent of cropped area, compared with only 5 per cent in the under-developed areas.  
\textsuperscript{b}Calculations based on Hossain (1988), Tables 48 and 64.  
\textsuperscript{c}Non-farm wage labour includes earth hauling, construction, transport and ‘other’ employment.

Source: Hossain (1988, pp. 95, 120).

phases, biological innovations increase labour demand by between 20 and 40 per cent (Jayasuriya and Shand, 1986; Lipton, 1989). In contrast, the mechanical technologies normally lower the demand for agricultural labour. Village-level studies reveal declines ranging from 6 per cent in India (Sisler and Coleman, 1979) to 8 per cent in Sierra Leone (Byerlee, Eicher, Liedholm and Spencer, 1977) and 26, 33 and 34 per cent in Thailand, the Philippines and Indonesia, respectively (Jayasuriya and Shand, 1986). Normally, mechanical innovations, especially in threshing and soil preparation, arrive after the biological ones. Induced by rising rural wages, they reduce initial gains in farm labour demand.

Labour supply, in the short run, depends on households’ willingness to forego leisure. In the medium and long run, it depends on population growth and ease of migration. Most household studies indicate short-run household labour supply as being inelastic, in the range of 0.1 to 0.26 (Singh, Squire and Strauss, 1986), yet, over time, aggregate estimates point to a growing rural labour force in all regions, spurred importantly by the growth of population (Anderson and Leiserson, 1978).

Trends in the rural wage rate reveal the relative strength of these supply and demand forces in the rural labour market. Real wages have increased in some areas following the introduction of biological innovations in farm technology, for example in the Punjab region of India (Chanda, 1986), Thailand and Malaysia (Lipton, 1989), yet, in countries with similar new farm technology –
Indonesia, the Philippines and Mexico – real rural wages declined or stagnated, indicating that increases in agricultural demand were insufficient to offset increases in the rural labour supply. In countries with mechanical innovations or with stagnant agricultural sectors, such as most of Sub-Saharan Africa, real rural wages have frequently declined (Griffin, 1989).

Changing rural wage rates signal a shifting opportunity cost of labour in rural non-farm activity. They raise costs of non-farm production but at the same time offer prospects of higher-productivity employment for landless and poor households who have only their labour to sell. Changing wage rates affect the rate of non-farm output growth as well as the composition of rural non-farm activity. A formal model of the farm–non-farm rural economy – one that includes a labour market – allows us to trace these different effects more clearly.

**MODELLING LABOUR MARKET LINKAGES AND THE RURAL NON-FARM ECONOMY**

Virtually all earlier work has modelled rural non-farm activity as a purely demand-driven spin-off of agricultural income growth. Normally, analysts have not embellished the supply side of the rural non-farm economy; they simply assume non-farm output supply to be perfectly elastic. Implicitly, this assumption requires excess capacity in fixed non-farm inputs as well as a perfectly elastic supply of non-farm labour.

This model begins to build up the supply side of the rural non-farm economy by adding a labour market to the standard demand linkage models of rural non-farm growth. Modelling the classic demand linkages allows estimates of the impact of agricultural growth on the size of the rural non-farm economy. The addition of a labour market enables the tracking of changing wage rates and employment and hence offers a window onto the shifting composition of rural non-farm activity.

The model (see appendix) compares two sources of growth in rural non-farm activity: (a) technological change in agriculture; and (b) population growth. The first raises farm income, thereby increasing demand for rural non-farm output and simultaneously raising demand for non-farm labour (Figure 1, Panel 1). To the extent that new agricultural technology requires additional labour, labour demand and wage rates will rise even further. Note that, where labour supply is upward-sloping, the inclusion of the labour market dampens non-farm income and output response from $N_1'$ to $N_1$. Population growth, on the other hand, increases labour supply, lowers wage rates, spurs demand for labour and thereby increases rural non-farm employment (Figure 1, Panel 2). By contrasting the changes resulting from these two driving forces, the model examines analytically the characteristics of non-farm activity in stagnant and growing agricultural regions.

Within prosperous agricultural regions, the model considers three forms of technological progress: labour-neutral, labour-using and labour-saving. Figure 1 depicts labour-using technological change, the most common experience in the green revolution. Labour-neutral change would differ only in that the
1. Green revolution

2. Population growth

FIGURE 1  Graphical interpretation of the model
labour demand shift 2b would not occur, and hence wage increases and the cost-push inflation in the rural non-farm supply curve would diminish. Labour-saving technological change would further dampen wage increases and hence lead to the largest non-farm output response.

The three technological options can be thought of, respectively, as investment in irrigation infrastructure that allows expansion and replication of existing agricultural technology, introduction of high-yielding packages of seed and fertilizer, and mechanization. Because the biological packages are perfectly divisible and normally labour-using, many associate them with employment-oriented, small farmer growth strategies. Mechanization, which displaces labour, is normally associated with large-farmer growth, what Johnston, Kilby and Mellor call a bimodal agricultural growth strategy.

The model presented here is a slightly embellished version of one developed by Haggblade, Hammer and Hazell (1991). It includes two sectors, one tradable and one non-tradable. For simplicity, this application assumes all agricultural commodities are tradable outside the rural region. Given the predominance of foodgrains and cash crops in much of the Third World, this assumption is not unreasonable. In contrast, the model assumes non-farm activity to be non-tradable. This likewise does not depart dramatically from reality, since non-farm income typically accounts for over 80 per cent of incremental non-tradable income (Haggblade and Hazell, 1989).

The model incorporates a simple neo-classical rural labour market. Rural households supply labour in response to the real wage rate and population pressure. Farms and non-farm businesses demand labour as a function of the nominal wage and technology. In response to shifting labour supply and demand, the rural wage rate adjusts until the labour market clears. A single rural wage prevails in both farm and non-farm activity.

Although the model accommodates any production function technology, the following experiments adopt very simple assumptions. In both agriculture and non-farm activity, Leontief technology governs the demand for intermediates. Non-farm businesses enjoy excess capacity in fixed inputs. Foodgrains account for 25 per cent of both income and
Employment. New agricultural technology increases output by 80 per cent among adopting farmers and increases their foodgrain income by 50 per cent. Farmers accounting for 50 per cent of the cropped area adopt the improved technology. Labour-using technology increases labour demand in foodgrains by 20 per cent (low) to 40 per cent (high), while labour-saving technology reduces foodgrain labour demand by 20 per cent.

The series of experiments summarized in Table 2 suggest four principal conclusions about the relationship between agriculture and evolution of the rural non-farm economy:

(1) *Rising wage rates dampen non-farm income growth.* If the rural labour supply is perfectly elastic, a demand injection from any new agricultural technology will stimulate the same increases in rural non-farm income and employment. The rural wage rate will not rise, even in the face of increasing labour demand by both farm and non-farm businesses (Table 2, Experiment 1). With no cost-push inflation in non-farm supply, spin-off growth in non-farm activity is highest in this setting.

But unlimited supplies of labour rarely occur, and, where labour supply comes only at increasing wage rates, labour-using technology will generate the smallest increase in rural non-farm income.² In the stylized rice-growing region described in Table 2, mechanization, or similar labour-saving farm technology, raises non-farm income by an amount equal to 3 per cent of total rural income. Yet labour-using biological innovations raise non-farm income by only 1.1 – 1.7 per cent, one-third to one-half as much (Table 2, Experiment 2).

The smaller income multipliers result because, when agricultural technology increases the demand for labour, it raises the rural wage rate. This raises the cost of production in non-farm activity and hence the price of rural non-farm output. At the higher price, rural households demand fewer non-farm goods and services. The dampened output response lowers rural non-farm income. Of course, smaller income multipliers do not represent unambiguously bad news. The opposite side of a dampened non-farm income growth is higher wage rates and consequently improved living standards for labour-selling households, typically the very poor. Note that the rural wage rises 6.6 per cent under labour-using agricultural technology and only 1.7 per cent when increased farm output results from introduction of labour-saving technology. Total rural employment also increases most with labour-using agricultural change, growing by 6.6 per cent compared to 1.7 per cent in response to labour-saving technology (Table 2, Experiment 2).

So the pure labour market effect suggests a trade-off between employment and growth in alternative agricultural development strategies. Models that consider only demand linkages ignore this tension. To the extent that small-farmer growth strategies are synonymous with labour-using technological change, the labour market effects suggest that a small farmer focus may lower income growth in return for greater equity and employment. Of course, consumption patterns, savings rates and investment propensities may also differ among large and small farmers. So the conventional wisdom in favour of a small farmer focus (Mellor, 1975; Johnston and Kilby, 1975) cannot be over-
TABLE 2  Modelling the impact of the green revolution and population growth on the rural non-farm economy in a stylized Asian rice-growing economy

<table>
<thead>
<tr>
<th>Labour supply elasticity infinite</th>
<th>Resulting change (% of regional totals)</th>
<th>Initial change in agriculture</th>
<th>Rural non-farm</th>
<th>Total rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Green revolution (improved agricultural technology)</td>
<td></td>
<td>Income</td>
<td>Employment</td>
<td>Income</td>
</tr>
<tr>
<td>(a) labour-saving</td>
<td>6.3</td>
<td>-2.5</td>
<td>0.0</td>
<td>3.7</td>
</tr>
<tr>
<td>(b) labour-neutral</td>
<td>6.3</td>
<td>0.0</td>
<td>0.1</td>
<td>3.7</td>
</tr>
<tr>
<td>(c) labour-using, low</td>
<td>6.3</td>
<td>2.5</td>
<td>0.1</td>
<td>3.7</td>
</tr>
<tr>
<td>(d) labour-using, high</td>
<td>6.3</td>
<td>5.0</td>
<td>0.1</td>
<td>3.7</td>
</tr>
<tr>
<td>Labour supply elasticity = 1</td>
<td>2 Green revolution (improved agricultural technology)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) labour-saving</td>
<td>6.3</td>
<td>-2.5</td>
<td>1.7</td>
<td>3.0</td>
</tr>
<tr>
<td>(b) labour-neutral</td>
<td>6.3</td>
<td>0.0</td>
<td>3.3</td>
<td>2.4</td>
</tr>
<tr>
<td>(c) labour-using, low</td>
<td>6.3</td>
<td>2.5</td>
<td>5.0</td>
<td>1.7</td>
</tr>
<tr>
<td>(d) labour-using, high</td>
<td>6.3</td>
<td>5.0</td>
<td>6.6</td>
<td>1.1</td>
</tr>
<tr>
<td>3 The sponge (population growth with stagnant agriculture)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>population growth, 6.0%</td>
<td>0</td>
<td>0</td>
<td>-3.9</td>
<td>-4.7</td>
</tr>
<tr>
<td>4 Green revolution plus population growth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) slow population growth, 1.8% for 4 yrs = 7.4%</td>
<td>6.3</td>
<td>5.0</td>
<td>1.8</td>
<td>-0.4</td>
</tr>
<tr>
<td>(b) rapid population growth, 2.8% for 4 yrs = 11.7%</td>
<td>6.3</td>
<td>5.0</td>
<td>-1.0</td>
<td>-3.8</td>
</tr>
</tbody>
</table>

Notes: *Real income includes a deduction for inflation in the price of non-farm goods and services. Using the small country assumption, however, the price of agricultural tradables in the rural region remains unchanged. Note that the per capita adjustment only affects experiments 3 and 4.

turned on the wage-dampening effects alone. A final pronouncement will require simultaneous comparison of demand, investment and labour market linkages, an important excursion that ventures beyond the scope of the current paper.

(2) The composition of rural non-farm activity changes most following labour-using technological change in agriculture. Rural wage rates rise most in the face of growing labour demand in agriculture – 6.6 per cent compared to 1.7 per cent with labour-saving farm technology (Experiment 2). This jump in the opportunity cost of non-farm labour signals a sizable shift in the composition of rural non-farm activity. Evidence from Table 1 and elsewhere suggests the shift involves an increase in high-value services, trade and a decline in low-productivity non-farm activity, often very labour-intensive manufacturing, and most prominently female-dominated cottage industries.
In contrast, where population pressure outpaces agricultural output growth, returns to farming labour decline. In these settings, the rural non-farm economy operates as a sponge, absorbing labour force into increasingly low-paying activities. This scenario plays out frequently in South Asia and Sub-Saharan Africa, where observers lament growing rural non-farm employment as a signal of diminished opportunities. Experiment 3 in Table 2 describes this situation: wage rates and per capita income decline, while non-farm employment increases in increasingly unrewarding activity.

(3) Employment data alone can mislead. Because of this, employment data can be dangerously misleading if considered by themselves. As Table 2 indicates, rural non-farm employment grows at the same rate, 1.9 per cent, in both Experiments 2(d) and 3. Yet trends in rural welfare differ dramatically in the two settings. Where new technology makes agricultural advance possible, the rising non-farm employment brings with it rising income and rising returns to labour and a shift to increasingly remunerative activities. The poor benefit especially as the labour they sell brings increasing remuneration.

To avoid misinterpreting employment data, students of the non-farm economy must track changes in rural wage rates together with the employment figures. Activity breakdowns of the employment data, if sufficiently detailed, can likewise signal shifts in the composition of non-farm activity and enable diagnosis of employment growth as a harbinger of opportunity or malaise.

(4) The race between population and technology. The last panel of Table 2 measures the impact of population growth together with new agricultural technology. Panel 4(b) indicates that population growth of 2.8 per cent per year, over four years, will nullify the wage and income gains resulting from typical new foodgrain technology. This result closely matches the common empirical finding of stagnant or declining real wages in areas where rapid population growth accompanies the green revolution.

CONCLUSIONS

Labour market linkages between agriculture and rural non-farm enterprises highlight the potential trade-off between employment and growth in alternative agricultural development strategies. Because labour-using agricultural technology raises wage rates, it dampens non-farm output supply response and reduces income gains as well. Thus the pure labour market effects suggest that an employment-oriented small farmer strategy will lead to lower growth than labour-saving farm technology, except where labour supply is perfectly elastic. Of course, since consumption and investment patterns may also differ between small and large farmers, this result does not constitute the final word on the small versus large farm debate.

Agriculture affects not only the size but also the composition of rural non-farm activity. Through the labour market and the rising opportunity cost of non-farm labour, agricultural growth fosters a shifting composition of non-farm activity. Although much of the literature on structural transformation
highlights changing sectoral shares, this review suggests that intrasectoral
shifts, especially within manufacturing, may be equally important in assessing
rural welfare.

Women are especially vulnerable. They predominate in the declining,
household-based activities and at the same time enjoy opportunities in the
growing, high-return market segments. Although they have the most to gain
from a shift to higher-return non-farm activities, institutional rigidities on
many occasions make this difficult. To facilitate transformation of the rural
non-farm economy, policy makers will need to pay particular attention to
opportunities and constraints facing women, both in agriculture and off the
farm.

NOTES

1 The helpful comments of Carl Eicher, Peter Hazell, John Staatz and John Strauss on an
earlier draft are gratefully acknowledged.

2 These experiments compare technological options for raising farm output. All raise foodgrain
income by 50 per cent, equivalent to a 6.3 per cent increase in rural income. This green
revolution income injection assumes that foodgrains constitute 25 per cent of rural income and
50 per cent of all foodgrain output shifts from traditional to improved varieties. Thus 0.5 x 0.25
x 0.5 = 6.25 per cent. The technologies differ only in that some demand more labour in
agriculture, while others demand less.

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**APPENDIX**

A labour market linkages model

Six equations summarize the formal model:

\[ T(P_t, P_n, w, \theta) = H_t(P_t, P_n, Y) + D_{nt}(P_t, P_n, w, \theta) + D_{nn}(P_t, P_n, Y) + G_t + V_t + \lambda_t \]  

\[ N(P_t, P_n, w) = H_n(P_t, P_n, Y) + D_{nt}(P_t, P_n, w, \theta) + D_{nn}(P_t, P_n, Y) + G_n + V_n \]  

\[ L_s(\bar{w}, Z) = L_{da}(P_t, P_n, w, \theta) + L_{dn}(P_t, P_n, Y) \]  

\[ \bar{w} = w/l \]  

\[ I = P_{nb} P_t(1-b) \]  

\[ Y = \pi_t(P_t, P_n, w) + \pi_d(P_t, P_n, w) + wL_s \]  

The first two set supply equal to demand in agricultural tradables \((T)\) and non-tradable non-farm activities \((N)\). Supply of both depends on input and output prices, that is on the price of non-tradables \((P_n)\), tradables \((P_t)\) and the wage rate \((w)\). In addition, the supply of tradables is influenced by a technology shift parameter \((\theta)\). Through its effect input demand in tradables \((D_{nt}, D_{nt} and L_{da})\), \(\theta\) offers the flexibility to model a wide array of new technology, including neutral, input-using or input-saving technical change.

The demand for tradables and non-tradables depends on household consumption \((H_t)\) of each, intermediate input requirements \((D_{ij})\) and exogenous government \((G_t)\) and investment \((V_t)\) demand for each sector’s output. In addition, because it can be imported or exported, tradable demand includes net
exports \( (X_i) \) from the region. Household consumption \( (H_i) \) depends on relative commodity prices \( (P_n \text{ and } P_i) \) as well as household income \( (Y) \).

A full-employment, neo-classical labour market clears through equation (3), which sets labour supply \( (L_s) \) equal to sum of labour demanded in each sector \( (L_{d1} \text{ and } L_{dn}) \). Labour demand depends on nominal input and output prices, while supply is a function of the real wage rate \( (\tilde{w}) \) and population \( (Z) \). The inflation rate \( (I) \) is defined in equation (5). Finally, equation 6 defines regional income as the sum of profits \( (\pi_n, \pi_t) \) and wages \( (w \cdot L_s) \).

When solved, the model traces changes in four endogenous variables \( (P_n, w, I \text{ and } Y) \) in response to exogenous changes in agricultural technology \( (\theta) \) and population \( (Z) \). Using \( (\cdot) \) to represent percentage changes, the model’s solution becomes:

\[
\hat{E} = A^{-1} [B \cdot d\theta + C \cdot \hat{Z}]
\]

where \( \hat{E} \) is a 4x1 column vector representing percentage changes in the four endogenous variables, \( A^{-1} \) is a 4x4 matrix of multipliers, and \( B \) and \( C \) are 4x1 column vectors containing shift parameters for each exogenous variable. Because it is additive, the model can solve for any combination of exogenous shifts, or it can isolate the effect of any single exogenous shock.

The full model mathematics have been presented elsewhere (Haggblade, Hazell and Hammer, 1991) for \( A \) and \( B \). For the population vector in \( C \) as well as the parameter restrictions associated with alternative forms of technical change in agriculture \( (\theta) \), a technical Appendix is available on request from the authors.

**DISCUSSION OPENING – DANIEL A. SUMNER**

No area of economics research is more important than the study of rural labour markets. It remains true that, for most people on earth, understanding rural labour markets is required to understand the factors that determine their well-being and economic prospects. It is particularly important to incorporate labour market considerations into the analysis of the linkages between farm and non-farm rural sectors, just as labour market considerations are important to improve our analysis of rural and non-farm rural sectors of the economy.

Haggblade and Liedholm have provided some examples of the importance of the labour market characteristics to an accurate understanding of the effects of technical change and population growth. They have emphasized that to ignore labour market linkages is to risk misunderstanding the consequences of factors that drive economic development in rural economies. On these points, they are surely right and have provided a useful reminder to analysts and policy officials alike.

In these comments, I want to clarify and extend some points made by the authors. My remarks can be summarized in three categories: (1) clarification of income effects of labour-using and labour-saving agricultural investments;

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(2) the importance of labour market relationships in understanding distribution impacts of agricultural investments; and (3) the importance of farm–non-farm labour market linkages in rural areas of developed countries.

First, I want to highlight a feature of the example simulation presented in Table 2 of the paper. In characterizing the four improvements in technology as labour-saving or labour-using, the authors emphasize the different impacts on wage rates, employment and income. They point out a trade-off between total rural employment and income, particularly in the relevant case of an upward-sloping supply curve of labour. But notice that the technologies labelled as labour-saving or labour-using differ fundamentally. The labour-saving technology uses less of all resources. It is really a pure gift to the economy. For the same 6.3 per cent increase in agricultural income the labour-saving technology uses 2.5 per cent less labour and no more of any resources. The high labour-using technology uses 5 per cent more labour and no less of any resource. Obviously, an economy gains more income from a pure improvement in technology, which is like manna from heaven, than from one that uses more of the scarce economic resources of the economy. It would be interesting to compare technologies that differed by being either a free lunch or not. The authors suggest mechanization as an example of labour-saving technology and, in that case, the capital-using characteristics are evident.

Clearly, this short paper by Haggblade and Liedholm is not attempting a fully realistic explanation of the consequences of technological change, but it is important not to make too much of the income trade-offs inherent in labour-saving versus labour-using technologies. One contribution of the model is to show, in a simple example, that even technologies which themselves reduce the use of labour can benefit rural employees (as seen by the wage rate gain of 1.7 per cent even if on-farm employment is reduced).

When a technological adoption increases the demand for labour in a rural area, the added labour comes from three sources: more hours per worker, more labour force participation by locals, and migration into the area. Leaving aside inward migration, the consequence of the demand increase in the rural labour market is reduced leisure and less time spent on other household activities. Therefore, because leisure is a 'good' and household hours are also productive, the gain in well-being is less than the gain in measured income. Only if the supply curve of labour were vertical would the higher earnings be a pure gain to the workers.

Second, Haggblade and Liedholm allude to the income distribution effects of agricultural investments and I want to reinforce their comments with an example from rural India. These comments are based on a very preliminary examination of data from a village-level survey at the Institute for Crop Research in the Semi-Arid Tropics in Hyderabad by Rolf Mueller and myself.

Some have suggested that policies to encourage individual investments in ground water irrigation in central India would be regressive because the larger farms have more access to capital. This means that the large farms where the necessary wells have been dug would profit most. However, irrigation does increase the demand for labour. Our preliminary examination of wage and employment data indicates that the incomes of the poorest segment of the population – the landless labourers and the small farmers who also work off
their farms—gain substantially from irrigation. So, in addition to profit for the larger farms, there are benefits for the very poor. To ignore the labour market consequences in this case is to get the distributional effects of the technology wrong. If irrigation was to be left out of the policy agenda, ignoring the labour market effects would also mean that we would be getting the policy wrong. The paper by Otsuka, in this volume, provides massive evidence from several Asian economies illustrating the importance of labour markets in understanding the distributional impacts of technology.

Finally, the issues of rural labour markets raised by Haggblade and Liedholm apply not only to developing economies but also to relatively wealthy countries. However, there are major differences in rural economies between rich and poor countries. These include the share of the economy accounted for by farming and, perhaps, the level of integration between rural and urban markets. In the United States, for example, less than 10 per cent of rural employment is in farming. Further, farms in the developed countries not only sell on the world market but also buy more of their inputs from off the farm and from outside the local rural economy. The highly developed information and distribution systems of rich countries mean that goods and services flow more easily between rural and urban sectors.

These basic economic differences suggest some differences in the way we should think about farm and non-farm rural labour market interactions in rich and poor economies. With few exceptions, technology adoption on farms is a relatively minor issue for rural labour markets in wealthy countries. The small share of the labour force employed on farms, and the larger share of farm and household inputs acquired from the urban sector, means that on-farm changes have less effect on the local rural economy. In the United States, for example, there is growing recognition that rural development policy is not a farm policy question. For an elaboration of this point, see a large body of work from the Economic Research Service of the US Department of Agriculture (Parker and Whitener, 1989) and a paper presented at the International Forum on Rural Development (Sumner, 1991a).

In both wealthy and poor countries, one feature of the farm–non-farm labour market connection is the tendency for farmers and farm family members to work off the farm. In the case of rich countries, almost all off-farm work is at non-farm jobs, whereas off-farm work on another farm is more common in poor countries.

The linkage between non-farm local labour market conditions and the opportunities for off-farm work deserves more attention. In the United States, at most 60 per cent of farm operators cite farming as their primary occupation, and some of those are people who have retired from a non-farm job and earn most of their income from non-farm sources. (US Department of Commerce, Bureau of the Census, 1989). To date, most of the research on off-farm work by farmers tends to treat it as a choice to work off the farm made by farmers, rather than a choice to work part-time as a self-employed farmer by someone whose primary occupation is in the non-farm labour market (Parker and Whitener, 1989; Sumner, 1991b). For this research we need more survey data that include both farm and non-farm households and information on human capital, farm characteristics and time allocation.
Off-farm work is also important in poor rural labour markets and, while not dealt with explicitly by Haggblade and Liedholm, is consistent with their model. When they refer to a labour-saving technology, it may well be an innovation that allows a farmer to satisfy the demand for labour on the farm by working only part-time on the farm and, thus, be available to work off the farm in the non-farm labour market. It may also be the spouse of the farmer who seeks off-farm employment to supplement the farm family income.

The analysis of Haggblade and Liedholm has considered an important set of issues. Agricultural economists often spend so much effort on commodity market or farm management issues that they tend to leave aside the labour market. These examples of the way labour market conditions affect the consequences of technologies and how different technologies affect labour market outcomes are useful reminders. The interactions between the farm and non-farm sectors are complex and important, and deserve continuing research effort.

REFERENCES


