THE IMPACT OF AGRICULTURAL RESEARCH ON THE POOR: A REVIEW OF THE STATE OF KNOWLEDGE

Peter B. R. Hazell[1]

DRAFT, 8/19/99

Prepared for
The International Center for Tropical Agriculture (CIAT) International Workshop:
Assessing the Impact of Agricultural Research on Poverty Alleviation
September 14-16, 1999
Cali, Costa Rica

INTRODUCTION

Each year, about eight billion dollars are spent by donors and national governments on agricultural research in the developing countries. Of this amount, $300 million (or less than 4 percent) is spent by the CGIAR system. There is widespread evidence that this research has led to significant increases in agricultural productivity and incomes in the developing world (Lipton and Longhurst 1989; Walker and Ryan 1990, Hazell and Ramasamy 1991, Kerr and Kolavalli, 1999). It has been further credited with generating the increases in food production that have outstripped population growth and thus averted widespread shortages (Tribe 1994). Moreover, publicly funded agricultural research has been found to have an exceptionally high rate of return (Alston et al, 1998). Yet despite such indications, the impact of CGIAR research on poverty remains controversial. New seed technologies have been seen at times to benefit the rich rather than the poor, the landed rather than the landless, and men rather than women and children.

Critics have focused on three areas of concern. First, that the uptake of modern technologies associated with commercialization is an inequitable process that at best worsens rural inequality but more likely increases absolute poverty. Second, that in the shift to cash cropping, small-scale farmers sacrifice their own food crops and expose their families to greater food insecurity. Third, that commercialization worsens regional inequities because it favors areas that have greater agricultural production potential. We shall review the empirical evidence on each of these issues, but first lay out a conceptual framework for analyzing impacts.

CONCEPTUAL FRAMEWORK

Agricultural research that leads to improved technologies has the potential to benefit the poor in five ways:

- It can benefit poor farmers directly through an increase in their level of own-farm production. This may involve production of more food for their own consumption, or increasing the output of marketed products that increase farm income;

- It can benefit small farmers and landless laborers through greater agricultural employment opportunities and higher wages within the adopting regions;

- It can benefit a wide range of rural poor within adopting regions through growth in the local nonfarm economy;

- It can increase migration opportunities for the poor to other regions and urban areas; and

- It can lower food prices for all.

But these benefits do not necessarily materialize for the poor, for there are innumerable conditioning factors that help determine who benefits. These factors work in a myriad of complex and often conflicting ways, and the outcomes are difficult to determine a priori.

On-Farm Productivity Impacts

Poor farmers will only obtain on-farm benefits from new technologies if they adopt them. This requires that the new technologies are appropriate and profitable for their farming conditions and that they have access to the necessary knowledge and inputs to adopt the technology. In principle, improved crop varieties are scale neutral and can be adopted by farms of all sizes, but the same is not always true of other technologies or of complementary inputs like irrigation and machines, and access to fertilizers and credit. If the institutions that provide these services and inputs are biased in favor of large farms, then the poor may not be able to adopt, or only much later.

Poor farmers also need secure ownership or tenancy rights if they are to invest in new technologies that do not have immediate returns (e.g. improved tree crops or better soil management techniques), and to obtain credit to finance such technology investments. Insecure rights to land may also increase poor farmers vulnerability to eviction should larger farmers and landlords decide that they want to expand their own cropped area as the result of more profitable technologies. Insecurity problems can be particularly severe when land is highly concentrated and most farmers only have very little land to begin with. Some tenancy contracts offer security, but reduce incentives to adopt new technologies because the tenant bears all the costs and risks of production, but has to share the crop output with the landlord.

Under risky agroclimatic conditions, poor farmers may be reluctant to adopt profitable new technologies because they require investments in inputs that could be lost in an unfavorable year. On the other hand, larger farmers are more likely to be able to handle such risks because they have larger reserves and better access to credit and insurance.

Farmers who adopt new technologies often succeed in lowering their production costs per unit of output (though not usually per hectare), and hence can better compete in the market. Moreover, if the technology is widely adopted and market prices fall as a result, then the decline in unit costs may be essential for maintaining farm income. In this case, farmers who do not adopt will be disadvantaged not only by stagnant production, but by declining prices and tighter profit margins. This profit squeeze can be detrimental to non-adopters within adopting regions, and to farmers who live in regions that are not appropriate for the new technology. However, poor farmers who are net buyers of food may benefit more as consumers from the price decline than they lose as producers.

Even when poor farmers do benefit from significant productivity gains, these benefits are not always shared equitably amongst household members. In many societies, men and women have responsibility for growing different crops, and which

crop benefits from technological change will also determine who has control of the increased production. Technological change for women's food crops may more easily translate into improved nutrition and well being for women and children than technological change for men's cash crops.

Agricultural Employment and Wage Impacts

Many yield enhancing technologies increase total on-farm employment, particularly if they expand the gross cropped area (e.g. irrigation and short season crop varieties). But whether this translates into higher wage earnings for the poor depends in large part on the elasticity of the supply of labor. If labor is abundant in the adopting region, then the additional employment will have little effect on wages, and there will be limited incentive for farmers to invest in labor replacing machines. But if labor supply is inelastic, then wages will rise sharply and labor displacing machines may become attractive. The initial mechanization may be targeted on labor intensive tasks like plowing and threshing, but once farmers invest in tractors then the incremental costs of mechanizing other tasks may become quite low, and more widespread displacement of labor can occur. Mechanization may also occur prematurely if government policies such as cheap credit for large farms make it less costly than it would otherwise be.

The additional wage earnings induced by technological change for local poor people may be diluted in adopting regions by seasonal or permanent migrants from other regions. This can be an effective way of spreading the benefits to the poor in other regions, but will not be of benefit to the local poor. Population growth has a similar diluting effect.

Impact on the Local Non-farm Economy

Agricultural growth generates important income and employment multipliers within the local non-farm economy. These are driven by a) increased farm demands for additional farm inputs, investment goods and marketing services (demands that often increase per hectare with technological change), and b) increased rural household demands for consumer goods and services as farm incomes rise. These multipliers can be large, often with $0.5 to $1.0 of additional value added created in the local non-farm economy for each dollar of additional value added created in agriculture (Haggblade and Hazell, 1989). The rural non-farm employment elasticities are also large; each one percent increase in agricultural output is often associated with a one percent increase in rural non-farm employment (Hazell and Haggblade, 1991). Multipliers of this size mean that technological change in agriculture has the potential to generate significant new non-farm income earning opportunities for the poor. These may arise in the form of greater non-farm employment opportunities and higher wages, and opportunities for starting or expanding non-farm businesses of their own. The increasing competition for labor between agriculture and the local non-farm economy can also contribute to higher agricultural wages, adding to agricultural wage earnings for the poor. A considerable body of empirical evidence shows that small farm and landless labor households typically obtain significant shares of their total household income from non-farm sources

(Hazell and Haggblade, 1993). They are therefore already well positioned to gain from growth in the rural non-farm economy.

The benefits of growth in the rural non-farm economy are more concentrated in rural towns than in the villages, so they impact on an important segment of the urban poor as well as on the rural poor. The distribution of the benefits between rural areas and local towns depends to a large extent on the state of infrastructure connecting the two, on population density, on government policies and average per capita income levels (Haggblade, Hazell and Brown, 1989).

Impact on Inter-regional Migration

Technological change in agriculture is typically site specific and does not benefit all regions equally. The green revolution, for example, was initially concentrated in irrigated regions, and only spread later to some of the more favorable rainfed areas. Technological change can, therefore, contribute to widening disparities between regions. But inter-regional migration acts to buffer these gaps, and provides an efficient way of spreading the benefits to poorer regions that have more limited agricultural growth potential.

As mentioned above, rapid agricultural growth also stimulates important rounds of secondary growth in the rural non-farm economy, and this provides increased opportunities for the rural poor to migrate and settle in local towns. But these growth impacts also spread more widely, and agricultural growth contributes to the growth of the national economy at large (Mellor, 1975). This generates additional migration opportunities for the poor to larger towns and cities, and can lead to greater remittances back to the rural poor.

Impact on Food Prices and Food Security

Technological change can lead to an increase in the aggregate output of affected commodities.

If the national demand for these products is downward sloping (i.e. export opportunities are constrained by trade policy or by high transport costs) then the output price will fall. Lower food prices are of benefit to rural and urban poor alike, and because food typically accounts for a very large share of their total expenditures, the poor gain proportionally more than the non-poor from a decline in food prices. These price reductions may not be very large in an open economy with low transport costs, and more countries now fall into this category than before because of recent rounds of market liberalization policies. But many poor countries still face high transport costs because of poor infrastructure, remoteness from world markets, or inefficient marketing institutions, and may still face considerable domestic price endogeneity even after market liberalization. In many landlocked African countries, for example, domestic prices still fall sharply when domestic food production increases suddenly.

The food price benefits may also be enhanced if technological change leads to a reduction in production costs per unit of output, since farmers can then maintain or increase profits even at lower sales prices. But whether consumers benefit from these lower costs depends on whether the food marketing and distribution system is sufficiently competitive that cost savings at the farm gate are passed up through the marketing chain. In some cases, the cost savings are simply captured as additional profits in the marketing chain.

Technological changes that smooth seasonal food supplies (e.g. irrigation and short season rice varieties) can also help smooth seasonal price variation, and this can be of considerable benefit to the poor. The rural poor may also obtain enhanced food security from increased production within their region if it displaces food purchases from outside the region that previously had to be priced to cover high transport costs.

Net Impacts for Different Types of Households

As discussed above, there many factors that condition whether technological change will benefit the poor, and these factors also interact in complex ways. It is, therefore, difficult to predict whether poor people will gain in each of the five ways discussed above. But the problem is even more challenging because poor people have complex livelihood strategies, and are often part farmers, part laborers, part non-farmers, and always consumers. They may gain or lose in each of these different dimensions at the same time, so that the net impact can remain ambiguous. A poor farmer, for example, might be able to gain from increased on-farm production as a technology adopter, but may lose or gain from increases in agricultural wages or reductions in food prices depending on whether he/she is a net buyer or seller of labor or food. Again, a small non-farm business entrepreneur might gain from cheaper food, but business profits might fall or rise depending on whether or not hired labor costs rise faster than sales. Understanding household livelihood strategies is therefore fundamental for assessing the impact of technological change.

IMPACT STUDIES

Given the complexity of the factors conditioning the impact of technology on the poor, assessing impact empirically is a complex task. It is not surprising that many studies have proved inconclusive or questionable; they were simply not well designed for the task.

Many studies have proved misleading because they were based on anecdote rather than fact, failed to establish an adequate counterfactual situation, failed to identify the true causality of change, were not representative, were too narrow in scope and did not consider all the indirect ways in which the poor are impacted, or were too short term in perspective. Some of the key analytical issues that need to be addressed in impact studies are reviewed below.

The scope of the analysis

The direct impact of improved agricultural technologies on poor farmers has been the focus of many studies. But these are often only a small proportion of overall impacts on the rural and urban poor. The direct effects are captured by poor farmers who adopt improved technologies in the regions in which they are released, and who produce more output which they can consume themselves or sell. However, there are important spillover benefits to other households or regions. These include the benefits that may arise from the generation of new employment, higher wages, and less costly food. These spillover effects have received inadequate empirical attention, despite their enormous potential impact on poor people, including landless laborers, the nonfarm rural poor and the urban poor. To capture these different effects requires a research design that operates at different scales of analysis (household, village, region, national).

Inter-household and inter-regional effects are one important dimension to the scope of the analysis. Intra household effects are another. Recent work undertaken by IFPRI and others shows that significant biases along gender and generational lines can arise when the distribution of production increases within households, and that technologies can reduce or reinforce these biases depending on who grows or owns the crops that are affected. Assessing the impact of improved technologies at this level requires information about individuals within households.

Establishing an Adequate Counter-factual Situation

In order to assess the impact of a new technology on poverty, the researcher must be able to assess what the situation would be like if the technology had not been adopted--the counterfactual situation. Many studies fail to establish an effective counterfactual situation, and often rely on a simple before-and-after analysis. This can be quite misleading, for many other factors may have changed along with the technology. Some critics of the green revolution, for example, tend to use the before green revolution situation as a counterfactual, and conclude that many of the poor would be better off if there was a switch back to the old technologies. But they forget that populations have grown enormously since the green revolution began, and that the situation would be drastically worse for the poor today if yields were to return to their pre-green revolution levels.

The best counterfactual is a comparable region or group of farmers who are identical in all respects to the adopters except that they have not had a chance to adopt the technology themselves. Such situations are extremely rare, and most often it is necessary to use comparator groups that differ in other attributes too. The danger of this is that there may be systematic reasons why the comparator group has not adopted (e.g. the technology is not appropriate to their conditions, or they do not have access to credit) and these other reasons would also have affected the impact of the technology had it been adopted. Such sample biases can be controlled through econometric techniques, but this does require that particular types of data be collected. Establishing appropriate counterfactuals for assessing the indirect benefits of technological change

is even more difficult, and it is difficult to avoid the need for sophisticated modeling or econometric approaches.

Controlling for other factors

Many other factors besides improved technologies affect changes in agricultural production and its impact on the poor. At the farm level, prices, access to inputs, credit and markets, education levels and the distribution of land, affect both the rate of uptake of improved technologies and the extent to which they benefit the poor. Improved technologies may fail to benefit poor farmers not because they are inherently biased against the poor, but because the distribution of land, or access to inputs and markets is unfair. It is only when these are taken into account that it becomes possible to explain why similar technologies can have very different impacts on the poor in different regions, or at different points in time. The need to control for other factors is even more challenging when assessing the indirect benefits for the poor. For example, changes in rural employment opportunities and wages in the farm and nonfarm sectors are affected by macro, trade, and agricultural sector policies, as well as by prevailing prices, public investments in rural infrastructure, health and education, and by public employment programs. Teasing out the specific impacts of production increases due to improved technologies needs to be done within an analytical framework that allows for all these important factors. Similar problems arise in trying to assess the indirect benefits to the poor arising from changes in food prices, or from improved migration opportunities. Resolving such difficulties can only occur by looking at countries over longer periods of time, and by comparing the experiences of different countries, or regions within a country (see for example, Fan, Hazell and Thorat 1998; Datt and Ravallion 1997, Datt and Ravallion 1998).

Allowing for time lags

There are often long time lags between expenditures on agricultural research and the widespread adoption of improved technologies that the research develops. There may be further lags between the adoption of improved technologies and their production and poverty impacts. For example, some technologies require long term investments (e.g. farm trees, livestock improvement, watershed development) before any additional production is achieved. Most of the indirect benefits arising from improved technologies also take time, as factor and product markets must adjust. The analytical framework must be sufficiently dynamic to capture and aggregate these kinds of lagged benefits.

Controlling for risk

Agricultural production is inherently risky, and yields and prices can fluctuate markedly from one season to another, particularly in rainfed farming systems that are home to many of the rural poor. Assessments of the impact of improved technologies on the poor need to average out these random effects, either by taking enough years in “with” and “without” analyses, or by using an analytical framework that specifically controls for weather and price variables.

Understanding institutional constraints

To have impact on the poor, good science must be targeted on the right problems and the resulting technology must reach and be adopted by farmers. Inadequate information flows, adverse incentive structures (e.g top down) and overly complex organizational structures can thwart the effective design and implementation of technically sound interventions and whenever possible these institutional features conditioning the relationship between agricultural research and the poor must either be controlled for or explicitly studied.

Defining the benefits

New technologies, practices and policies can potentially affect a wide range of indicators. Process indicators assess whether the new intervention is being used and used as intended. Intermediate outcome indicators assess intermediate outcomes of the intervention such as impacts on crop yields, post-harvest losses, soil fertility, and improved forest management. Welfare outcome indicators assess the well-being of adopters and non-adopters of the intervention. Welfare can be measured in a number of ways (for example: income, expenditure, food consumption, nutrition status, decision-making ability), at a number of different levels (for example: community, household and individual), for different types of individuals (adopters, non-adopters, farmers, non-farm rural, and urban).

REVIEW OF EMPIRICAL EVIDENCE

Despite the difficulties of designing and implementing sound impact studies, there is a wealth of relevant empirical material available in the literature. This was definitively reviewed by Michael Lipton and Richard Longhurst in their 1989 book, and Kerr and Kolavalli (1999) have now provided a recent update. Because relatively little of this evidence derives from rigorous studies with sound counterfactuals, synthesizing the findings remains a subjective and potentially controversial task. The following section represents the joint views of the author and his IFPRI colleague Mark Rosegrant (Rosegrant and Hazell, 1999).

Impact of Technological Change

Concerns about the adverse impact of modern agricultural technologies on the poor reached their zenith in the 1970s when critics debated the negative impacts of the green revolution. Critics argued that, because of their better access to irrigation water, fertilizers, seeds and credit, large farmers were the main adopters of the new technology, and smaller farmers were either left unaffected or were made worse off because the green revolution resulted in lower prices, higher input prices, and efforts by larger farmers to increase rents or force tenants off the land. It was also argued that the green revolution encouraged unnecessary mechanization, with a resulting reduction in

rural wages and employment. The net result, some critics argued, was an increase in the inequality of income and land distribution, an increase in landlessness, and a worsening of absolute poverty in areas affected by the green revolution (see, for example, Griffin, 1972, 1974; Frankel, 1976; Farmer, 1977; ILO, 1977; Pearse, 1980).

Although a number of village and household based studies conducted soon after the green revolution technologies were released lent some support to the critics (e.g. Farmer, 1986), the conclusions have not proved valid when subjected to the scrutiny of more recent evidence (Barker and Herdt, 1978; Blyn, 1983; Pinstrup-Andersen and Hazell, 1985; Lipton and Longhurst, 1989; Hazell and Ramasamy, 1991). Although small farmers did lag behind large farmers in adopting the green revolution technologies, most of them did eventually adopt and benefit from increased production, as well as from greater employment opportunities and higher wages in the agricultural and nonfarm sectors. Nor did the distribution of land worsen in most cases (Rosegrant and Hazell, 1999). Large numbers of other poor people also benefited from the green revolution through increased employment and business earnings in the farm and nonfarm sectors, and from lower food prices (Pinstrup-Andersen and Hazell, 1985). This is not to say that the green revolution was equitable everywhere, but the conditions under which it and other yield enhancing technologies are likely to be equitable are now reasonably well understood. These include a) a scale-neutral technology package that can be profitably adopted on farms of all size; b) an equitable distribution of land with secure ownership or tenancy rights; c) efficient input, credit and product markets so that farms of all sizes have access to needed modern farm inputs and receive similar prices for their products; d) a mobile labor force that can migrate or diversify into the rural nonfarm economy; and e) policies that do not discriminate against small farms (e.g. no subsidies on mechanization, or scale-biases in agricultural research and extension).

Impact of Commercialization

Critics of commercialization also fear that small farms will be left out of the commercialization process and will be unable to compete in the market as competition increases and prices fall. However, they also fear that if small farm households forgo some or all of their traditional food crops in order to grow more cash crops for the market, then this will a) increase their dependence on purchased foods, exposing the household to greater food security risk because of volatile market prices and uncertain income from cash crops, and b) lead to a reallocation of income within the household in favor of men (who typically grow cash crops) with possibly adverse nutritional consequences for women and children (e.g. Lappe and Collins, 1977;Hernandez et al, 1974; Lambert, 1979; Gross and Underwood, 1971).

A recent study by Von Braun (1995) and von Braun and Kennedy (1994) refutes the critics of commercialization. The study summarizes a series of comparative studies of selected sites where farm households had recently switched from semi-subsistence staple food production with low levels of external inputs to production of more crops for sale in the market or to production with more purchased inputs. These studies find that, with few exceptions, commercialization of agriculture benefits the poor by directly

generating employment and increased agricultural labor productivity. Both the households that are commercializing their production and the hired laborers receive direct income benefits. Furthermore, in all but one study site, the increased household income generated by commercialization was associated with an improvement in nutritional status for children in the household.

However, while commercialization by itself rarely has adverse consequences on household welfare, commercialization combined with failures of institutions, policies, or markets can be damaging. It is therefore essential that government policies facilitate the transition to commercialized agriculture in a manner that benefits the poor and does not simply replace subsistence-related production risks with new market and policy failure risks, which may be even more devastating to the poor. Important policy goals should include avoidance of trade shocks and appropriate sequencing of input and output market reform.

Regional Disparities

It has also been argued that agricultural intensification and commercialization that proceeds in certain regions but not in others can worsen regional disparities, with lagging regions falling farther behind as commodity prices drop in the wake of increasing productivity in the rapidly growing region. The widening productivity gap between commercializing regions and slower growing subsistence-oriented regions could not only accentuate relative income differences, but even cause an increase in absolute poverty in the lagging regions. In the study sites examined in von Braun (1995), however, indirect income benefits were generated through the increased demand for goods and services by the direct income beneficiaries as well as by increased demand for inputs for commercialized agriculture. The wage rate and other employment benefits from commercialization spread to other regions when labor migrates from other regions into scheme areas. The more mobile the labor force, the more the benefits from commercialization will spread across the economy and other regions. Similar results have been found for the spread of modern rice technology in Asia (a classic process of commercialization). In a comprehensive cross-country comparative study, David and Otsuka (1994) found that the differential impact of new rice technology across regions did not worsen income distribution, due to the significant indirect effects which worked through labor, land, and product markets. Interregional labor migration from unfavorable to favorable regions tended to equalize wages across regions, allowing landless labor and small farmers in unfavorable areas to benefit also. Landowners in lagging regions were sometimes worse off, but also partially protected their incomes through diversification out of rice.

While well-functioning product and factor markets help to equalize wages and incomes across regions, they are not always sufficient. In India, for example, poverty in many low potential rainfall areas has improved little even while irrigated and high potential rainfall areas have progressed (Fan and Hazell, 1998). Regional inequalities have also worsened in China in recent years (Knight and Song, 1992). Worsening

regional disparities seem most likely to occur when agriculture is still the predominant source of national employment, and when the non-farm economy is growing at only moderate rates. In these circumstances the opportunities for outmigration from, and rural income diversification in, backward areas are likely to be smaller than needed. Where regional disparities worsen, there is need for increased public investment in backward areas, particularly in roads, agricultural research and development, and education (Fan and Hazell, 1999).

CONCLUSIONS

Despite more than forty years of research on the food problems of the developing world, and despite dramatic increases in food production as a result, controversy still abounds about whether agricultural research is beneficial to the poor. There is a huge body of empirical evidence that has relevance to this theme, but it includes very few studies that meet acceptable standards of analysis, particularly with respect to a) establishing an adequate counterfactual (without technology) situation for comparative purposes, b) controlling for the many other variables that condition the multifaceted impacts of technological change on the poor, and c) assessing the indirect as well as the direct impacts. Without such studies it is all too easy to draw simplistic and misleading conclusions; the most dangerous of which would be that governments and donors should cease to maintain adequate levels of investment in agricultural research on the food problems of the poor. There is no sound empirical basis for such a conclusion, yet if adopted and subsequently proven wrong, the consequences for the poor could be dire indeed. Agricultural research is a longer-term endeavor with long lead times between the initiation of new research and impact in farmers' fields. Funding decisions today will largely determine the kinds of research outputs that will be available to benefit the poor in 10 to 20 years hence. There is an urgent need for more representative and best practice case studies to resolve this controversy once and for all.

ENDNOTES

1. Peter Hazell is Director of the Environment and Production Technology Division at the International Food Policy Research Institute, Washington DC. In writing this paper, he has benefited from a recent literature review and synthesis paper written for IFPRI and the IAEG by John Kerr and Shashi Kolavalli (Kerr and Kolavalli, 1999). He has also benefited from recent joint work with Lawrence Haddad and Mark Rosegrant on these topics.

REFERENCES

Alston Julian.M., Michele C. Marra, Philip G. Pardey, and T.J. Wyatt, 1998. *Research Returns Redux: A Meta-Analysis of the Returns to Agricultural R&D*. Environment and Production Technology Division Discussion Paper No.38. International Food Policy Research Institute, Washington, D.C.

Barker, R. and R. Herdt. 1978. *Interpretive Analysis of Selected Papers from Changes in Rice Farming in Selected Areas of Asia*. Los Baños, Philippines: International Rice Research Institute.

Blyn, G. 1983. "The Green Revolution Revisited," *Economic Development and Cultural Change*, vol. 31, no. 4 (July), pp. 705-25.

Datt, G. and M. Ravallion. 1997. "Macroeconomic Crises and Poverty Monitoring: A Case Study for India," *Review of Development Economics*, vol. 1, no. 2, pp. 135-152.

Datt, Gaurav and Martin Ravallion. 1998. Farm productivity and rural poverty in India. *Journal of Development Studies*, Vol. 34, No. 4, pp. 62-85.

David, Cristina, and Keijiro Otsuka, eds. 1994. Modern Rice Technology and Income Distribution in Asia. Boulder: Rienner.

Fan, Shenggen and Hazell, Peter. 1999. Are Returns to Public Investment Lower in Less-favored Rural Areas? An Empirical Analysis of India. Environment and Production Technology Division Discussion Paper No. 43. International Food Policy Research Institute, Washington, D.C.

Farmer, .B.H. 1977. *Green Revolution?* London: MacMillan Press.

Frankel, F.R. 1976. *India's Green Revolution: Economic Gains and Political Costs*. Princeton, NJ: Princeton University Press.

Griffin, K. 1972. *The Green Revolution: An Economic Analysis*. Geneva: United Nations Research Institute for Social Development.

Griffin. K. 1774. *The Political Economy of Agrarian Change. Macmillan, London.*

Gross, Daniel R., and Barbara A. Underwood. 1971 Technological Change and Calorie Costs: Sisal Agriculture in Northeastern Brazil. *American Anthropologist.* 73(3):725-40.

Haggblade, S., P.B.R. Hazell and J. Brown. 1989. Farm-Non-Farm Linkages in Rural Sub-Saharan Africa. *World Development,* 17(8):1173-1201.

Haggblade, Steven and Peter Hazell. 1989. Agricultural Technology and Farm-Nonfarm Growth Linkages. *Agricultural Economics*, Vol. 3, pp. 345-64.

Hazell, P.B.R., and S. Haggblade. 1991. Rural-Urban Growth Linkages in India. *Indian Journal of Agricultural Economics,* 46(4):515-29.

Hazell, P.B.R., and S. Haggblade. 1993. Farm-Nonfarm Growth Linkages and the Welfare of the Poor. In *Including the Poor*, edited by Michael Lipton and Jacques van der Gaag. World Bank.

Hazell, Peter, and C. Ramasamy. 1991. The Green Revolution Reconsidered: The Impact of High Yielding Rice Varieties in South India. Baltimore: Johns Hopkins University Press.

Hernandez , Merecedes, Carlos P. Hidalgo, Juan R. Hernandez, J. Madrigal, and Adolfo Chavez. 1974. Effect of Economic Growth on Nutrition in a Tropical Community. *Ecology of Food and Nutrition.* 3(4): 283-91.

International Labor Organization. 1977. *Poverty and Landlessness in Rural Asia*. Geneva: ILO.

Kerr, John and Shashi Kolavalli. 1999. Impact of Agricultural Research on Poverty Alleviation: Conceptual Framework with Illustrations from the literature. Draft paper prepared for the IAEG and IFPRI, Washington DC.

Knight, J. and L. Song. 1992. Income Inequality in Rural China: Communities, Households and Resource Mobility. Oxford Applied Economics Discussion Paper Series No. 150. (November). University of Oxford: Institute of Economics and Statistics

Lambert, J.N. 1978. Does cash Cropping Cause Malnutrition: Port Moresby, Papua New Guinea: National Planning Office. Processed.

Lappe, F.M. and Collins, J. 1977. *Food First: Beyond the Myth of Scarcity*. Boston: Houghton Mifflin.

Lipton, Michael and Richard Longhurst. 1989. New Seeds and Poor People. Baltimore: Johns Hopkins University Press.

Mellor, J.W. 1976. *The New Economics of Growth*. Ithaca, N.Y.: Cornell University Press.

Pearse, A. 1980. *Seeds of Plenty, Seeds of Want*. London: Oxford University Press.

Pinstrup-Anderson, Per and Peter B.R. Hazell. 1985. The Impact of Green Revolution and Prospects for the future. Food Review International. 1(1),

Rosegrant, Mark and Peter B.R. Hazell. 1999. Transforming the Rural Asia Economy: The Unfinished Revolution. Oxford University Press for the Asian Development Bank, Hong Kong. (Forthcoming).

Tribe, Derek 1994. Feeding and Greening the World: The Role of International Agricultural Research. CAB International in association with the Crawford Fund for International Agricultural Research.

Von Braun, Joachim. 1995. *Agricultural Commercialization: Impacts on Income and Nutrition and Implications for Policy,* Food Policy, vol. 20, pp. 187-202.

Von Braun, J. and E. Kennedy. 1994 A*gricultural Commercialization, Economic Development, and Nutrition*. Baltimore, MD: John Hopkins Press.

Walker, T. and J. Ryan. 1990. *Village and Household Economies in India's Semi-arid Tropics*. Baltimore, MD: Johns Hopkins University Press.