Agricultural Research and Poverty Alleviation: Some International Perspectives

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Contents

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Preface

It is widely recognised that growth in agricultural production leads to improved economic development in both developed and developing countries. By increasing productivity, agricultural research is a major source of increased agricultural production and income.

A review in 1997 of Australia's overseas aid program (of which ACIAR is a small part) made a strong recommendation that 'the objective of the Australian aid program should be to assist developing countries to reduce poverty through sustainable economic and social development'.

Like other international agricultural R&D organisations, ACIAR is committed to improving the focus of its research on poverty alleviation.

This report is a revised and expanded version of an earlier draft paper prepared by Jim Ryan at the request of ACIAR for presentation at a staff training and discussion session.

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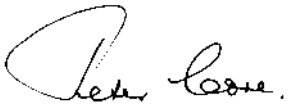

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1. Introduction

Poverty alleviation has become a primary goal of overseas development assistance of most donor countries and of the international financial institutions. As a result, international public agricultural R & D institutions increasingly are being held to account to articulate how and to what extent investments in them are especially impacting on the poor, and not just to general economic welfare and the environment (see Pachico *et al*. 2000). The implications of this are that it must be demonstrated that such investments are more effective than alternatives in targeting the poor in order to increase and maybe even maintain the level of investment of public funds.

An explicit poverty alleviation focus in international agricultural R & D requires attention both in *ex ante* and *ex post* impact evaluation and priority assessment. There are various levels at which such a focus is relevant. These range from global, regional, national, zonal, institutional, program and project levels. The approaches and degrees of freedom to measure poverty impacts and to purposely modify future priorities may differ depending on the level at which one is operating.

In this paper, we first examine the range of indicators that are commonly used to define the nature and degree of poverty before summarising the current state of empirical knowledge of its location and extent. This is followed by a discussion of the relationships between income and food and nutrition security, which are the keys to understanding how R & D interventions might influence the well-being of the poor. The extent to which the agricultural potential of land is a major determinant of the extent of poverty is then addressed. The empirical evidence on the linkages between agricultural R & D, economic growth and poverty are then explored. This includes a discussion of the relative productivity and poverty reduction benefits of public investments in R & D and other infrastructure in irrigated versus rainfed agriculture. A section on issues related to the documentation and articulation of the impacts of R & D on poverty precedes one on mainstreaming poverty in the formulation of priorities and strategies. Some conclusions are drawn in the final section.

2. Poverty Indicators

The most common indicators of poverty are related to measurable material deprivation such as consumption, nutrition, income and wealth. The most common measures are based upon income and four are usually used: (a) the number of people in absolute poverty (the headcount), as measured by those below a "poverty line", usually calculated as the income required to provide basic needs or a minimum recommended dietary intake of major nutrients; (b) the incidence of poverty as in (a) but expressed as a proportion of the total population in a country or region; (c) the depth of poverty as measured by the poverty gap, or the mean shortfall in income of those below the poverty line expressed as a percentage of the poverty line; and (d) the Gini coefficient which measures the degree to which the distribution of income shares across the population differs from the distribution of population. If the distributions were identical then the Gini coefficient would be zero. The more unequal they are the closer the coefficient is to unity.

The quantitative measures based on material deprivation are being supplemented by considerations that relate to the contexts in which the poor find themselves, thereby broadening the understanding of poverty. As the World Bank puts it: *Let us move from counting the poor to making the poor count!* Among the concepts being explored in both the donor community and in the Consultative Group on International Agricultural Research (CGIAR) to characterise poverty and its alleviation are well-being, livelihoods, vulnerability, social exclusion and empowerment. These are captured in the sustainable livelihoods framework (SLF) as highlighted in the 1997 UK Government White Paper on International Development (DFID 1997). This will be elaborated on later in the paper.

The World Bank is trying to build an improved understanding of the underlying determinants of poverty and the pathways to its alleviation with its Participatory Poverty Assessment Project (Narayan *et al*. 2000). The PPAP employs participatory and qualitative research methods to understand the perceptions of the poor about the realities of their lives and experiences of poverty, and their interactions with institutions from the level of the state to the household. It represents a synthesis of the voices of 60,000 poor people from 60 countries.

The PPAP has revealed the similarities in the experiences of the poor everywhere: hunger, deprivation, powerlessness, violation of dignity, social isolation, resilience, resourcefulness, solidarity, state corruption, rudeness of service providers and gender inequity. The poor rarely speak of income but focus instead on managing assets — physical, human, social and environmental — as a way of coping with their vulnerability. The main conclusions that have emerged are:

- Poverty is multidimensional;
- The state is largely ineffective in reaching the poor;
- The role of NGOs in the lives of the poor is limited, forcing the poor to depend primarily on their own networks;
- Households are crumbling under the stresses of poverty;
- The social fabric — the poor's only "insurance" — is unravelling.

3. The Location and Extent of Poverty

Sections 3 to 6 have drawn liberally on Ryan and Spencer (2001).

Using the TAC/FAO databases, it is estimated that in the mid-1990s there were about 1.3 billion people living below the poverty line of $US 1 per day in developing countries. Some three-quarters of these were in rural areas and the balance were in urban areas (Tables 1 and 2). The poor represent about one third of the population of developing countries. About 44% of the world's poor reside in South Asia, 24% in Sub-Saharan Africa, 23% in East Asia and the Pacific, 7% in Latin America and the Caribbean, 2% in Europe and Central Asia and less than 1% in the Middle East and North Africa. Since 1987, East Asia and the Pacific have been able to reduce the number of poor by more than 130 million. In all other regions except West Asia and North Africa the numbers have increased markedly.

According to the World Food Summit as reported in TAC (1997), since the 1970s the number of women below the poverty line has increased by 50%, compared with 30% for men. This means today the estimate is that more than 70% of the 1.3 billion poor are women. It is estimated by IFAD that women represent about 60% of the rural poor.

Table 1. Total rural poor in developing countries in 1996.

	Number (millions)	Per cent of total population
Arid/Semi-Arid Tropics	379	27
Rainfed	199	28
Irrigated	180	25
Humid/Sub-Humid Tropics	500	25
Rainfed	259	25
Irrigated	241	25
Temperate/Cool	116	24
Rainfed	89	51
Irrigated	27	9
Total Rural	995 (75 per cent)[a]	26

[a] Per cent of the total number of poor.
Source: Derived from the TAC/FAO database as described by Gryseels *et al.* (1997) using Sere and Steinfeld (1996) as described in Thornton *et al.* (2000).

Table 2. Total urban poor in developing countries in 1996.

	Number (millions)	Per cent of total population
Total Urban	326 (25 per cent)[a]	8
Total Rural and Urban	1321 (100 per cent)	34

Per cent of the total number of poor.
Source: Derived from the TAC/FAO database as described by Gryseels *et al.* (1997) using Sere and Steinfeld (1996) as described in Thornton *et al.* (2000).

Of the rural poor, we estimate that around 380 million (38%) reside in the arid/semi-arid tropics (Table 1). By far the largest numbers of rural poor reside in the humid/subhumid tropics, where 500 million people comprise 50% of the total. The rainfed areas have slightly more poor people within each of these agroecological zones than do the more irrigated areas. Worldwide, the most vulnerable groups in the rural sector are small farmers, the landless, women, pastoralists, artisanal fisherfolk, indigenous ethnic groups, and displaced people. Smallholder farmers and the landless represent more than 90% of those who are vulnerable.

In future urban poverty is likely to grow more rapidly than rural poverty. Rosegrant *et al.* (1995), Pinstrup-Anderson *et al.* (1997 and 1999) predict that between 1995 and 2020 the urban population will double in developing countries to about 3.5 billion while the rural population will increase only by 11% to 3.0 billion. Fifty-two percent of the world population will live in urban areas in 2020, up from 38% in 1995. Of the 1.9 billion projected increase in the population of the developing world to 2025, some 90% of it is estimated to be in urban areas (Garrett and Ruel 1999). The proportion of poor who reside in urban areas increased in the past two decades in seven of the eight developing countries they examined. However, in spite of the relatively higher growth rates of urban poverty expected in the future, poverty will remain primarily a rural phenomenon in terms of absolute numbers.

4. Income, Food Security and Nutrition

FAO (2000b) indicates that the incidence of undernourishment in Sub-Saharan Africa has stayed around one-third of the population from the seventies through to the nineties but is projected by them to decline significantly towards 2030 (Table 3). In contrast in South Asia the incidence declined during the eighties and nineties and it is projected to further fall to only 4% by 2030. Needless to say, there will remain 165 million undernourished people in Sub-Saharan Africa in 2030 and 82 million in South Asia.

Table 3. Incidence of undernourishment in developing countries.

Region	1995–97	2015	2030	1995–97	2015	2030
	Per cent of Population			Millions of persons		
Sub-Saharan Africa	33	22	15	180	184	165
South Asia	23	10	4	284	165	82
Developing countries	18	10	6	790	576	401

Source: FAO (2000b).

Child malnutrition is the most insidious manifestation of food insecurity. In 1995 there were estimated to be 167 million malnourished children (underweight for age) in developing countries (Table 4). Of these, 86 million (51%) were in South Asia and 31 million (19%) in Sub-Saharan Africa (Smith and Haddad 2000). South Asia has a much higher incidence of child malnutrition than Sub-Saharan Africa, although the numbers have been increasing in the latter since 1970, whereas in the former there has been a decrease. Similarly to the FAO projection, the IFPRI projections to 2020 indicate that the numbers of malnourished children will continue to rise in Sub-Saharan Africa, with the incidence remaining about the same. Although an improvement is expected in South Asia, both the absolute numbers and the incidence will remain well above those of Sub-Saharan Africa in 2020. According to Garrett and Ruel (1999) the urban share of malnourished children has increased in 11 of the 15 countries they examined, and their absolute numbers in urban areas increased in nine of the 15.

Table 4. Trends in child malnutrition in developing countries.

Measure	Change from 1970 to 1995	Level in 1995	Projections to 2020[a]
Proportion of children malnourished	**(percentage points)**	**(per cent)**	**(per cent)**
South Asia	–23.0	49.3	34.5–40.3
Sub-Saharan Africa	–3.9	31.1	25.7–32.4
Developing countries	–15.5	31.1	15.1–21.8
Number of children malnourished	**(million)**	**(million)**	**(million)**
South Asia	–6.2	86.0	60.9–71.1
Sub-Saharan Africa	+12.9	31.1	43.3–54.6
Developing countries	–36.7	167.1	127.6–154.6

These are the ranges projected based on varying assumptions.
Source: Smith and Haddad (2000).

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The highest prevalence rates of child malnutrition and the largest numbers occur in the semi-arid tropics (Table 5). Within the SAT it is estimated there were 49 million malnourished children in 1990. It is suggested that one reason for the high prevalence rates in the semi-arid tropics (SAT) is that there have been smaller increases in land and labour productivity growth rates there than most other agroecological regions. Some 38 million (79%) of the malnourished children in the SAT were in South Asia and 10 million in Sub-Saharan Africa (21%). The highland arid/semi-arid tropics of Sub-Saharan Africa had much more severe child malnutrition than the lowland arid/semi-arid tropics. Stunting (underheight for age) in the former regions had a median prevalence of 55% and in the latter 27%. Comparable prevalence figures for underweight children in the two regions were 34% and 24% respectively.

Table 5. Distribution of malnourished children by agroecological zone, 1990.

Agroecological zone	Malnourished children	
	Percent	Number (million)
Warm, semi-arid tropics	49.0	48.8
Warm, subhumid tropics	36.4	20.6
Warm, humid tropics	37.0	38.0
Cool tropics	26.0	8.1
Warm, semi-arid subtropics (summer rainfall)	44.0	31.7
Warm, subhumid subtropics (summer rainfall)	38.0	7.4
Warm/cool, humid subtropics (summer rainfall)	19.0	10.0
Cool subtropics (summer rainfall)	23.0	10.6
Cool subtropics (winter rainfall)	17.4	8.2

Source: Sharma *et al.* (1996).

A cross-country analysis by Smith and Haddad (2000) of the determinants of child nutrition indicated that to reduce child malnutrition further in both South Asia and Sub-Saharan Africa the top priorities are improved per capita food availability, women's education and status relative to men's and the health environment (hygiene, sanitation and clean water). These priorities take account of the ranking of determinants by those with both the most potent impact on malnutrition relative to the existing range in each region, and by the most potential for impact based upon increases needed to reach desirable levels. Although the basic determinants of child malnutrition and future priorities are similar in the two regions, even if the determinants are brought to desirable levels, the enigma of a significant level (24%) of child malnutrition in South Asia would remain, compared with a virtual absence in Sub-Saharan Africa.

The key issue arising from this work is the importance of per capita food availability to the further alleviation of child malnutrition. Although it is not a sufficient condition, it seems a necessary one and reinforces the value of R & D on the foods that are important in the food baskets of the poor. Multisectoral investments such as irrigation, roads and education are also required to reduce poverty and malnutrition, as will be discussed later.

5. Poverty and Land Potential

It is important to recognise that the poor are evident in both high- and low-potential agroecological regions. Depending on one's definition of what constitutes land potential and the dividing lines, so one can conclude from the statistics on poverty that the numbers of poor people are more or less in the low-potential regions.

Pinstrup-Andersen and Pandya-Lorch (1994) maintain that, for developing countries as a whole, the numbers in absolute poverty are, to a large extent, in low-potential environmentally vulnerable areas. Citing Leonard (1989) they point out that, of the 463 million people identified as the poorest of the rural poor in Asia, 57%, or 265 million, live in low-potential agricultural areas.

A TAC-commissioned study estimated that 630 million poor (66% of the total rural poor in developing countries) rely on marginal agricultural lands. The balance of 325 million (34%) depend on favourable agricultural lands (TAC 1997). The study recommended that the CGIAR sharpen its focus on poverty alleviation in setting priorities for marginal areas, which they defined as those with a high incidence of rural poverty subject to a relatively homogeneous set of determining conditions. Biophysical productivity potential of land was discarded by the TAC panel as an indicator of what the CGIAR ought to regard as marginal lands. Instead the term "marginal areas" was preferred. They were characterised as isolated, risky and of low potential, where inhabitants have little political power and have been bypassed by R & D, such that the people are marginalised rather than the land. After much deliberation, TAC has concluded that the evidence is inconclusive and neither confirms nor rejects the conventional wisdom that most of the rural poor are located in areas characterised by marginal lands and that marginal lands are more susceptible to resource degradation.

The situation in India seems different to that for Asia as portrayed by Leonard (1989). Classifying as marginal environments those rural districts in India with productivity levels less than Rs 500/ha, Kelley and Parthasarathy Rao (1995) found there were significantly fewer absolutely poor people residing in the more marginal rural environments. The regression analysis showed that for every 1% increase in the proportion of total cropped land in a state classified as "marginal", the number of absolutely poor people fell by 380,000. This was after accounting for the effects of the absolute size of the state. In other words the *breadth* of rural poverty in India is greater in the higher potential agroecological environments. This seems counter intuitive, but it is corroborated by Byerlee and Morris (1993) for the wheat growing environments of South Asia. But is the *depth* of poverty in India greater in the more marginal environments, as measured by the proportion of the population in absolute poverty there? Kelley and Parthasarathy Rao found there was no statistical relationship between the proportion of marginal land in a region and the depth of poverty.

Ryan and Spencer (2001) updated the Kelley and Parthasarathy Rao analysis using more recent data on the SAT and included the value of livestock products along with crop income in calculating the productivity of land on which to classify regions for their potential. The analysis shows a similar result (Table 6). There were fewer poor rural people in the more marginal districts, as measured by gross values of production below Rs5500 per ha, compared with the favourable districts with a productivity of more than Rs10,000 per ha. The depth of poverty in the more marginal districts was about the same as in the favourable districts. Regression analysis showed that the elasticity of the breadth of poverty with respect to the gross value of agricultural production per net-cropped hectare was positive and significant with a value of 0.62. This implies for every one per cent increase in the productivity of land (the measure of potential), the number of rural poor residing in that

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ACIAR Working Paper No. 56 (printed version published in 2004)

region is greater by 345,000. This is a similar statistic to that found earlier by Kelley and Parthasarathy Rao (1995) and reinforces their conclusion that in India there tends to be more rural poor in the more favoured or higher productivity regions.

Table 6. Poverty in the Indian SAT, 1991–93.

SAT region	Average gross value[a] per ha of NCA (Rs)	Number of rural poor (millions)	Share of poor in rural population (per cent)
Marginal	5,474	26.2	34.7
Average	9,540	30.6	31.0
Favourable	18,529	39.3	32.3
TOTAL	10,027	96.1	32.5

[a] Includes value of crops, small ruminant meat and milk.
Source: Compiled from SEPP-ICRISAT databases of Kelley and Parthasarathy Rao.

Both ILRI (Thornton *et al*. 2002) and IFPRI (Stan Wood) are employing GIS to map poverty using more precise definitions of agroecological potentials and current agricultural and livestock production systems. These should assist in the further refinement of agricultural research strategies and priorities to reflect a more specific poverty focus. However, these and other studies that examine the location of the poor all suffer from their static view of poverty. Poor people often migrate seasonally where income prospects are better. Hence their location at any one time may not necessarily be the most accurate indicator of how best to target them in R & D strategies. Also, the pervasiveness of serendipitous and/or unplanned research spillovers (Alston 2002) further dilutes the ability to ensure R & D investments in specific agroecological zones or research/recommendation domains will, in fact, generate new income streams limited to the poor in these domains.

6. Links between Agricultural R & D, Economic Growth and Poverty

This section has drawn heavily on Ryan et al. (1998).

There is now persuasive empirical evidence that absolute poverty in developing countries declines with growth in average incomes. Based on a study of 20 countries between 1984 and 1993, Bruno *et al.* (1998) estimate that a 10% increase in mean incomes led to a 20% decrease in the proportion of people living on less than $1 per day. Roemer and Gugerty (1997) found that GDP growth of 10% per year is associated with income growth of 9% for the poorest 20% of the population. In reviewing 95 country growth experiences, Deininger and Squire (1996) found a strong positive relationship between growth and poverty reduction in more than 85% of cases, whereas economic decline quite often hurt the poor disproportionately. This was painfully evident in 1997 when the economic crisis halted economic growth in most Southeast Asian countries. In their review of the Asian experience Rosegrant and Hazell (2000) concluded: "The countries that have been most successful in attacking poverty have achieved rapid agricultural growth and broader economic growth that makes efficient use of labour and have invested in the human capital of the poor."

Ravallion and Chen (1997) found that a 10% increase in the mean standard of living could be expected to result in a 31% drop in the proportion of people living on less than $1 per day. For higher poverty lines, the growth elasticity falls in absolute value. Deininger and Squire (1996) also found little relationship between growth and inequality change, although there are obviously losers and winners in the growth process.

Datt (1998) found that among Indian states, the growth in mean consumption has explained 87% of the reduction in the headcount index of total poverty from 1951–96. Only 13% was explained by redistribution, which did account for more of the changes in the depth and severity of poverty. "The more serious constraint on poverty reduction seems to have been that there just was not enough growth." Changes in rural poverty numbers accounted for 80% of the cumulative change in the national poverty count index. Intersectoral population shifts explained little.

Ravallion and Datt (1996) show that in India both the urban and rural poor gained from rural sector growth. By contrast, capital intensive urban growth had adverse distributional effects within urban areas inimical to the urban poor and, importantly, had no discernible impact on rural poverty. Rural-urban migration also did not result in significant gains to India's poor. Ravallion and Datt conclude: "Fostering the conditions for growth in the rural economy — in both the primary and tertiary sectors — must thus be considered central to an effective strategy for poverty reduction in India." Sectoral biases against the rural sector in pricing, exchange rates and public investment are not conducive to growth, poverty alleviation or reductions in inequality.

Perhaps of more significance is the strong evidence from Ravallion and Datt (1998(a) and (b)), using both state and household data for India, that indicates trend growth rates of farm yields per hectare were important in explaining differences in trend rates of reduction in poverty. By contrast, differences in trend growth rates of non-agricultural output (rural and urban) were not important. A large share of the gains to the poor was from wage rises and price falls resulting from the increase in farm yields. The long-run elasticity (10 years or more) of higher farm productivity on the head count index (breadth) of poverty was 1.0, whereas the short-run elasticity (one to two years) was 0.2. There was no evidence these elasticities were falling over time. After allowing for the trend in farm

Agricultural Research and Poverty Alleviation: Some International Perspectives
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ACIAR Working Paper No. 56 (printed version published in 2004)

yields, the initial endowments of human and physical capital such as higher irrigation intensity, higher literacy and lower infant mortality all contributed to higher long-term rates of poverty reduction in rural areas.

Irz *et al*. (2001) use a cross-country empirical estimation of the links between changes in agricultural yields per ha and the incidence of poverty. They find the elasticity to be around –0.9, which is similar to that found by Ravallion and Datt (1998) of –1.0 for India. These imply that yield increases of 20% could lead to a reduction of at least 18% in the numbers of poor. As agricultural research has led to these types of gains in the past, and could no doubt continue to do this in future — perhaps at a faster pace with biotechnology than without it — the scope for poverty reductions and increased food security from enhanced investments is large. As Irz *et al*. conclude: "It is unlikely that there are many other development interventions capable of reducing the numbers in poverty so effectively".

The speed of the reduction in poverty from agricultural growth can be significantly retarded if there are concentrations in land ownership leading to uncompetitive markets in land and labour (Otsuka 1993, Gaiha 1995 and Roemer and Gugerty 1997). Anti-poverty measures such as market-mediated land distribution, relaxation of tenancy regulations and employment guarantee schemes can be important in enhancing the effect of growth on poverty reduction in rural areas. However, in Asia there will not be enough land to redistribute to all the poor to sustain their livelihoods. To cater for this, labour-using R&D strategies also must be employed both within the agricultural sector and in non-farm rural enterprises.

Thus, it seems clear that a focus on growth-enhancing initiatives and on countries and provinces with large numbers of poor people will be conducive to poverty reduction. Some attention to interventions that redistribute income to the losers is also appropriate, but not to the exclusion of growth-enhancing investments. The jury is apparently still out on whether an unequal distribution is more or less conducive to growth. More egalitarian countries may be more likely to respond to the need for reforms — such as land reform, improved credit access and investment in basic education — which will promote sustained growth and poverty reduction.

Recent research by Fan *et al*. (1998 and 1999a), of IFPRI, found that expenditure on rural roads and research and development in India has had the largest impacts on both rural poverty reduction and agricultural productivity growth. Government expenditure on education significantly reduces the number of people below the poverty line, as does expenditures on rural development. However, neither of these investments have discernible effects on productivity growth and hence do not provide a sustainable solution to the poverty problem. Investments in irrigation, soil and water conservation, power and human health have small effects on rural poverty and no effects on productivity growth.

The IFPRI research in India by Hazell and Fan (1998) also examined the potential of alternative investments in irrigated, high- and low-potential rainfed areas to contribute to agricultural productivity growth and poverty alleviation. It shows that investments in rural infrastructure, agricultural technology and human capital in many rainfed areas, are now at least as productive as in irrigated areas and they have a much larger impact on poverty. They conclude that increased investments in rainfed areas could be a win-win proposition. The productivity impacts of agricultural technology investments as measured by the coverage of high yielding varieties, were similar in both the high- and low-potential rainfed regions (Table 7). The poverty impact was less than half in the low-potential areas. However, both rainfed areas generated greater poverty and productivity impacts from investments in agricultural technology than in the irrigated regions. Markets, irrigation and road investments had a larger impact in the low-potential areas.

Fan *et al.* (1999 b) maintain that in India investments in irrigated areas have diminishing marginal returns and that it is now rainfed areas where the marginal returns from additional government investments in technology and infrastructure are the largest. In contrast to Hazell and Fan (1998), who used state data and an agroecological classification, Fan *et al.* used an ICRISAT (1999) typology of farming systems and associated district data. The results were similar, except that the marginal rainfed regions had much lower impacts on both productivity and on the poor than high potential rainfed regions (Table 8).

Table 7. Marginal impact of investments in agricultural technology in India[a].

Measure	Regions		
	Irrigated	High-potential rainfed	Low-potential rainfed
Returns to production (Rs. ha^{-1} 1990 prices)	352	686	642
Returns to poverty reduction (persons 100 ha^{-1})	0	11	5

[a] As measured by the coverage of HYVs. All coefficients significant at 5% level.
Source: Hazell and Fan (1998).

Table 8. Marginal effects of investments in agricultural technology in India[a].

Classifications of regions	Number of zones	Average land productivity (Rs. ha^{-1} in 1994 prices)[b]	Added value of agricultural output per Rs. of investment (Rs. Rs^{-1}. p.a.)	Reduction in number of poor per million Rs. investment (Persons Rs. 1 million^{-1} in 1994 prices)
Rainfed				
Marginal	5	4,670	5.04	0.92
Moderate potential	5	7,121	8.79	3.95
High potential	3	13,383	16.21	11.18
Irrigated	1	12,455	4.64	0.76

[a] Agricultural technology as measured by coverage of HYVs.
[b] Includes crop and livestock income.
Source: Fan *et al.* (1999 b).

In yet another analysis, Fan and Hazell (2000) used the same ICAR agroecological classification for India as the earlier study by Hazell and Fan (1998) but, instead of a cut-off point for classifying irrigated districts of 40%, Fan and Hazell used 25%. This resulted in approximately the same estimated number of rural poor in the low-potential regions as in those with high potential. In the low-potential rainfed regions the incremental effect of investments in agricultural technology on production were about 180% higher than in the higher potential ones, and some 150% more on poverty reduction. Again, both rainfed regions gave far higher production and poverty dividends than the irrigated regions. Needless to say, agricultural growth in dry low-potential areas is unlikely to become a major factor in meeting national cereal needs but, as this research clearly shows, they will be important for redressing poverty and environmental problems for the large numbers of poor people who live in these areas (Byerlee *et al.* 1997).

Ravallion and Woden (1998(a) and (b)) found in Bangladesh that poor areas are not poor because resident households have characteristics that inherently foster poverty. Rather, there appear to be

Agricultural Research and Poverty Alleviation: Some International Perspectives
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ACIAR Working Paper No. 56 (printed version published in 2004)

structural differences to returns to given household characteristics in such regions, such as their education levels. "Our results reinforce the case for anti-poverty programs targeted to poor areas even in an economy with few obvious impediments to mobility." (1998(b)). Comparing average living standards in rural versus non-rural areas overstates the gains from switching, as often those in poor areas are poorly endowed with characteristics conducive to success in more profitable non-farm activities. Needless to say, the World Bank (1999) found on balance that in rural Bangladesh the gains from switching from the farm to the non-farm sector are positive and large for the poor, implying that developing the rural non-farm sector holds considerable potential for poverty reduction. However, the net elasticity of poverty reduction with respect to growth was still the largest in agriculture.

The Asian Development Bank in their major review of the problems, lessons and prospects in Asia (ADB 2000) concluded that:

- agricultural growth is a prerequisite for economic development in general and rural development in particular;
- to reduce poverty and improve the quality of life in rural areas, agricultural growth must be both pro-poor and environmentally sustainable;
- promoting growth of the rural nonfarm economy will greatly enhance the pace of rural development;
- efficient rural financial markets play a key role in promoting rural development;
- it is necessary to ensure effective institutions for rural development;
- to improve the overall quality of life in rural areas it is necessary to go beyond growth, poverty, and environmental considerations and directly address specific concerns of particular relevance to rural Asia.

Agricultural research is seen by ADB as a key element in enhancing agricultural growth, including both the public and, increasingly, the private sector. Land and water saving innovations will be required in Asia, as most growth must come from land already cropped. Public sector research was seen as of particular relevance to the resource-poor areas, where the returns to research have historically been less than in the irrigated and high potential areas. The private sector is seen as the major player in the latter regions. The premises on which this public-private sector dichotomy seem to have been based appear to us to be flawed. For one thing, Fan *et al*. have shown that research returns are often higher in the more marginal areas; for another, there are complementarities to be exploited between public and private sector research, even in low-potential marginal areas. Fortunately ADB seems to recommend that additional R & D resources be provided to both high- and low-potential rural areas, rather than seeing them as alternatives. Rosegrant and Hazell (2000) in the same ADB publication, argue that:

> … on poverty and environmental grounds alone, more attention will have to be given to less favoured lands in setting priorities for policy and public investments. The successful development of less favoured lands will require new and improved approaches, particularly for agricultural intensification.

7. Articulating Poverty Impacts

There are primarily six ways agricultural research can benefit the poor:

- by increasing poor farmers' own-farm productivity, involving the production of more food for home consumption and/or increased output of marketed products that increase farm income;
- greater employment opportunities for small farmers and landless labourers through greater agricultural employment opportunities and higher wages in adopting regions;
- growth in the rural and urban non-farm economy;
- lowering food prices;
- greater access to crops high in nutrients that are crucial to the well-being of the poor and to poor women in particular;
- empowering the poor by increasing their access to decision-making processes, increasing the capacity for collective action and reducing their vulnerability to shocks via asset accumulation.

It is difficult to measure and attribute the effects of research on poverty as many poor are simultaneously producers, wage earners and consumers, so technological change has complex and often offsetting effects on their real income. The recent review by Kerr and Kolavalli (1999) illustrated this. They find that, over the years, population gains have obscured the tremendous increases in the amount of food produced and the numbers of people food production employs. The proportion of people who are poor has fallen significantly but, with population growth, the absolute number of poor people has not. Needless to say, *a priori* the evidence that agricultural R & D has contributed to significant reductions in poverty is compelling. However, the number of counterfactual studies on which to draw to prove this is limited.

Kerr and Kolavalli also conclude that the evidence on the effects of improved technology on income distribution across farms with different resource endowments has been ambiguous. More equitable outcomes are more likely if land and income are relatively equally distributed and markets, government services and infrastructure are well developed. Unfavourable social outcomes are more likely when these conditions are not in place. Similar issues surround the distribution of benefits of new technologies between farms in favourable and unfavourable agroecological regions. There is evidence that irrigated adopting regions have gained relatively more than non-adopting rainfed regions. However, shifts to other crops that have a comparative advantage in rainfed regions, along with migration, has mediated the adverse consequences somewhat.

The effects of technological change on wages and employment are also difficult to articulate. There are three reasons: first, wages in the nonagricultural sector play a role in determining agricultural wages; second, economic policies influence wages; and third, steady growth in the population of unskilled job-seekers and migrants counteracts the demand effect. Kerr and Kolavalli conclude that, while economic growth is not sufficient to alleviate poverty, evidence suggests that it is necessary. Alongside economic growth, poverty alleviation requires special programs targeted to poor people to provide safety nets and give them opportunities. Technology alone cannot solve problems of unequal distribution of productive assets and access to markets and services and is no substitute for reforms to policies and structures biased against small farmers.

The sustainable livelihoods framework (SLF) focusses on two components of well-being: having a secure livelihood to meet one's basic needs and realising and expanding one's capabilities in order to achieve fulfilment. Under the livelihoods approach, alleviating poverty focuses on building poor

Agricultural Research and Poverty Alleviation: Some International Perspectives
edited by Jim Ryan
ACIAR Working Paper No. 56 (printed version published in 2004)

people's capital assets, which include natural capital, physical capital, social capital, human capital and financial capital. Vulnerability refers to exposure to contingencies and the stress and difficulty in coping with them. It has two components: external risks and shocks and internal coping mechanisms. Social exclusion focuses on the institutional process through which individuals or groups are wholly or partially excluded from full participation in the society in which they live, leading to deprivation. Empowerment aims to enhance capabilities of people to participate in development processes. It has its roots in participatory action research.

There is an initiative by SPIA and IFPRI to explore with case studies the use of the SLF in better articulating the benefits to the poor of CGIAR-derived technology options. Adato and Meinzen-Dick (2002) describe these in a recent paper. Their approach combines quantitative and qualitative methods. It recognises that the survival and prosperity of the poor depends on the pursuit of diverse and multiple objectives simultaneously by different family members, taking advantage of different resources and opportunities at different times. It requires development of an understanding of the processes that underlie poverty and the social, cultural, political and institutional contexts in which poor people live. Individual households and communities are the primary levels of analysis but relevant interactions at the micro, macro and intermediate levels are addressed. The SLF goes beyond poverty measures based on income, consumption or nutrition to include access to resources, vulnerability, rights, safety and social relations. It includes social differentiation by class, ethnic group, gender and perceptions by local communities as to who is poor in lieu of external standards.

The SLF conceptual framework portrays the five livelihood assets of the poor mentioned earlier as being influenced by agricultural technologies, shocks, trends, seasonality, policies, institutions and processes to produce livelihood strategies that generate livelihood outcomes for the poor. These include income, improved well-being, reduced vulnerability, improved food security and sustained use of natural resources.

The SLF is a holistic framework and, to this author, embraces elements of its predecessors or precursors; namely farming systems research, rapid rural appraisal and participatory rural appraisal. It uses a variety of instruments including surveys, focus groups, key informant interviews, case studies, participant observation and secondary data in an iterative, interdisciplinary process. As yet it seems to be no more than a set of organising principles and techniques rather than providing a new paradigm by which improved poverty-oriented impact assessment and priority setting in agricultural research can be undertaken. Indeed, it is doubtful if it will ever assist in the allocation of research resources among competing topics, commodities, regions, research institutions or programs. It may prove valuable at the project or micro-level but, here again, more as a tool for linking *ex ante* and *ex post* impact assessment in a continuous fashion so as to enhance research effectiveness in targeting the poor. Whether it can provide best practice guidelines and methodologies for more general use is a moot point. However, we must await the completion of the case studies being undertaken by SPIA/IFPRI before forming a firm opinion.

If it does indeed prove to have merit, then it is likely that this will be best expressed by using it to study both *a priori* "success stories" of impact and also "failures", so as to maximise its value to management and scientists in research planning, conducting research, prioritisation and in monitoring and evaluation. However, it is likely to prove expensive per unit of observation and hence must be able to derive generalisable inferences if it is to be cost-effective. Maybe its most valuable role will be to make it clearer when agricultural research interventions *will not* be a preferred tool in poverty alleviation rather than when and in what form they will be? But this is speculation.

8. Mainstreaming Poverty in Strategies and Priorities

There are several levels on which choices have to be made in establishing priorities and strategies in agricultural research. Some of these are:

- countries, regions or agroecologies;
- commodities;
- research programs or themes;
- farming or agricultural systems.

To inform such choices one can array the quantitative information increasingly available on the location and extent of poverty provided in a form such as shown in Tables 1–5 on pages 9 to 12. At best, though, such information is only available on a country, regional or agroecological basis. Of course we have information about the consumption patterns of the poor that can assist in choosing commodities which offer the best prospects of benefiting the poor from the consumption side, but not from the production side. There is not necessarily a one-to-one relationship between the location of the poor at any point in time and the prospects that research investments targeted at those locations will achieve maximum impact on the resident poor. Many other factors mediate this relationship and make it difficult to argue that priorities and resource allocations at the macro level should be primarily based upon the location of the poor. Research spillovers to other regions, migration and market price effects all act to diffuse the relationship and these are often serendipitous. Inter-commodity spillovers are less likely.

If commodities consumed by the poor are non-tradable it is more likely the poor will benefit significantly from cost- and price-reducing agricultural research on them. Where poor households in marginal areas are net food purchasers and market infrastructure is adequate, then technological change in more favoured areas can be an effective way of benefiting the poor in marginal areas. Lower commodity prices result and migration offers opportunities for low income workers to participate in the benefits of higher wages and employment. However, if, as Hazell and Fan have shown, the marginal returns to research are higher in less-favoured environments and also the effect of this on poverty alleviation is greater, then it is not clear that it is appropriate to neglect the less-favoured areas and allow "trickle down" forces from more-favoured areas to equilibrate the benefits.

The wage and employment effects of targeted research can often be counter-intuitive. For example, if labour intensive commodities have inelastic demands then research on them could lead to mechanisation and/or to their substitution in production by less labour intensive commodities.

There is lack of agreement about the ability of research to target the poor at the more micro levels such as the program, thematic or project levels. More participatory involvement of farmers in determining research priorities is occurring at these levels. These demand-driven approaches are in contrast to the more supply-driven approaches using economic surplus estimates and benefit/cost calculus. In principle, participatory research offers better scope for the poor to influence research agendas. However, there is a danger that rural élites can dominate these processes and not represent the interests of poor consumers, small farmers and the landless. The poor will not be empowered if this occurs. The jury is still out on whether these demand-driven approaches can deliver better outcomes for the poor than can the alternatives. It does seem to have some potential in complex and heterogeneous production systems in guiding applied and adaptive research designed to derive technology options that are more acceptable to the poor. Demand-driven approaches are limited in their ability to guide macro-priority setting because of the wide diversity of their clientele and the complexity of their systems.

Agricultural Research and Poverty Alleviation: Some International Perspectives
edited by Jim Ryan
ACIAR Working Paper No. 56 (printed version published in 2004)

For research institutions mandated to focus at the more strategic end of the research spectrum, such as the CGIAR centres, it is not clear that demand-driven approaches offer substantial benefits in terms of enhancing the probability of success in better targeting the poor. That is not to say that they should not help develop methodologies that can assist national programs to more effectively elicit the needs of the poor, as they have in the past. This remains a legitimate endeavour for the centres. Involvement in, rather than leading participatory research programs at the local level, is the appropriate way for centres to ensure their strategic agendas remain appropriately focused on the priorities of the poor in ways that complement national programs. Such approaches might usefully be broadened to include participation of other sectors such as health, education and community welfare, which sometimes might offer more cost-effective interventions for the benefit of the poor than agricultural research.

Growth linkages between agriculture and nearby rural industry can generate multiplier effects of 1.3 to 2.0. They are larger in irrigated regions with medium-sized farms and modern input-intensive farming systems than in rainfed systems and in regions dominated by very small farms or large estates. These multipliers will benefit the poor most when:

- the direct benefits of technological change are equitably distributed;
- poor consumers demand local and more labour intensive goods;
- agricultural income is a high proportion of total income;
- the initial asset distribution is relatively equitable;
- economic capacity is under-utilised.

In Asia the evidence is accumulating that a high percentage of rural workers are engaged primarily in non-agricultural employment. This is reflected in an inverse relationship between non-agricultural income and farm size, with landless and near-landless workers deriving between one-third and two-thirds of their income from off-farm sources. Hence, they stand to benefit more from growth in the non-farm sector than do the more affluent larger farmers. Renkow and others deduce from this evidence that it is difficult to rationalise a priority for agricultural R & D in the quest for poverty alleviation. To the extent that non-farm income is even more important for the poor in marginal areas, he contends that agricultural R & D should give way to other interventions and instead be focussed on more-favoured areas. In Africa the picture seems to be the opposite, with the rural poor depending more on agriculture than the non-poor (Reardon 1997).

Current research by Fane and Warr (2001) and Warr (2002 (a) (b) and (c)) seems to confirm that, even though the rural poor dominate the statistics on poverty, and will for the foreseeable future, it is inappropriate to conclude *ipso facto* that agricultural growth (and agricultural R & D leading to productivity gains) is the panacea for alleviating rural poverty. This is especially the case where the agricultural sector represents a small and declining portion of GDP, when R & D investment in sectors that are more significant are growing most rapidly and are not capital intensive and are likely to offer better prospects. Haggblade *et al.* (2002) point out that rural non-farm employment accounts for around 25% of full-time rural employment and 35–40% of rural incomes across the developing world. Against this dynamic, the numbers of rural poor per dollar of agricultural GDP might provide an indicator of the likelihood that agricultural R & D could provide the engine of rural poverty alleviation. Other things being equal, the lower this ratio the more likely it is that agricultural R & D would provide the required horsepower. Mapping this statistic against the numbers of poor, as in Figure 1, provides an efficiency-equity array to guide decision-making. *Ceteris paribus,* the highest priority in poverty-focussed agricultural R & D strategies would be accorded to countries in the northwestern quadrant and the lowest to those in the southeastern quadrant.

Agricultural Research and Poverty Alleviation: Some International Perspectives
edited by Jim Ryan
ACIAR Working Paper No. 56 (printed version published in 2004)

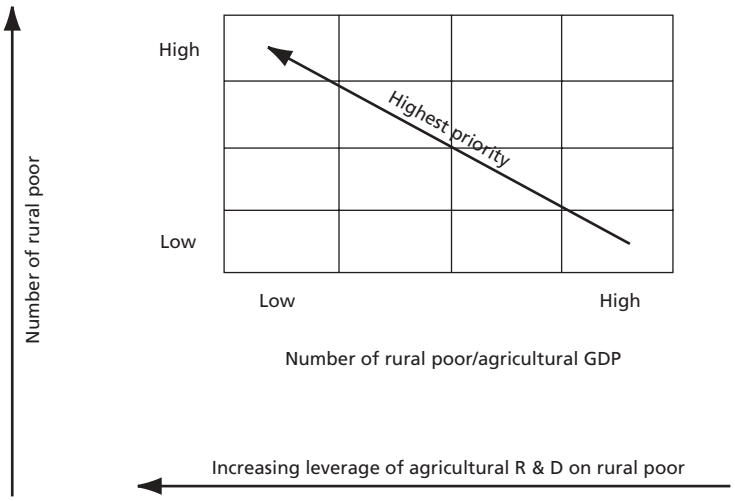

Figure 1. Factoring poverty into agricultural R & D priorities.

This relationship has been arrayed for selected developing countries and regions in Appendix 1 and is summarised in Figure 2. The potential ability of agricultural R & D to impact on the incomes of the poor is greatest in East Asia, Latin America and the Caribbean, West Asia, North Africa and Southeast Asia. The prospects are much worse in South Asia and Sub-Saharan Africa, where the numbers of poor are by far the largest of any region. In these two regions considerable emphasis on rural non-farm R & D is also required in order to have a meaningful impact on the numbers in poverty. Expanded agricultural R & D alone will not suffice.

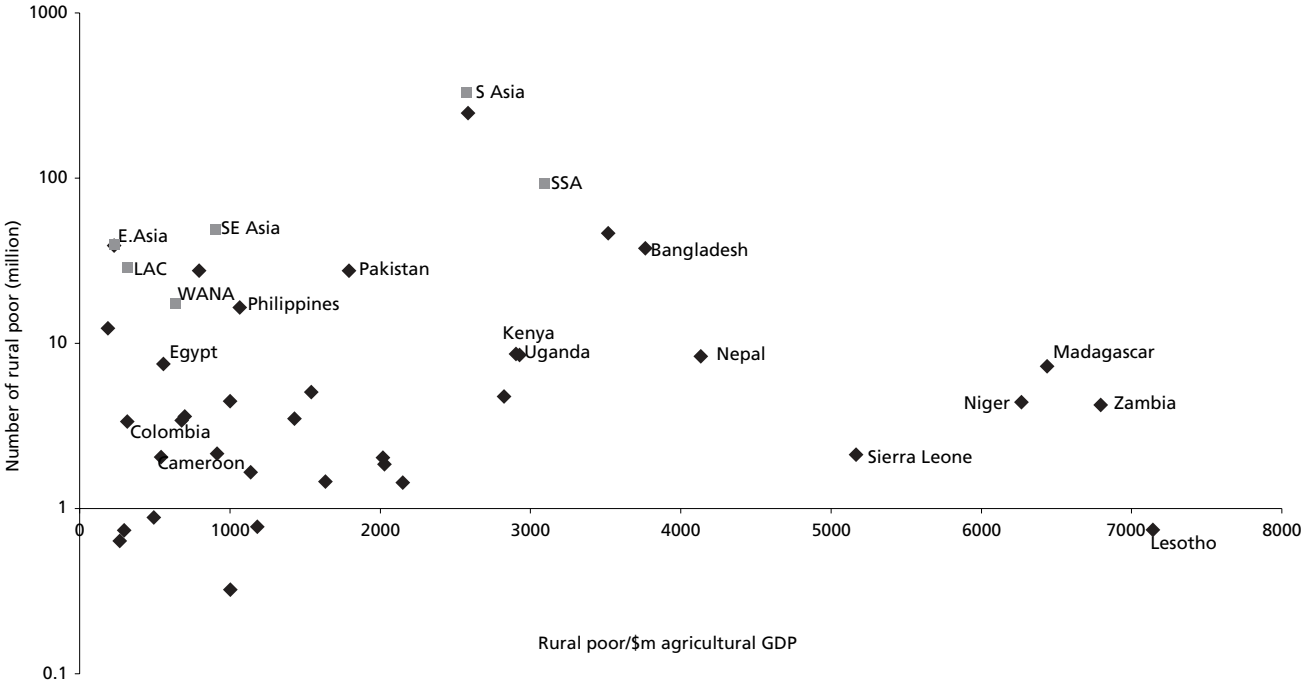

Figure 2. Relationship between numbers of rural poor in selected developing countries and their number per $million of agricultural GDP.

Other dimensions of course are relevant in assessing priorities in addition to those in Figure 2. For example, the share of agricultural GDP accruing to labour and land can influence the distribution of income between landless and land-owning households. To the extent that landlessness contributes to poverty, as it does in South Asia for example, the new income streams from agricultural R & D may not have a major impact on poverty if labour shares are low and the technological change is capital-using/labour-saving. The dominant trait developed so far with biotechnology in genetically modified crops is herbicide tolerance. It is not clear that landless labourers, especially women who are predominately engaged in the hand weeding of crops in South Asia, would benefit from this labour-saving technology. Capital-intensive growth, either in the agricultural or industrial sectors, is unlikely to be beneficial to the poor who depend on labour earnings for the bulk of their meagre incomes. What is required is to incorporate these additional dimensions into the analysis in Figure 2.

Studies by Kelley *et al.* (1995), Walker (2000) and those cited in Byerlee (2000) where alternative research projects are assessed according to both efficiency and equity outcomes, indicate that rankings seem to be relatively insensitive to an increase in the weighting given to poverty. In other words, the size of the expected or realised total economic benefits in an efficiency sense provided a good guide to the magnitude of the poverty benefits. Perhaps then, the conclusions of Byerlee are apposite here (2000):

> *At all levels of priority setting, substantial benefits to the poor are often possible by increasing the efficiency and effectiveness with which research resources are currently employed to ensure widely-shared adoption of the products of the research system. Institutional innovations to improve research system-performance in terms of broad-based efficiency impacts will often produce greater benefits for the poor, than major efforts to target research on poverty alleviation.*

Scherr (2000) says that to jointly address poverty and environmental objectives higher priority ought to be given to R & D in densely populated marginal lands in the tropics and to the integration of environmental concerns more centrally in research on smallholder irrigation systems in Asia.

Hazell (1999) cites reviews by von Braun and Kennedy that showed with few exceptions commercialisation benefited the poor by directly generating employment and increased labour productivity. Hence, it seems at least from the production or income side, there is little reason *a priori* to exclude commercial crops from research agendas aimed at the poor.

As globalisation and trade liberalisation proceed, local improvements in productivity may be less effective in future than in the past in reducing real prices paid by food consumers because demand will become more elastic. In such circumstances, the payoffs to increased productivity of smallholder agriculture with labour-using technological change and a focus on commercial crops where they have a comparative advantage, may be the preferred ways to target the poor. However, to offset this will be the effects of increasing urbanisation and ever smaller farm sizes, with increasing numbers of small farmers and landless who are net purchasers of food. Reduced food prices will remain of particular benefit to these poor groups and hence reinforce the need for continuing national and international research on staple foods in both developed and developing countries. It should be recognised, though, that the consumption patterns of the poor are diversifying. For example, there is evidence that the share of traditional cereals like sorghum and millet in the diets of the poor in India has rapidly declined in favour of wheat, rice, pulses, edible oils, meat, eggs and milk (Ryan and Spencer 2001).

Haddad and Hazell (2001) provide a typology of agricultural regions based upon agroecological zones and socioeconomic factors that condition the size and distribution of the benefits from technological change (Table 9). From this they derive a list of five broad areas of focus for a pro-poor research agenda:

Agricultural Research and Poverty Alleviation: Some International Perspectives
edited by Jim Ryan
ACIAR Working Paper No. 56 (printed version published in 2004)

1. An increased production of staple food production where food price effects are still important and/or that have a comparative advantage in growing these crops.
2. Helping smallholder farms to diversify into higher value products, including livestock products, especially where export market prospects are good.
3. Increasing agricultural productivity in many less-favoured lands, especially where they are heavily populated, but also in high-potential lands constrained by poor infrastructure and market access.
4. Increasing employment and income earning opportunities for landless and near-landless workers in labour surplus regions.
5. Nutritional enhancement of diets by investing in agricultural technology that reduces the price of micronutrient rich foods in urban and well-integrated rural areas, increases in physical access in remote rural areas, or increases in the nutrient content of food staple crops via traditional or transgenic technologies.

Among the nine agricultural research priorities Hazell and Haddad considered in the typology in Table 9 the four most frequent ones cited were smallholder farms, staple food production, employment intensive growth and high external-input farming. With respect to a focus on smallholders, the experience of the green revolution is that they generally adopted the technologies more slowly than larger farmers did, but that they reached comparable adoption levels a few years later. Whether this implies that there is a need to specially target smallholders in agricultural research is moot though. One must recognise, for example, that the same larger farmers in Punjab and Haryana in India who adopted the HYV wheats were subsequently early adopters of the new hybrid pearl millet cultivars that soon succumbed to downy mildew disease. Their early innovator rents on the HYV wheats were dissipated by early innovator losses on the hybrid pearl millets. Hence, the slower adoption by smallholders may be a natural part of acquiring information on technology performance by larger farmers who are prepared to bear the uncertainties of early adoption. One should not formulate targeted research strategies based upon the experience with single innovations but examine the whole portfolio of innovations faced by larger farmers and the contribution of information on the performance and adoption of all of them to the decisions of smallholders. In addition, Ryan and Rathore (1980) found in India that the resource ownership and use ratios between smallholders and large farmers were not sufficiently different as to justify the design of differentiated technology options for these categories of farmers anyway. Much agricultural technology, especially of the biological type, is scale neutral.

It is inescapable that there may be many instances where there are trade-offs between targeting the poor and general productivity or efficiency gains. This can be at the level of small versus large farms, less-favoured versus more-favoured lands or poor people's food crops versus most profitable food and/or commercial crops. Where such trade-offs seem high, it is important to recognise that there are other policy measures and sectoral investments that might provide sharper instruments to effectively target the poor than agricultural R & D.

Agricultural Research and Poverty Alleviation: Some International Perspectives
edited by Jim Ryan
ACIAR Working Paper No. 56 (printed version published in 2004)

9. Conclusions

International agricultural R & D institutions are increasingly committed to improving the focus of their research on poverty alleviation. Many institutions such as the CGIAR are reviewing past performance in this regard in order to determine both the extent to which the poor have participated in the benefits derived from their research and to establish how they might improve the impact on and relevance to the poor. They are examining the increasing amount of quantitative information on the location, extent and nature of poverty to see how priorities and resource allocations might be refined to more appropriately target the poor. New approaches to understanding how the poor formulate their livelihood strategies are being researched to see how these might complement conventional quantitative ways of measuring poverty and determining the influence of agricultural R & D on it.

The jury would still seem to be out on whether and how agricultural R & D institutions could improve the impact of their research on poverty alleviation. Potential trade-offs between efficiency and equity outcomes need to be better articulated before one can confidently conclude that they could have done better in targeting the poor and hence should change the way future strategies and priorities are articulated. The major difficulty is the complexity of the transmission of the gains and losses from agricultural R & D to the various actors, which makes it a challenge to confidently predict the outcomes on the poor of alternative choices. Clearly though, agricultural R & D is but one instrument, *albeit* a necessary one, in the quest for the eradication of poverty. R & D in other sectors are complementary to agriculture in this respect. None alone is a panacea.

Table 9. Priorities for agricultural research to reduce national poverty by type of adopting region.

Country setting	Regional characteristics							
	Good infrastructure				Poor infrastructure			
	Surplus labor		Scarce labor		Surplus labor		Scarce labor	
	Low potential	High potential	Low potential	High potential	Low potential	High potential	Low potential	High potential
Middle-income country								
Markets liberalised	1, 2, 3, 5	2, 3, 5, 8	1, 4, 6	4, 6, 8	1, 3, 5, 7	3, 5, 8	1, 4, 6, 7	4, 6, 8
Markets not liberalised	1, 2, 3, 5	1, 2, 3, 5, 8	1, 4, 6	1, 4, 6, 8	1, 3, 5, 7, 9	1, 3, 5, 8	1, 4, 6, 7, 9	1, 4, 6, 8
Low-income country								
Markets liberalised	3, 5	1, 2, 3, 5, 8	2, 4, 5, 8	1, 2, 4, 5, 6, 8	1, 3, 5, 7, 9	1, 3, 5, 7, 9	1, 4, 5, 7, 9	1, 4, 5, 7, 9
Markets not liberalised	1, 3, 5, 9	1, 3, 5, 8, 9	1, 4, 5, 8, 9	1, 4, 5, 8, 9	1, 3, 5, 7, 9	1, 3, 5, 7, 9	1, 4, 5, 7, 9	1, 4, 5, 7, 9

Priorities for agricultural research:
1. Staple food production.
2. High-value crops, trees and livestock.
3. Employment intensive growth.
4. Increased labor productivity.
5. Smallholder farms.
6. Medium and large farms.
7. Low external-input farming.
8. High external-input farming.
9. Nutritional content of food staples.

Source: Hazell and Haddad (2001).

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Appendix 1

Rural Poor and Agricultural GDP[a]			
Region/Country	**Agricultural GDP ($m)**	**No. Rural Poor (m)**	**Rural Poor/$m Agric. GDP**
East Asia			
China	171,376	39.21	228.80
Mongolia	319	0.32	1003.13
Total	171,695	39.53	230.23
Latin America/Caribbean			
Brazil	65,630	12.38	188.63
Columbia	10,532	3.37	319.98
Dominican Republic	1,805	0.89	493.07
Ecuador	2,372	2.16	910.62
El Salvador	1,464	1.67	1140.71
Honduras	898	1.47	1636.97
Nicaragua	670	1.44	2149.25
Panama	660	0.78	1181.82
Paraguay	2,341	0.63	269.12
Peru	4,469	4.47	1000.22
Total	90,841	29.26	322.10
South Asia			
Bangladesh	9,941	37.43	3765.21
India	95,392	246.19	2580.82
Nepal	2,021	8.36	4136.57
Pakistan	15,417	27.64	1792.83
Sri Lanka	3,320	5.1	1536.14
Total	126,091	324.72	2575.28
Southeast Asia			
Indonesia	34,399	27.43	797.41
Lao PDR	912	1.85	2028.51
Philippines	15,610	16.63	1065.34
Total	50,921	45.91	901.59
Sub-Saharan Africa			
Cameroon	3,737	2.04	545.89
Ghana	2,478	3.53	1424.54
Kenya	2,970	8.63	2905.72
Lesotho	105	0.75	7142.86
Madagascar	1,135	7.31	6440.53
Niger	705	4.42	6269.50
Nigeria	13,152	46.26	3517.34
Sierra Leone	412	2.13	5169.90
Uganda	2,896	8.48	2928.18
Zambia	618	4.2	6796.12
Zimbabwe	1,692	4.78	2825.06
Total	29,900	92.53	3094.65
West Asia/North Africa			
Algeria	5,178	3.64	702.97
Egypt	13,609	7.55	554.78
Morocco	5,027	3.43	682.32
Tunisia	2,462	0.73	296.51
Yemen	1,018	2.05	2013.75
Total	27,294	17.40	637.50

[a] *Source*: Derived by the author from World Bank, 1999, World Development Indicators, and N. Okidegbe, 2001. Rural Poverty: Trends and Measurement. Rural Development Strategy Paper Number 3. The World Bank, World Development Family. The GDP data refer to 1997 and the poverty data to various years between 1989 and 1997, depending on the country. The fourth column is calculated as (column 3 $\times$ 10^6)/column 2.

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