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Agriculture and poverty

Agriculture and growth evidence paper series

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Front cover picture: Robert Stansfield/DFID

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This paper has been subjected to a series peer reviews by DFID staff and external experts, see below:

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DFID evidence papers

DFID uses a range of evidence synthesis approaches to address the challenge of providing decision makers with the evidence that they need to make better choices.

The “evidence paper” is an expression of the opinion that DFID has of the existing evidence on a given subject.

This paper, written by staff members of DFID, provides a summary of evidence underpinning a range of debates related to agriculture and poverty reduction.

The authors do not attempt to prescribe policy conclusions, which, for DFID, will appear elsewhere. This is not a policy document, and is not meant to represent DFID's policy position.

Executive summary

Agriculture and poverty reduction

- **Agriculture can be an effective channel for poverty reduction.** There is consensus that growth in agriculture is associated with reduction in poverty. Cross-country regression analyses have concluded that the poverty reduction from growth in agriculture is on average 2 to 4 times greater than from equivalent growth in other sectors. This is frequently attributed to a greater level of (poor) labour participation in this type of growth as compared to other sectors.

- **Context determines the impact of agriculture on poverty.** Theory and evidence find substantial variation in impact across countries and over time. Effectiveness is likely to be contingent on appropriate targeting and complementary policies in other areas. The correlation between agricultural productivity growth and poverty reduction is strongest amongst the poorest and in resource poor low-income countries. However, it is important to note that indirect effects of agricultural growth, linked to growth in the rural non-farm economy, may be more significant for poverty reduction and the cost of raising productivity, in some areas and for some segment of the farming population, may outweigh the benefits and favour investment in other sectors. The evidence suggests that a focus on agricultural development to reduce poverty is likely to be most appropriate in circumstances where:

    - **The domestic market is less well integrated into global trade.** The potential to import food may offer an alternative to process of improving agricultural productivity, particularly where this is likely to be a slow and difficult process. In more isolated contexts, food prices are likely to be more sensitive to domestic production.
    - **A higher proportion of increased income is likely to be spent locally and on locally-produced goods and services.** Under such circumstances, the impact of increased agricultural incomes on the poor not directly involved in agriculture in rural areas is likely to be greater.
    - **There is an enabling environment and capacity in the local non-farm economy to increase production in response to increased demand.** With capacity to increase output, increases in agricultural incomes are more likely to drive demand for locally produced (non-tradable) goods and services.
    - **Where small-holders have capability and capacity to either increase either the scale of production or the value of the produce.** Without this it is unlikely that gains in productivity can be sufficient to raise incomes to a level that pulls farming households out of poverty.

- **The Value for Money (VfM) case for public investment in agriculture is similarly context-specific.** Studies have found high rates of return to public investment in agriculture and agricultural research, but substantial variation and self-selection bias call for careful consideration of the context for investments.

- **Neither a default agriculture-first development strategy nor agricultural neglect is warranted.** The available evidence points to the types of circumstances where poverty reduction from agricultural development is likely to be highest. In general, the most useful approach is likely to involve flexibility in supporting those parts of the economy where the potential for labour-intensive growth is highest, rather than an automatic appeal to agriculture.

The agriculture and growth evidence paper series

Agriculture is and will continue to be critical to the futures of many developing countries. This may or may not be because agriculture can contribute directly and/or indirectly to economic growth. But it will certainly be critical because poverty is still predominantly a rural phenomenon and this looks set to remain for the next two decades at least.

The Agriculture and Growth Evidence Paper Series has been developed to cover a range of issues that are of most relevance to DFID staff. The first five topics that are covered by this series are shown below. However, as further issues are identified so further papers will be commissioned.

Agriculture and growth
- *Agricultural growth and the national economy*
- *Agriculture's contribution to economic growth*
- *Agricultural growth and structural transformation*

Food prices and poverty
- *Is there such a thing as an optimum staple food price or food price trend relative to other prices or income?*
- *Food price spikes and poor households*

Agriculture and poverty
- *Agricultural growth and poverty reduction*
- *Agricultural growth vs. growth in other sectors*
- *Value for money of agricultural growth*
- *Contextual influences of agricultural growth and poverty reduction*

Agriculture and the private sector
- *Direct state involvement in agricultural input and output markets.*
- *The role of the public sector in supporting private sector investment*
- *Opportunities for commercialisation of agriculture*

Agriculture and women
- *The impact of agricultural growth on women*
- *The impact of women on agricultural growth*

How to use this paper

The paper is not intended to be a comprehensive overview of all issues relating to agriculture and poverty. It concentrates on those areas that are of particular focus for DFID policy and strategy.

The search strategy for the evidence is shown in annex 2. The objective of this search strategy was to identify the range of evidence that is indicative of the body of evidence that underpins the statements that are included throughout this paper. The evidence includes qualitative and quantitative evidence from both peer reviewed and grey sources.

All papers directly referred to within this evidence paper are described and assessed (where appropriate) in accordance with the DFID How to note Assessing the strength of evidence (see annex 3 for a summary of appraisal criteria). These assessments are undertaken by the author and are intended to act as a guide for the reader. While guided by a systematic assessment framework they are subjective and cannot be taken as the definitive assessment of the quality of the research that the evidence is based on. Efforts have been made by the editor to ensure that the methods and approach to the evidence assessment have been consistent across the papers in this series.

The descriptors that are used to articulate this assessment are summarised in the tables below.

Table 1: Descriptors of research type and design

Research type	Research design
Primary and empirical (P&E)	Experimental (EXP)
	Observational (OBS)
Secondary (S)	Systematic review (SR)
	Other review (OR)
Theoretical or conceptual (TC)	N/A

Table 2: Descriptors of research quality

Study quality	Abbreviation	What might this mean…
High	↑	Demonstrates adherence to principles of appropriateness/rigour, validity and reliability; likely to demonstrate principles of conceptual framing, openness/ transparency and cogency.
Moderate	→	Some deficiencies in appropriateness/rigour, validity and/or reliability, or difficulty in determining these; may or may not demonstrate principles of conceptual framing, openness/transparency and cogency.
Low	↓	Major and/or numerous deficiencies in appropriateness/rigour, validity and reliability; may/may not demonstrate principles of conceptual framing, openness/ transparency and cogency.

The synthesis of evidence and description of the overall “evidence base” are based on combining this grading of strength of the individual pieces with three other characteristics: the size of the total body of evidence assessed; the context/s in which this evidence is set (local,

regional or global); and the consistency of the findings produced by the studies constituting the body of evidence.

1. Is there a relationship between agricultural development and poverty reduction?

Theoretical and conceptual overview

In the last decade, debate on the role of agriculture in the development process has often been polarised around a pro-agricultural view[1] and a so-called 'agri-sceptic' view.[2] This relates to both the importance of agricultural development for wider economic growth and structural transformation and its importance to poverty reduction.

An extensive literature discusses related theoretical arguments, much of it drawing on the 'classical' model of Lewis (1954 [TC]), and later contributions by Ranis and Fei (1961 [TC]) and Johnston and Mellor (1961 [TC]). Lewis' dual sector model, and the advances to it made by Ranis and Fei, characterised the process of development as entailing a transfer of surplus labour from a relatively less productive subsistence sector to a relatively more productive capitalist sector, which is the driver of growth. Conversely, Johnston and Mellor underline the importance of agriculture at early stages of development, identifying linkages with the rest of the economy.

In general, three main channels are identified through which agricultural development may reduce poverty:

i. **Wages and jobs** – increasing farming incomes and wage labour or more formal employment opportunities in farming;
ii. **Food prices and availability** – reducing the price of food; effectively increasing the incomes of net food purchasers;
iii. **Multiplier effects on other sectors** – feeding income into both the non-farm economy and along agriculture supply chains.

Multiplier effects refer to the indirect impact of agricultural growth on other sectors of the economy through a range of hypothesized linkages.[3] These include: consumption linkages (increased agricultural incomes result in increased demand for other parts of the economy)

[1] For example see Timmer, 2005 [S; OR]
[2] For example see Ellis, 2005 [TC]
[3] Discussions of linkages are included in Tiffin and Irz 2006 [P&E; OBS; →]; Bravo-Ortega and Lederman, 2005 [P&E; OBS; →]; Christiaensen *et al,* 2011 [P&E; OBS; →]; Irz *et al*, 2001 [P&E; OBS;→]; Hazell and Haggblade (1993 [S; OR]); de Janvry and Sadoulet (2010 [S; OR]); Hazell and Roell (1983 [P&E; OBS; →]).

and production linkages (agricultural outputs supplied as inputs for non-agricultural production, for example agro-processing, and agricultural growth increasing demand for inputs such as fertilizers and marketing services)

Empirical evidence

All studies identified consistently found that growth in agriculture is correlated with reductions in poverty. Studies drew on cross-country econometric research and country case studies, and are generally of moderate quality. Secondary literature indicates strong consensus.

Empirical studies have generally found that agricultural development is correlated with reductions in poverty.

Studies comparing income, poverty levels, and agricultural development across countries consistently found that higher levels of agricultural development (variously defined) tend to be associated with lower levels of poverty. Moreover, studies examining both differences across countries and changes over time have found that agricultural development tends to precede improvements in income. Studies are based on large international data sets, with sub-Saharan Africa, Asia, and Latin America all well represented.

Irz *et al* (2001 [P&E; OBS;→]) run cross-country regressions investigating the impact of improvements in agricultural land productivity, agricultural labour productivity, and a combination of the two on headcount poverty using a sample of 40 countries, including 18 from sub-Saharan Africa. They conclude that there is a significant relationship whereby increases in yields are an important determinant of poverty, but acknowledge that results may have been biased by variables omitted from their model.

A study by Ligon and Sadoulet (2007 [P&E; OBS; →]) uses a sample of 41 countries, covering all major developing regions, and attempts to address the possibility that unobserved factors may influence both their variable of interest and their explanatory factors, potentially resulting in spurious results. This is done by including neighbouring country agricultural income as an instrumental variable.[4] Their model specification considers the relationship between changes in national agricultural and non-agricultural income on expenditure for different deciles of the income distribution. The study finds that agricultural income growth has a particularly beneficial effect on the poorest groups' expenditure, whilst the benefits from non-agricultural growth are more modest for lower deciles.

Using 40 years of data from India, Ravallion and Datt (1996 [P&E; OBS; ↑]) found that output growth in the primary and tertiary sectors reduced headcount poverty in both urban and rural areas, but secondary growth did not reduce poverty in either. Conversely, using state-level data from India, Besley *et al* (2005 [P&E; OBS; →]) control for unobserved state and year effects[5] and find that output growth in the primary sector reduced poverty more slowly than

[4] This is done on the basis that many unobserved factors are likely to be correlated across neighbouring countries (for example, if one country experiences a severe drought, it is likely that there are also effects in its neighbours). Therefore including neighbouring agricultural income could act as a second-best way of including missing variables in the model.

[5] State level panel fixed effects model controlling for state and year effects.

growth in other sectors. However, Timmer (2005 [S; OR]) criticise the technique used by Besley et al as potentially obscuring the true poverty reducing effect of agriculture.[6]

Diao *et al* (2008 [TC]) use a multi-market model to simulate a scenario where agricultural productivity across Africa converges on the regional productivity frontier and regional trade barriers are removed, finding that under such conditions 74 million people would be lifted out of poverty. However, the modelling approach used is sensitive to choices made in elasticities, which were based on findings in the broader literature. Furthermore, the removal of trade barriers envisaged in the model would require substantial investment in infrastructure, so arguably infrastructure would be major joint contributor to poverty reduction.

Studies identified consistently found evidence of a multiplier effect from agricultural growth to the rural non-farm economy, increasing the poverty reducing effectiveness of agricultural growth.

The first paper of this series, 'Agricultural and economic growth', concluded that evidence from studies of agricultural multipliers in Africa and Asia suggest that rising farming incomes with improving agricultural productivity create demand for the non-farm sectors. At early stages of development, consumption linkages appear to dominate the positive relationship between agriculture and the rest of the economy. However, as economies grow, forward linkages with sectors processing agricultural output become more important.

[6] Timmer argues that much of the impact of agriculture on poverty is likely to be state- and year-specific because of ecological endowments and monsoon patterns, and so the technique used by Besley *et al* risks missing much of the affect.

2. Is growth in agriculture more effective at reducing poverty than growth in other sectors?

Theoretical and conceptual overview

Given the number of people in developing countries employed in agriculture[7], and the proportion of their incomes that the poor spend on food[8], agricultural development has a strong intuitive appeal as a mechanism for poverty reduction. However, the fact that a greater proportion of the currently poor participate in agricultural growth alone is not sufficient to demonstrate that the sector is relatively more efficient at poverty reduction. Whilst the evidence shows that agricultural growth is good for poverty reduction, it is not the only sector to have this characteristic.

Gollin (2009 [S; OR]) observes that agriculture is, as a general rule, a lower productivity sector than non-agriculture. In the spirit of Lewis (1954 [TC]), this prompts questions as to whether it is self-evidently desirable to focus resources primarily on a lower productivity sector, rather than also facilitating movement to higher productivity alternatives and supporting a structural transformation from an agrarian economy.

Empirical evidence

Identified studies consider the impact of agricultural growth on both poverty rates, and the income of the poorest quintile. In general, findings are that agricultural growth offers better marginal poverty or welfare outcomes than other sectors, particularly in sub-Saharan Africa and South Asia. Studies identified draw on large international datasets and country studies for 5 sub-Saharan African countries and China.

Empirical studies have consistently found that growth in agriculture is associated with faster poverty reduction than growth in other sectors.

Bravo-Ortega and Lederman (2005 [P&E; OBS; →]) conduct cross-country regressions using data from 128 countries. The study finds that in developing countries generally the average income of the poorest quintile of the income distribution is more positively affected by

[7] Hazell, 2012 [TC]; "Agriculture accounts for 70% of full-time employment in Africa"
[8] See section 4 for discussion of the extent to which the poorest are net food buyers.

agricultural growth than non-agricultural growth. However, for Latin America and the Caribbean the marginal welfare effects of non-agricultural growth were greater than those for agricultural growth.

A similar econometric study by Hasan and Quibria (2004 [P&E; OBS; →]) considers the welfare effects of growth in agricultural and non-agricultural sectors. Data was drawn from 45 countries[9] and the $2 per day poverty line was used. Across regions, agricultural growth was found to be most effective for poverty reduction in sub-Saharan Africa and South Asia, but in East Asia industrial growth was found to be most effective and in Latin America it was the growth of the service sector. However, this pattern may reflect a sample problem. The household surveys used to generate poverty estimates began in most countries in the late 1980s, after the Green Revolution in some East Asian countries.

Three identified studies develop general equilibrium models to investigate the effects of agricultural development. These have the advantages in terms of internal consistency and allowing for clearer identification of causality than is possible with cross-country regressions. However, they require simplifying assumptions that are open to challenge and are very sensitive to changes in elasticity estimates.[10]

Diao and Pratt (2007 [P&E; OBS; →]) apply a general-equilibrium type framework to data from Ethiopia, finding that that growth in agriculture, specifically staple crop and livestock production, reduces poverty faster than growth in other sectors. The model predicts that a growth rate of staple crop production 1.5 percentage points above the baseline would reduce rural poverty by 10 percentage points relative to the business-as-usual scenario. Urban poverty would be 5.7 percentage points below the baseline, which is attributed to lower food prices.

Pauw and Thurlow (2011 [P&E; OBS; →]) estimate a general equilibrium model for Tanzania, concluding that growth in agricultural productivity is more effective at reducing poverty than non-agricultural growth.

Diao *et al* (2007 [P&E; OBS; →]) estimate general equilibrium-type models for Rwanda, Uganda, Ghana, Ethiopia, and Zambia, finding that the poverty elasticities of export-oriented agricultural growth are lower than those for staple food growth.

Studies identified have estimated the poverty elasticity of agricultural growth to be 2 to 4 times larger than the poverty elasticity of non-agricultural growth.

Seven cross-country econometric studies were identified that focus on estimating the elasticity of poverty reduction to growth in agriculture relative to growth in other sectors; that is the amount of poverty reduction that would be expected for a percentage increase in

[9] Countries were grouped into 4 developing regions: East Asia, Latin America and the Caribbean, South Asia, and sub-Saharan Africa.
[10] Gollin (2009 [S; OR])

output from different sectors.[11] Studies draw on large international data sets, with all major developing regions well represented.

Notable studies include Christiaensen *et al* (2011 [P&E; OBS; →]), which uses data from 106 countries to estimate the poverty elasticity of agricultural growth to be on average 3.2 times larger than the elasticity for non-agricultural growth. The study found that whilst both agricultural and non-agricultural growth offer scope for reduction in $1-per-day poverty in middle income countries, only agricultural growth appeared to affect the poorest in low income countries. However, the impact of agricultural growth on poverty was found to vary considerably with inequality (less impact with high inequality), income (less impact with higher average incomes) and natural resource sectors (non-agricultural growth from extractives dampens its relative poverty impact).

Using data from 41 countries, Ligon and Sadoulet (2007 [P&E; OBS; →]) find that GDP growth originating in agriculture increases the income of the poorest 40% of the income distribution at approximately three times the rate of growth from other sectors. Bravo-Ortega and Lederman (2005 [P&E; OBS; →]) use cross country regressions to estimate the effect of changes in sectoral productivity on GDP and the incomes of the poor. They find that, on average, GDP growth originating from increases in agricultural productivity is 2.9 times more effective at raising the incomes of the poorest quintile in developing countries that an equivalent increase in GDP from non-agricultural growth.

Loayza and Raddatz (2006 [P&E; OBS; ↑]) use a cross section of 55 developing countries to show that increases in value added in more labour-intensive sectors reduces headcount poverty faster than growth in other sectors. Growth from agriculture is found to reduce poverty three times faster than growth in manufacturing, and 1.8 times faster than growth in construction.

In a study of the drivers of headcount poverty reduction in China over 21 years, Ravallion and Chen (2004 [P&E; OBS; ↑]) find that almost all of the observed reduction in the poverty rate, poverty gap, and squared poverty gap between 1980 and 2001 can be attributed to agricultural and diversified rural economic growth. The study finds that the primary sector (primarily agriculture) has a four times larger impact on poverty than the secondary or tertiary sectors.

The World Development Report 2008 (2007 [S; OR]), summarising empirical results (including Ligon and Sadoulet (2007 [P&E; OBS; →])), concluded that that growth in agriculture is up to five times as effective at increasing the incomes of the poor as growth in other sectors. De Janvry and Sadoulet (2010 [S; OR]) review the literature on the relative impact of agricultural growth on poverty and the incomes of the poorest, consistently finding estimates that place agricultural growth as two to three times more beneficial for the poor.

[11] Bravo-Ortega and Lederman, 2005 [P&E; OBS; →]; Hasan and Quibria, 2004 [P&E; OBS; →]; Christiaensen *et al*, 2011 [P&E; OBS; →]; Thirtle *et al,* 2003 [P&E; OBS; →]; Irz *et al,* 2001 [P&E; OBS;→]; Cervantes-Godoy and Dewbre, 2010 [P&E; OBS; →]; Loayza and Raddatz, 2006 [P&E; OBS; ↑].

3. The Value for Money (VfM) of supporting growth in agriculture

Theoretical and conceptual overview

Resource allocation decisions require an understanding of the reduction in poverty that can be achieved through investment in agriculture relative to equivalent investment in other areas in a given context. Essentially, a comparison of the relative cost-effectiveness of efforts to boost growth via agriculture versus other sectors is needed. This is an empirical question, requiring estimation of both the poverty impact of public investment in agriculture, and the poverty impact of public investment in other sectors.

Studies such as Ellis (2007 [TC]) provide a general critique of public investment in agriculture for poverty reduction in Africa on the basis of four decades of attempts with little to show in terms of progress. Ellis argues that the Asian green revolution was extensively underpinned by government support that is not likely to play a significant role in the generally liberalised markets of contemporary sub-Saharan Africa. However, Gollin (2009 [S; OR]) argues that claims in this vein are misleading on the basis that a lack of aggregate progress should cast doubt on all extant development efforts, not agriculture alone, and we cannot refute the possibility that other factors have played important roles. Institutions or civil conflict are given as examples, but additional candidates could include policies leading to inefficient protection.

Bezemer and Headey (2008 [TC]) observe that with all government interventions there is potential for rent-seeking and corruption, but to conclude from this that there should be no state involvement in agriculture specifically does not follow. They argue that substantial government involvement in agriculture is a necessary precursor to agricultural development and overall economic progress, on the basis of pervasive market failures and the fact that agricultural development creates positive externalities for other sectors that would lead private agents to underinvest in the sector. A quite extensive 'industrial policy' for agriculture is advocated, with successful support programs identified as including: pricing, taxation, trade policies, direct and indirect support for research, extension, technological innovation, quality management, information provision, infrastructural investment, human capital development, and export potential.

In general, the most useful approach is likely to involve flexibility in supporting those parts of the economy where the potential for labour-intensive growth is most evident, rather than an automatic focus on agriculture or an exclusive focus on long-term growth sectors.[12] This applies to both the scale and nature of support.

[12] Collier and Dercon, 2013 [TC]; Ellis, 2005 [TC]

The majority of studies identified that evaluate investments in agricultural research and development report estimates of the Internal Rate of Return (IRR). However, there are reasons why this estimate may be subject to upward bias. Rao *et al* (2012 [P&E; OBS; →]) stress the implicit assumption in IRR calculations that intermediate cash flow from investments can be reinvested with the same return as the initial investment. This is likely to be higher than the cost of capital, which is generally taken as the return on most of other risk-weighted investment opportunities. In any case this is unlikely to be possible, with the overall result being an upward biasing of estimates. Instead, Rao *et al* advocate use of the Modified Internal Rate of Return (MIRR), which does not make this implicit assumption. However, the study notes that even using the MIRR would not justify scaling back public agricultural R&D spending.

Empirical evidence

A relatively small body of analytical studies were identified that examined the VfM of investment in agricultural growth for poverty reduction. These were assessed to be of moderate quality as evidence for policy decisions.

There is evidence that investment in agriculture may increase rural incomes and reduce poverty faster than investment in other sectors, but the basis for generalisation is weak. There is little written on how VfM should be measured, and there is less of an established theoretical narrative. Parameters for the definition of investment in agricultural growth are also ambiguous, particularly the overlap between investment in agriculture and rural infrastructure.

An extensive review of agricultural research projects finds high estimated rates of return for investment in this area, but it is not clear that returns would be comparably high in contexts other than those where heavy investment in agriculture is already occurring (Alston *et al* 2000 [S; OR]).

A lack of clear definitions and self-selection bias in investment decisions undermines robust estimates of the rate of return to agricultural investment.

De Janvry and Sadoulet (2009 [S; OR]) identify two key obstructions to attempts to determine when poverty reduction resulting from public investment in agriculture outweighs that from investment in other sectors, one conceptual and the other econometric. Firstly, strong inter-sectoral spill overs in many investments (including those that are considered necessary for rapid agricultural development, such as improved infrastructure) make it difficult to define investment in agriculture specifically. Investment for agriculture is a wider overlapping concept than investment in agriculture. This reflects the wider point that conceiving of investment as either being in agriculture or non-agriculture is often a false dichotomy.[13]

[13] Christiaensen *et al* 2011 [P&E; OBS; →]

Secondly, in practice, investments tend to be targeted where growth potential is considered to be highest. Average observed rates of return to agricultural research may well over-estimate the return that would be achievable by further investments. This is due to the non-random nature of those countries that have chosen to invest in agricultural research, making it difficult to disentangle the extent to which productivity improvements are due to the research or to those factors that make a country more likely to do research.

In an attempt to address technical problems, a number of authors have made use of instrumental variables techniques[14], but Loayza and Raddatz (2006 [P&E; OBS; ↑]) note a general lack of instruments that unambiguously meet the necessary requirements for proper inference in the literature.

Empirical estimates frequently found agricultural investments to have higher rates of return than most non-agricultural investments.

Empirical estimates of the rate of return to public investment in agriculture were identified for China, India, and four sub-Saharan African countries. These studies are from a narrow range of authors. The China and India studies were more detailed, reflecting better data availability. As a basis for making policy decisions, the body of evidence was rated as low to moderate quality.

Fan *et al* (2009, [S; OR]) report estimated rates of return for public investment in agriculture for four sub-Saharan African countries.[15] The authors report that the increase in rural income from agricultural investment is greater than for investment in education, health, or roads. However, in terms of poverty reduction, returns are highest for investment in education for Tanzania and (poverty impact estimates are not provided for Ghana or Ethiopia).

Fan *et al* (2000 [P&E; OBS; →]) estimate the cost effectiveness of a variety of public investments in India using state-level data from 1970-93, concluding that to maximise impact on rural poverty, investment should be focussed on rural roads and agricultural research. In a similar exercise for China using provincial data from 1970-97, Fan *et al* (2002 [S; OR]) found that investment in rural education had the greatest impact on poverty reduction, followed by investment in agricultural research. Dercon and Gollin (2014 [S; OR]) argue that both of these papers suffer from severe limitations in ability to identify causal relationships, stemming from the fact that government investments are not randomly allocated, spill across district lines, and interact in complicated ways. Statistical attempts to overcome these issues leave substantial questions remaining.

Studies generally find high rates of return to investment in agricultural research, but with a high degree of variation.

[14] Bravo-Ortega and Lederman (2005 [P&E; OBS; →]); Ligon and Sadoulet (2008 [P&E; OBS; →]); Loayza and Raddatz (2006 [P&E; OBS; ↑])

[15] Ghana, Uganda, Tanzania, and Ethiopia.

Alston *et al* (2000 [S; OR]) conduct a meta-analysis of rates of return to agricultural research. The study reports that internal rates of return averaged 43% in 700 research and development projects evaluated in developing countries. However, a wide range of returns and a low signal-to-noise ratio was observed in estimates, leading the study to stress the importance of systematic analysis of the body of available literature.

Alene and Coulibaly (2009 [P&E; OBS; →]), using cross-country regressions, estimate that the aggregate rate of return on agricultural research is 55%. However, there is substantial variation across countries from a low of 5% in Lesotho to a high of 82% in Ethiopia.

From cross-country regressions, Thirtle *et al* (2003 [P&E; OBS; →]) find that the average rate of return for investment in agricultural R&D is 22% in Africa and 31% in Asia, but negative 6% in Latin America. The authors also go further, to estimate the per capita cost of poverty reduction through agricultural R&D, reporting a figure of $144 for Africa, $179 for Asia, and $11,397 for Latin America.[16]

Rao *et al* (2012 [P&E; OBS; →]) argue that by estimating the Internal Rate of Return (IRR), the majority of studies are likely to overestimate actual returns. Instead, Rao *et al* advocate the use of the Modified Internal Rate of Return (MIRR), which addresses a number of their concerns with the IRR.[17] Recalculating IRR estimates for 431 evaluations from 65 studies, they find the average MIRR was 16% per year, and the median 14% per year. However, they conclude that even using the MIRR, which results in lower estimated rates of return to agricultural research investments, there is underinvestment in the area.

Evenson and Gollin (2003 [S; OR]) found that productivity gains from international crop genetic improvement research have been uneven across crops and regions. Those famers who did not experience productivity gains (for example because they were located in less suitable areas), but did experience falling prices because of productivity gains by others underwent a reduction in income.

[16] All in 2000 US dollars [1000??]

[17] The MIRR is conceptually similar to the IRR in that both are the discount rates that equate the present value of costs and benefits. However, with the MIRR, the discount rates used to calculate the future value of investment benefits and the present value of investment costs need not be equal to each other, which is argued to better reflect actual circumstances. The solution to the MIRR is also unique.

4. The importance of context in the relationship between agriculture and poverty reduction

Broad cross-country characterisations of the relationship between agricultural development and poverty reduction obscure the fact that across countries and over time there is substantial variation in impact on poverty that could result from agriculture sector growth. This variation is driven by a wide range of factors relating to: the country (e.g. location, trade linkages, potential of non-farm growth, distribution of poverty); and the sector (e.g. land quality, farm size and distribution, employment density, linkages with economy and crop types). The role and contribution of the agricultural sector (comprising both primary production and agro-industry) in driving or supporting economic growth (see Agriculture and growth paper 1 – Agriculture and economic growth) will shape its contribution to poverty reduction. In addition, the above factors will determine the quantity and quality of poverty reduction that is driven through different channels which are either direct e.g. by raising farm productivity and thus profitability and farm income; or indirect e.g. by creating jobs, bidding up the price of wage labour, or by lowering food prices.

In this section each of the important contextual factors are described and linked (where available) to evidence. At the end of the section table 1 summarises how each of the factors can influence the relationship between agriculture sector growth and poverty alleviation.

Income distribution and sources of growth

The share of agriculture in GDP tends to decline with the process of development.[18] The World Development Report 2008 (World Bank, 2007 [S; OR]) observes that the poverty reducing impact of agricultural growth tends to be more robust in low income countries, where agriculture typically accounts for large shares of GDP, employment, and exports.

Christiaensen et al 2011 [P&E; OBS; →] synthesise the effects of agriculture and non-agriculture on poverty into three sources: a growth, a participation, and a size effect. They then use cross-country analysis to compare each of these effects empirically across sectors and settings (including the sub-Saharan Africa (SSA) context), drawing on national accounts

[18] Bravo-Ortega and Lederman, 2005 [P&E; OBS; →]

evidence on sectoral growth and household survey data on poverty. The results from the analysis show:

1. Irrespective of the setting, agriculture is much more powerful in reducing poverty among the poorest of the poor ($1dollar per day) when inequality is not too high.

2. Non-agriculture growth is more powerful in reducing poverty among the better-off poor in resource poor countries, i.e. in reducing the $2-day poverty headcount in countries where the extractive industry makes up less than 10% of GDP. The relative advantage is strongest in middle income countries, but still by a factor of five in SSA. When it comes to resource rich countries, the picture is mixed, with non-agriculture more effective in reducing the $2-day head count when inequality is low, but potentially more harmful (poverty increasing) at higher levels of inequality.

3. Non-agricultural growth originating in the extractive industry substantially dampens its effect on poverty reduction. As a result, in resource rich countries, agriculture is usually more powerful in reducing poverty, especially when it comes to $1-day poverty. This also holds in middle income countries where the advantage of non-agriculture in reducing the $1-day poverty headcount reverses ingoing from resource poor to resource rich countries middle income countries.

4. The advantage of agriculture in reducing $1-day headcount poverty declines as countries become richer and inequality increases.

Land distribution

Sectoral variations in the poverty reducing effects of growth are likely to arise from differences in asset inequality, particularly the distribution of land. Bourguignon and Morrisson (1998)[19] find that the larger is the share of land cultivated by small and medium farmers, the lower is the observed income inequality, and thus the greater the impact of productivity growth, where it can be achieved, on poverty.

Relative land distribution is likely to affect the impact of agricultural growth on poverty reduction. As argued by Hazell et al (2010 [S; OR]), where land is distributed relatively evenly, the impact of agricultural sector growth on poverty reduction may be greater as it raises small farm incomes and employment, with potentially significant indirect impacts though consumption linkages. Conversely, it is argued that in countries with very uneven land distribution, agricultural growth has much weaker impacts on poverty reduction. In these cases, impact on incomes is likely to be concentrated in larger farms which may only employ few workers.

Farm size and income potential

However, where farm size falls below a threshold of minimum economic viability, productivity growth may have little impact on poverty reduction. Harris & Orr (2014 [P&E; OBS; →]) question to what extent productivity growth on very small farms, e.g. below 1 ha, can

[19] Cited in Christiaensen 2011

contribute to poverty reduction, noting that arguments about the relationship between agricultural productivity increases and poverty reduction rarely consider the relative share of farm income within overall household income, which in turn will depend significantly on farm size.

Harris and Orr 2014 (2014 [P&E; OBS; →]) used secondary data drawn from 2 separate schools of literature (poverty dynamics and agriculture technology) to analyse the linkages between rural livelihoods, farms sizes and new agriculture technology. Their analysis found that:

1. Across the household survey data (taken from seven countries in sub-Saharan Africa and one from India), the figures demonstrate that crop production alone is not likely to generate enough income per year to allow adult workers to live above the poverty line, and certainly does not allow support of dependents at that minimal level.

2. Analysis of potential impacts of new technology showed that it can, not only raise the absolute level of income from crop production but also reduce the variability of that income (although data on the variability of particular technologies is scarce). However, they also demonstrated that the impact on poverty of this is limited in 2 ways: firstly by the very small farm sizes (e.g. 22 million farms in SSA <2ha); secondly rapid population growth and land fragmentation will reduce average farm size still further.

In their conclusion, Harris and Orr 2014 (2014 [P&E; OBS→]) suggest that there are two situations where crop production can be a pathway from poverty: 1. Where smallholders have the ability and opportunity to acquire new land to increase farm size enough to generate an adequate income; 2. Where markets demand higher value crops and small holders have the capability to change their production and access the higher value markets. Where neither of these scenarios exists Harris and Orr suggest that the direct benefits from agriculture productivity growth will support a stable foundation of food security that, if not accompanied by increased risk, provides a stepping stone from poverty but not a complete pathway

A related argument (see Reardon and Berdegue, 2002, Maxwell 2004; Collier and Dercon 2009) is that productivity growth is more likely to occur in the first place on larger farms, particularly due to economies of scale in transactions beyond the farm gate. In the absence of a systematic definition of ‘larger farm’ and recognising that even relatively small commercial farms have been at the centre of dynamic agricultural sectors in South and East Asia, it is safe to assume that minimum size will vary based on different factors. Other research also points to the importance of farm size as a key variable affecting if not determining the extent to which farms are likely to benefit directly from growth through higher farm incomes.

Land quality and productive capacity have been identified as key determinants of the capacity for agricultural growth, for example Timmer (2005 [S: OR]) highlights the irrigable river plains as enabling the Green Revolution in South Asia. Irrigation can significantly

increase land productivity and may therefore affect the minimum threshold for economic viability and also the potential for productivity growth per se.

Crop mix

The optimal crop mix for agriculture to contribute to poverty reduction will be influenced by the competitive potential and advantage of different crops in domestic, regional and international markets and the extent to which the poor are likely to benefit from productivity growth in different sub-sectors as producers, workers and/or as consumers of the crop itself. Depending on the extent to which a region or country in integrated into global markets, this is likely to involve a trade-off between the wider benefits of lower food prices resulting from increased staple production, expected returns from production of other crops (including for export), and the extent to which poor households can capture these returns through own production or indirect effects.

(Diao and Pratt, 2007 [P&E; OBS; →]) using an economy wide model for Ethiopia identified variable poverty effects (advancing and lagging regions) for similar agricultural growth rates, even where agriculture's overall effect is positive. Specifically, growth in staples production was found to reduce poverty substantially in food surplus areas, but by a much smaller amount in food deficit areas, which also tended to have a higher prevalence of poverty. They concluded that growth in cereals and other staple crops should be given priority for poverty reduction through agriculture. However, this finding is likely to depend on specific country circumstances. General equilibrium calculations by Pauw and Thurlow (2011 [P&E; OBS; →]) attributed Tanzania's relatively weak growth-poverty relationship to the structure of agricultural growth, which favoured large scale production of wheat, rice, and export crops in specific geographic areas.

Economic linkages

In their overview of agriculture development in Latin America Berdegué and Fuentealba (2011) [S, OR] highlighted that one of the main lessons learned from successful agricultural development experiences with smallholders, is that economic growth with social inclusion is not only about what happens in the farms of smallholders, or even in their communities and organisations. Such development outcomes involve whole territories, with a multitude of inter-linked actors (poor and non-poor, agrarian and not, urban and rural, private and public) that mobilise complementary assets and capabilities.

Where farmers are more likely to spend increases in income locally or domestically, increases in demand for the production of other goods and services as a result of agricultural development would be larger. Where there is spare capacity in the non-farm economy to respond to this demand stimulus, there is likely to be a greater production increase (as opposed to increases in imports or prices).

Hazell and Roell (1983 [P&E; OBS; →]) stress the importance of increased consumption demand in rural areas from agricultural growth. Using household survey data from north-west Malaysia and northern Nigeria, the study finds that for the Malaysia sample 37% of any increase in expenditure goes towards locally produced non-food goods and services, whilst for the Nigeria sample it was 11%. The authors propose that the difference may be

attributable to the greater relative isolation of the Nigeria sample, making it more difficult to reach local towns to buy goods and services.

This underlines the importance of an understanding of local context in determining the effectiveness of agricultural support. On the one hand, very well-connected areas are more likely to spend increases in income on imports. On the other, in very remote areas, there may not be sufficient capacity for the non-farm economy to respond to increases in agricultural incomes. The balance of these factors is highly-context specific, and likely to evolve over time.

Table 3: Summary of factors that influence the relationship between agriculture growth and poverty reduction.

Context	Things to think about		References
Levels of poverty and income distribution	Most effective for people on $1 per day where there is good distribution of income. Non ag more effective for people on $2 per day.		Christiaensen *et al* 2011 [P&E; OBS; →]
Distribution of land	Where land is distributed evenly, the impact of growth on poverty will be greater as small farmers have a chance to benefit, but important to consider minimum farm size for economic viability.		Hazell 2010. Bourguignon and Morrisson (1998)[20]
Farm size	New technology / production efficiency is unlikely to yield sufficient income to small farm households – to take them out of poverty.	Unless small holders have the capability to grow – into higher value markets or expand farms.	Harris & Orr (2014 [P&E; OBS; →])
Quality and potential of land	Will determine the capability of smallholders to capitalise on productivity improvements / new markets, to generate sufficient income to climb out of poverty.		Timmer (2005 [S: OR])
Distribution of labour	The larger the number of people employed in the sector the wider income gains from agriculture growth will be spread.	Assuming the growth occurs equally across the sector and is not simply focused in the large scale operations.	Christiaensen *et al* 2011 [P&E; OBS; →] Dercon (2009 [TC])
Crop mix	Optimal crop mix depends on a trade-off between any expected reduction in domestic food prices from increased staple production, expected returns from production of other crops and the extent to which poor households can capture these returns.		Diao and Pratt, 2007 [P&E; OBS; →]) Pauw and Thurlow (2011 [P&E; OBS; →])
Economic linkages	Capacity of the non-farm economy to magnify growth effects.		Berdegué and Fuentealba (2011) [S, NSR] Hazell and Roell (1983 [P&E; OBS; →])

[20] Cited in Christiaensen *et al* 2011 [P&E; OBS; →]

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Annex 1: Appraisal table

Study	Research type	Research design	Transparency	Rigour	Validity	Reliability	Cogency	Quality	Relevance
Alene and Coulibaly, 2009	P&E	OBS						→	
Alston et al, 2000	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Berdegué J.A., Fuentealba R (2011)	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	Medium
Besley et al, 2005	P&E	OBS	Moderate	Moderate	Moderate	Moderate	Moderate	→	High
Bezemer and Headey, 2008	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
Bravo-Ortega and Lederman, 2005	P&E	OBS	High	Moderate	Moderate	Moderate	Moderate	→	High
Byerlee et al, 2009	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Cervantes-Godoy and Dewbre, 2010	P&E	OBS						→	
Christiaensen	P&E	OBS	Moderate	Moderate	Moderate	Moderate	Moderate	→	High

et al, 2011									
Collier and Dercon, 2009	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
de Janvry and Sadoulet, 2010	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Dercon, 2009	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
Dercon and Gollin, 2014	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Diao et al, 2007	P&E	OBS	Moderate	Moderate	Moderate	Moderate	Moderate	→	High
Diao et al, 2008	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
Diao and Nin Pratt, 2007	P&E	OBS						→	
Ellis, 2005	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
Ellis, 2007	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
Evenson and Gollin, 2003	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Fan et al, 2000	P&E	OBS	Moderate	Moderate	Moderate	Moderate	High	→	High
Fan et al, 2002	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Fan et al, 2009	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Gollin, 2009	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Hasan and	P&E	OBS						→	

Quibria, 2004									
Hazell et al, 2010	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Hazell, 2012	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
Hazell and Haggblade, 1993	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
Hazell and Roell, 1983	P&E	OBS	Moderate	Moderate	Moderate	Moderate	Moderate	→	High
Irz et al, 2001	P&E	OBS						→	
Johnston and Mellor, 1961	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
Lewis, 1954	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
Ligon and Sadoulet, 2007	P&E	OBS	Moderate	Moderate	Moderate	Moderate	Moderate	→	High
Loayza and Raddatz, 2006	P&E	OBS	High	High	Moderate	High	Moderate	↑	High
Pauw and Thurlow, 2011	P&E	OBS						→	
Ranis and Fei, 1961	TC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	High
Rao et al, 2012	P&E	OBS	Moderate	Moderate	Moderate	Moderate	Moderate	→	Moderate
Ravallion and Chen, 2004	P&E	OBS						↑	

Ravallion and Datt, 1996	P&E	OBS	High	Moderate	Moderate	High	High	↑	High
Thirtle et al, 2003	P&E	OBS	Moderate	Moderate	Moderate	Moderate	Moderate	→	High
Tiffin and Irz, 2006	P&E	OBS						→	
Timmer, 2005	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High
World Bank, 2007	S	OR	N/A	N/A	N/A	N/A	N/A	N/A	High

Annex 2: Literature search methodology

The interrogation of the evidence base for this paper was built on an iterative process designed to ensure that the paper covers a range of evidence that was indicative of the scope of the evidence base for each of the sections (that is, the full range of arguments and empirical research was represented). This included:

A structured literature search of the following databases and repositories:

- SviVerse Scopus
- Web of Knowledge
- Google Scholar
- DFID's research repository R4D
- International Initiative for Impact Evaluation (3ie) systematic review and impact evaluation databases.

The search was designed around search strings created for each of the sections. Further inclusion criteria for this rapid search were:

- Date: after 2000 – present - unless considered seminal.
- Languages - English
- Population - developing countries
- Region - no regional limitations.

Focused searches by authors - The results of this search were used by authors to construct their theoretical and conceptual arguments. Once constructed the theoretical and conceptual sections of the paper formed a framework for a further literature search to identify further sources of the empirical evidence that underpins the arguments presented.

Peer review – The development of the paper is supported by a steering group and each section has both DFID peer reviewers and external peer reviewers. At each stage of the process – from the identification of the focus areas to the drafting of the final documents the peer reviewers have contributed their assessments and suggestions relating to the representativeness and strength of the evidence base that we are drawing from.

Annex 3: Critical appraisal

For a full description of the methods used for critical appraisal in this paper please refer to the ***DFID How to note on assessing the strength of evidence***.

The basic criteria for assessing the quality of the studies cited in this paper are summarised in the table below:

Principles of quality	Associated principles	YES/NO
Conceptual framing	Does the study acknowledge existing research?	
	Does the study construct a conceptual framework?	
	Does the study pose a research question?	
	Does the study outline a hypothesis?	
Openness and transparency	Does the study present the raw data it analyses?	
	Does the author recognise limitations/weaknesses in their work?	
Appropriateness and rigour	Does the study identify a research design?	
	Does the study identify a research method?	
	Does the study demonstrate why the chosen design and method are good ways to explore the research question?	
Validity	Has the study demonstrated measurement validity?	
	Is the study internally valid?	
	Is the study externally valid?	
Reliability	Has the study demonstrated measurement reliability?	
	Has the study demonstrated that its selected analytical technique is reliable?	
Cogency	Does the author 'signpost' the reader throughout?	
	Are the conclusions clearly based on the study's results?	

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