A brief history of poverty impact assessment of agricultural research
For participants in the SPIA-IFPRI workshop *"New approaches to assessing the impact of agricultural research on poverty and undernutrition"*, 3rd / 4th December 2010, IFPRI, Washington DC

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Context

As a driver of broad-based technological change in agriculture, agricultural research can help contribute to reducing poverty in a number of ways. It can help reduce poverty directly by raising the incomes (or home consumption) of poor farm households who adopt the resulting technological innovation. Technological change can also help reduce poverty indirectly through the effects which adoption, by both poor and non-poor farmers, can have on the real incomes of others through lower food prices for consumers, increased employment and wage effects in agriculture and on other sectors of economic activity through production, consumption, and savings linkages.

This note briefly reviews some notable impact assessment (IA) studies that have attempted to assess direct and indirect effects of agricultural research on poverty related indicators[1]. It is critical to note at the outset that this review focuses exclusively on (a) *ex post* IA (rather than *ex-ante*, adoption analysis, or *in-time* type impact evaluations) – consistent with the SPIA's mandate, and (b) large-scale adoption/impact of the agricultural technology.

There are a veritable range of diverse types of evaluations and assessments being done in the context of agricultural research, each serving a specific function. The timing and location of the IA on the research-to-development pathway, i.e., after the research-derived technology has been widely adopted (e.g., 5, 10 or even 20 years after the research is completed), and the ultimate objective of the assessment, i.e., accountability and strategic validation function (vs. learning and adaptation), are what primarily characterize an *ex post* IA[2].

The requirement for assessing primarily large scale adoption and impact relates chiefly to the need to justify large investments in research to generate international public goods (IPGs), such as in the CGIAR. While it is possible to document impacts on poverty reduction from a given intervention applied (or assigned) on a small scale, i.e., prior to scaling up, a major constraint in doing IA of agricultural research is that one cannot pre-determine the scale and extent of adoption of a given technology that results from research. This distinguishes an impact evaluation of a development intervention from an *ex post* impact assessment of a research-led agricultural innovation widely adopted.

These characteristics, *ex post* IA and large scale, have important implications for assessment methods appropriate to the task. In addition to the timeframe and scale, methods for evaluation will also depend on the particular outcome of interest – economic, social or environmental, the distance down the impact pathway (short vs. long-term), degree of credibility/rigour to be achieved, and cost restrictions.

The different types of evaluations and assessments along the research to development pathway are diagrammatically presented in Annex 1 where both the time and scale element are highlighted to help make these distinctions. Finally, we recognize that a comprehensive impact pathway encompasses a more complete range of physical, economic, social and environmental outcomes and impact. Annex 2 shows the interconnectedness of different types of impacts; where economic impacts are linked with social and distributional impacts. In the past most epIAs stopped at estimating the economic effects). This overview focuses on evidence of impacts beyond economic effects on producers and consumers, i.e.,mainly impacts on poverty and, to a lesser extent, on food security related goals.

[1] This note is not a critical review of methods used to assess poverty impacts from agricultural research, but simply an overview of what has been done. See de Janvry et al. (2010) for a recent critical review.
[2] Thus, we are documenting 'success', as a proof of concept – that, in the context of the CGIAR, international agricultural research constitutes a viable IPG related tool for reducing poverty on a significant scale. The objective, therefore, is to understand and measure what impacts have occurred and not in the first instance how they have occurred or how they could be enhanced. Other forms of evaluation, including impact evaluation, could address the latter topics.

I. Empirical studies linking economic/agricultural growth to poverty alleviation[3]

Deininger and Squire (1996) multi-country analysis (1950-1990) showed that in 95 cases of economic growth, over 85% were accompanied by an increase in the incomes of the poorest quintile of population. Smith and Haddad (1999) did a similar analysis for 63 countries (1970-1995) but measured percentage of children malnourished, and found that a doubling of national income contributed a 7.4% reduction in child malnutrition. Other studies examining this linkage include:

- Timmer (1997) one of the first to estimate agricultural growth-poverty elasticity using cross country analysis (35 countries)
- Datt and Ravallion (1998) examined farm productivity effects on numbers of rural poor in India.
- Irz, Lin, Thirtle, and Wiggins (2001) examined the effect of agricultural productivity on poverty alleviation using cross-country estimations.
- de Janvry and Sadoulet (2001) estimated income, wage rate and employment effects from agricultural productivity improvements in three regions using archetype models (CGE model)
- Thirtle, Lin, and Piesse (2003) estimated the effect of a 1% growth in agriculture on relative change in poverty levels.
- Ivanic et al. (2005) simulated the impact of agricultural productivity growth on poverty by mapping changes in prices to changes in poverty using detailed household level data + CGE model.

A comprehensive summary of evidence of impact of agricultural development on the poor can be found in the World Development Report, 2008.

In a more recent study, Valdes and Foster (2010) uses econometric evidence to show that in Latin America and other developing regions, growth in agriculture has an impact on national economic growth and poverty reduction that is greater than its simple share of national GDP.

Christiaensen et al. (2010)[4] also using cross-country econometric evidence show agriculture to be significantly more effective than non-agriculture in reducing poverty among the poorest of the poor, as reflected in the $1-day squared poverty gap. It is also up to 3.2 times better at reducing $1-day headcount poverty in low-income and resource-rich countries (including those in sub-Saharan Africa), at least when societies are not fundamentally unequal. Pauw and Thurlow (2010) used a regionalized dynamic CGE and micro-simulation model to show that higher crop yields in Tanzania improve nutritional outcomes from both the supply-side (increased calories and micro-nutrients) and the demand-side (low prices and increased purchasing power for the poor).

II. Empirical studies linking technology adoption and welfare/poverty effects

In their review, Kerr and Kolavalli (1999) examined the empirical evidence for direct and indirect effects of agricultural technology adoption on various outcome indicators. The direct effect – on income/livelihood of producers who adopt the new technology – has undoubtedly received the lion's share of attention in the literature, though most studies stopped well short of estimating the ultimate impact on poverty reduction. Most have emphasized economic rates of returns to research investments. Indirect effects refer to food price, employment creation, wage rate, and growth linkage effects, and therefore are likely to affect a much broader group of stakeholders including non-adopting producers, landless labour households and other rural and urban consumers.

Some early studies were unique in their attempt to document not only direct effects but indirect effects on different groups. Scobie and Posada (1978) and Pinstrup Andersen (1979), for example, using economic surplus analysis measured the differential effects from adoption of modern agricultural technology, e.g., improved rice varieties, on both producers (direct and indirect) and consumers (indirect). Both found that producers were sometimes gainers (adopters) and sometimes losers (non-adopters), whereas the main beneficiaries were consumers, via significant price effects, thus benefiting the poor disproportionately. However, no specific measures of poverty reduction were used in those

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[3] The strength of the link between agricultural growth and poverty is conditioned by agro-ecological conditions, level of technology use, access to assets, infrastructure, markets and institutions, and other factors (Byerlee and Alex 2002).
[4] Christiaensen, L., L. Demery, and J. Kuhl. 2010. *The (evolving) role of agriculture in poverty reduction: An empirical perspective*. WIDER Working Paper No. 36. Helsinki, Finland: UNU World Institute for Development Economics Research (UNU-WIDER).

studies. Indeed, few studies to-date have attempted to quantify the number of people lifted out of poverty due to direct and indirect effects from adoption of new agricultural technologies.

Many partial attempts have been made to document poverty-related effects from adoption of new technology. These have typically focused on indirect effects on urban/rural consumers, non-adopting farm households and rural labourers—through lower food/commodity prices, higher rural wages/greater employment creation and growth linkage effects. One example of the impact of widespread adoption of new technology on food prices is Warr and Coxhead (1993) who measured the impact of reduced food expenditures on the poorest quintile of population in the Philippines. Other researchers studied the impact of technology adoption on wages and employment: including reduced unemployment in rural Bangladesh (Alauddin and Tisdell, 1986), higher demand for labour in northern India and Nigeria (Goldman and Smith, 1995), facilitating movement of poor people from non-adopting to adopting regions in several Asian countries (David and Otsuka, 1994), and landless labourers (generally associated with 'poor') in the southern Indian state of Tamil Nadu gaining proportionately more in terms of wages and employment (Hazell and Ramaswamy, 1991). Studies have also looked at the effect of technology adoption on income distribution and equity, e.g., comparing poverty alleviation impacts in favourable and unfavourable areas of Pakistan (Renkow, 1993).

A classic study by Lipton and Longhurst (1989)[5] found that with the adoption of modern varieties productivity generally increased faster than the decline in food prices, so that both poor farmers and poor consumers benefited. Also land productivity increased faster than growth in the labor force, so that wages also increased.

While the above studies were useful in breaking new ground, it was clear that gaps remained in the links between improved agricultural technology adoption and larger development goals such as poverty, nutrition and food security at the end of the impact pathway. More recent studies have attempted to fill that void.

Lanjouw and Stern (1998) analysed developments in Palanpur village, Uttar Pradesh, using data from about 500 household surveys taken periodically between 1957 and 1993 to link changes in irrigation, modern variety adoption and chemical fertilizers to economic and social variables, such as real income/capita; real agricultural wages; percent below the poverty line. They conclude that new agricultural technology (not all of it due to research) improved the distribution of income and reduced poverty.

Sanginga et al. (1999) looked at the social impacts of adoption of improved soybean varieties and utilization technologies in Nigeria. Although this was a relatively small sample (203 households from 24 communities in one state), it nevertheless represents a good example of measuring *ex-post* the direct economic and social effects of an improved technology. The authors employed focus groups interviews, participatory rural appraisals, a food consumption survey, anthropometric measurement, field observations and conducted a multivariate analysis. They documented positive impacts on household income & distribution, human capital development, gender, resource use and social equity; e.g., income earned from women's production of soybean had significant positive impacts on short and long-term nutritional status and indices.

Minten and Barrett (2006) examined the farm income, food price, real wage rate effect and poverty impact from adoption of HYV rice across all of Madagascar.

Mendola (2007) – although a relatively small scale study (3,800 hh in 4 villages) uses a Propensity Score Matching approach to estimate income and poverty impacts from adoption of HYV rice in Bangladesh. Adekambi et al. (2009) used the counterfactual outcomes framework of modern evaluation theory to estimate the *Local Average Treatment Effect* of NERICA adoption on household expenditure among 268 households from rural Benin. Results indicated that the adoption of NERICA varieties had a positive and significant impact on household expenditure, and greater impact on female-headed households than male-headed households. Both of these studies attempt to correct for the selection bias problem

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[5] Lipton, M., with R. Longhurst.1989. New seeds and poor people. London: Unwin Hyman. This is updated in Lipton, M. 2005. The Family Farm in a Globalizing World: The Role of Crop Science in Alleviating Poverty. 2020 Vision Discussion Paper No. 20, International Food Policy Research Institute, Washington D.C.

inherent in naïve comparisons of outcomes between adopters and non-adopters by controlling for observable differences. These "selection on observables" methods are critiqued in the paper by de Janvry et al (2010).

III. Empirical studies linking agricultural research and poverty alleviation (only CGIAR studies)

In 2000, The Technical Advisory Committee of the CGIAR requested IFPRI to prepare a report on the links between CGIAR agricultural research and poverty reduction. The resulting report by Hazell and Haddad (2001) found that anecdotal evidence existed but did not scale up to comprehensive interpretation, and that the evidence was not firmly linked in causal relations, clearly implying the need for more empirical evidence. Subsequently, TAC, through its Impact Assessment and Evaluation Group (IAEG, later SPIA) requested IFPRI to develop, in collaboration with other CGIAR centers, case studies seeking to establish empirically the technology – poverty linkages. This led to a book (Adato and Meinzen-Dick, 2007) profiling seven impact assessment case studies of the CGIAR, which, with varying degrees of success, brought empirical evidence to support the links between agricultural research, new technology adoption and poverty reduction. The unique feature of micro-level studies (5 of 7 cases) was using a sustainable livelihoods framework in an attempt to be more comprehensive in assessing impacts (both intended and unintended) from the targeted beneficiary perspective. While impacts on the poor were measured using both quantitative (in most cases) and qualitative techniques (all cases), most case studies were relatively small scale and not truly *ex-post*, i.e., many were technologies recently introduced and still undergoing adaptation and experimentation[6].

Two of the case studies from the Adato-Meinzen-Dick study, however, were macro-level assessments which examined the combined direct and indirect impacts of investments in rice research on rural poverty in India and China (Fan et al., 2007) and the impact of investments in agricultural research *per se* on urban poverty in India and China (Fan, 2007). In the former study, the authors used estimates of economic surplus generated from adoption of modern rice varieties with a simultaneous equations model to estimate the number of rural poor lifted out of poverty due to both direct (producer) and indirect (prices, wages, employment) effects due to increases in rice production[7].

The Evenson and Gollin (2003) synthesis which brought together data on adoption of improved varieties of CGIAR mandated crops (maize, wheat, rice, sorghum, millet, beans, cassava, lentils, potato) in Asia, Africa and South America is perhaps the landmark CGIAR study linking agricultural research (crop improvement in this case) to poverty-related goals. After estimating the productivity (i.e., yield) gains from adoption of improved varieties and using a multi-market, multi-country partial equilibrium trade model (IMPACT), Evenson and Rosegrant (2003) calculated the impact on economic and social indicators such as food production per capita, food prices, calorie availability per capita, number of malnourished children, etc. They estimated that without any CGIAR research, developing countries food production would have been 7-8% lower, food & feed prices 18-21% higher, calorie intake some 4-5% lower, and some 13-15 million more children would have been malnourished. They stopped short of estimating the impact of these effects on actual numbers of people lifted out of poverty.

Alene et al. (2009) estimated that in West and Central Africa more than one million people per year have been moved out of poverty through adoption of new maize varieties since the mid 1990s. They attribute over half of these poverty exits to research carried out by IITA and CIMMYT. Kassie, Shiferaw and Muricho (2010) estimates with PSM the impact of adoption of ICRISAT bred improved cultivars of groundnut on crop income and # of poor in rural Uganda.

[6] An exception was the Bangladesh study examining the impact of adoption of modern varieties of rice on productivity, profitability, rural wage rates and employment across the country. Hossain et al. (2007) found that the direct effect of modern variety adoption on overall household income was small, but that indirect benefits (including stable employment, reduced prices, reduction in vulnerability) were significant, however the latter were only measured in a qualitative manner.

[7] The key result being that the reduction in rural poor from rice varietal research in India varied from 4.9m in 1991 to 3.1m in 1999 and in China from 23m in 1983 to 1.5m in 1999. This was based on an estimated 1% increase in ag prod reducing the rural poor by 0.24% in India and by 1.9% in China.

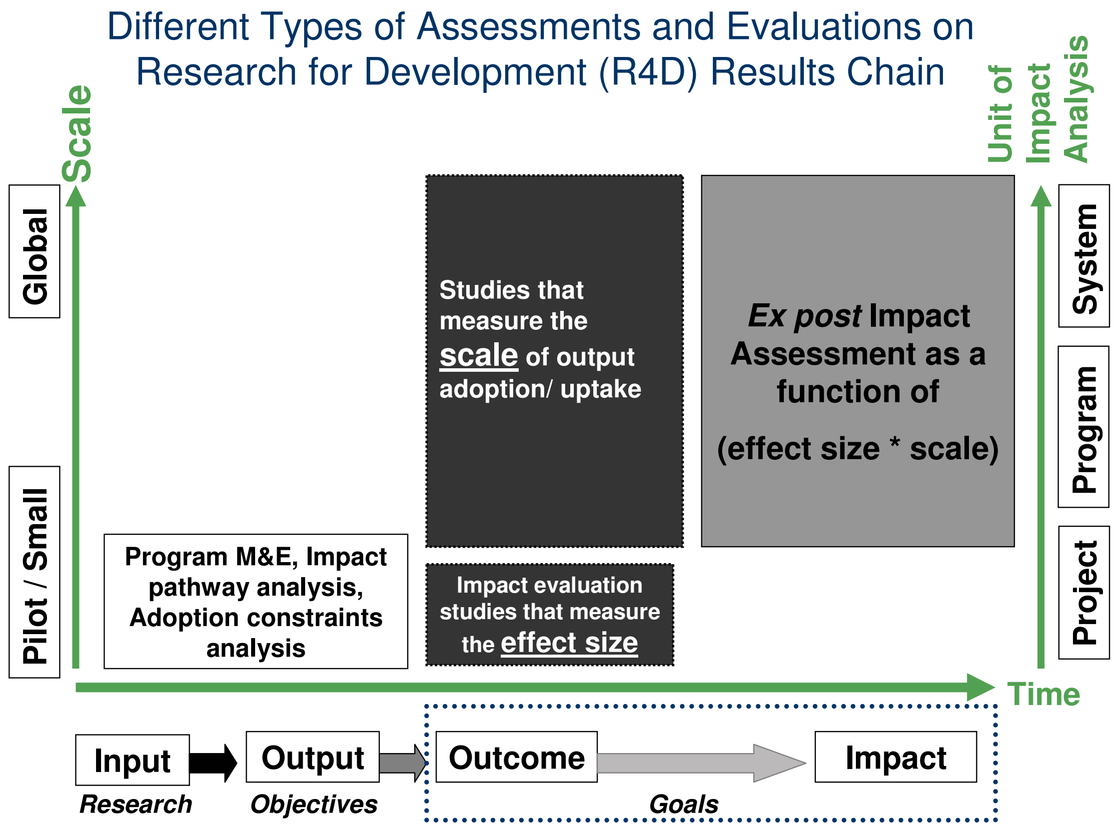
Examples (not an exhaustive list) of some key studies attempting to document the impact of agricultural research on poverty
(NB. - not including traditional economic rate of return studies)

Authors (year)	**Research/tech. evaluated**	**Direct or indirect effect**	**Impact/Poverty indicator (income, nutrition, etc.)**	**Methodology**	**Key result**
Micro-Meso level					
Lanjouw and Stern, 1998 (as cited by Herdt, 2010)	GR tech (irrigation, MVs, machinery, chemical fertilizer) in Palanpur village (500 hh), U.P., India	direct and indirect	real income/capita; real ag wages; population; % in poverty	surveys taken periodically between 1957–93 from 500 hh on poverty & ag related variables; correlations (?)	new agricultural technology improved the distribution of income and reduced poverty.
Hazell and Ramaswamy, 1991	technological change in rice production in 11 villages in N. Arcot, Tamil Nadu, India	direct and indirect: income, food consumption & nutrition, wages, food prices, employment, and effects on the non-farm economy)	direct: farm production, farm & family income, employment, wages, consumption expenditure, food consumption, nutrition indirect: ,	farm and non-farm hh surveys 1973 to 1983 used to estimate pooled village level changes from rice MV technology and use of SAM to look at regional effects and linkages.	New technology increased rice output, lowered poverty, improved diets and positively affected non-farm economy; small paddy farmers and landless laborers gained the largest proportional increases in family income.
Sanginga et al. 1999	improved soybean varieties & utilization technology in 203 hh (24 communities) in Benue state, Nigeria	direct effects	economic + social impact: income, nutritional status, by gender	social IA framework, stratified sample of hh: focus groups, PRAs, food consumption survey, anthropometric measuremt, field observations; multivariate analysis	+ impact on “hh income & distribution, human capital development, gender, resource use and social equity; e.g., income earned from women’s production of soybean had significant + impacts on short and long-term nutritional status indices
Hallman et al., 2007 (from Adato and Meinzen-Dick case studies on poverty impacts)	selected vegetable and fishpond technologies in three sites (27 villages) in Bangladesh	direct and indirect combined	income, expenditures and status of women, vulnerability	combines quantit (survey) and qualitative (focus group interview) data to probe adoption factors and impact on livelihoods	few quantitative results; most derived from focus groups show variable effects of the technologies on income, empowermt of women, & vulnerability (+ and -) across sites and hhs;
Mendola, 2007	HYV rice technology effects in 2 clusters of 4 villages in B-desh (3,800 hh)	direct on farm households	income and propensity to fall below the poverty line	cross sectional hh survey + propensity score matching to address ‘causal effects’	impact of HYV adoption is lower for near landless, but higher for small and medium scale farmers.
Kassie, Shiferaw & Muricho, 2010	improved groundnut varieties in 7 districts of Uganda (945 hh) meso-level study ??	direct and indirect	crop income reduction in # poor (based on income poverty indicator)	cross sectional farm hh data combined with PSM, poverty dominance analys and regression model	adoption of improved gnut has significant positive impact on crop income and poverty reduction

Authors (year)	Research/tech. evaluated	Direct or indirect effect	Impact/Poverty indicator (income, nutrition, etc.)	Methodology	Key result
Macro-level					
Scobie & Posada, 1978	rice crop germplasm improvement in Colombia differential impact on producers and consumers	direct: producers/adopter indirect: consumers and upland producers	income effects for upland and irrigated rice producers and for consumers	economic surplus + data on producer/consumer income profiles	net benefits, both relative and absolute, accrued disproportionately to the poor
Timmer, 1997	agricultural productivity growth per se, estimating growth-poverty elasticities	combined direct and indirect	???		A 1% increase in ag GDP per capita increased by 1.6% the per capita incomes of the two lowest deciles in 35 countries
Datt and Ravilion, 1998	farm productivity in general	direct and indirect effects combined	# people below poverty line (based on hh expenditure); real agric. wages; relative price of food	hh sample surveys over 35 years, estimate a model of joint determination of consumption-poverty measures, agricultural wages, and food prices	Yield growth contributes to poverty alleviation both directly and by inducing a rise in the wage rate and a decline in the price of food
Evenson & Rosegrant, 2001	improved crop germplasm of 8 CGIAR crops;	direct and indirect	economic and social impacts: food production per capita, commodity prices, calorie availability per capita, food imports prices,	Economic surplus estimate from adoption of MVs of 8 crops + multi-market, multi-country trade model (IMPACT) used to predict food production, prices, consumption and trade	(w/o CGIAR): developing countries food production 7-8% lower, food & feed prices 18-21% higher, crop area 1.5 - 2.7% larger globally; and calorie intake lower by 4-5% in developing countries
de Janvry & Sadoulet, 2001	ag technology in general for South Asia, SSA and LAC	direct (producer income) and indirect (wage rate, employment, prices, growth linkages)	income (direct and indirect), food prices, wage rates and employment creation	uses CGE model applied to archetypal models for the 3 regions (not clear what is source of data)	dominant effect of technology on poverty is direct effects in SSA, indirect ag employment effects in Asia, and linkage effects in LAC
Thirtle, Lin & Piesse, 2003	research-led technological change in general	Both	poverty headcount (check?)	causal links (econometric) between ag research – ag productivity – GDP per capita - poverty	A 1% increase in ag yields reduces # poor in SSA by 0.72% and by 0.48% in South Asia
Ivanic et al., 2005	agricultural productivity growth impact on poverty using CGE model	Both	income, poverty numbers	maps changes in prices to changes in poverty based on detailed hh data on income from land, unskilled & skilled labor and capital allocated to cereal & livestock prod., and	technological change that occurred over the period had different effects depending on what changes in factor use it generated, the pattern of factor ownership among households, the pattern of demand, and the extent to which a country is open to

				to other food, durables, non-durables and services	international trade
Minten & Barrett, 2006	rice crop germplasm improvement in Madagascar using data from focus group interviews from every 'commune' in the country	direct and indirect	farm profits, food prices, real wage rate, welfare indicators (# people in extreme poverty)	spatially explicit, multi-equation model examines how adoption of rice MV affects income & poverty on net food buyers, net suppliers and unskilled workers	higher rates of adoption of MVs & broader access to irrigation (= higher crop yields) result in lower real food prices, higher real wages for unskilled workers, greater profits for farmers, and fewer people in extreme poverty.
Hossain et al., 2007 [from Adato and Meinzen-Dick case studies on poverty impacts]	rice varietal improvement in Bangladesh	direct and indirect on livelihoods of rural poor	productivity, profitability, increasing rural wage rate effect; greater employment	country-wide multi-stage random sampling of hh level quantitative & qualitative data, to analyze impact of adoption of MV on poor and non-poor income and asset base	Direct effect of MV adoption on overall hh income was small, but indirect benefits (based on qualitative analys.) included stable employment, reduced prices, and reduction in vulnerability. Negative effects also reported.
Fan et al., 2007 [from Adato and Meinzen-Dick case studies on poverty impacts]	national and international rice varietal improvement research in China & India	direct and indirect on the rural poor (a related study looked at effects on the urban poor)	# of rural poor reduced by increasing incomes to MV rice producers and by generating income effects (via falling prices) for rural net rice buyers and higher wages/employment	(1) economic surplus from adoption of MVs rice, (2) simultaneous equations model to estimate impact on poor from ag prod. increases (from Fan et al. 2000), (3) MV contribution to ag prod increase, (4) # rural poor reduced	Reduction in rural poor from rice varietal research in India varied from 4.9m in 1991 to 3.1m in 1999 and in China from 23m in 1983 to 1.5m in 1999. This was based on an estimated 1% increase in ag prod reducing the rural poor by 0.24% in India and by 1.9% in China.
Alene et al., 2009	Using data on maize varietal release, adoption, yield gains and research investments in WCA (9 countries) from 1971-2005, economic & poverty reduction impacts are estimated	direct and indirect	# poor reduced via improved maize variety adoption	annual economic benefits from maize research estimated for each country using econ surplus model; ag productivity increases from maize research as a basis for calculating # people lifted out of poverty (based on earlier poverty elasticity estimates in SSA)	# of poor lifted out of poverty attributable to maize research ranges from 189,000 in 1981 to 3 million in 2004, with an average of 1.6 million per year.
Pauw and Thurlow (2010)	agricultural production generally in Tanzania	Both	direct: calorie consumption & micro-nutrients in direct: lower prices & higher purchasing power	link production trends to household incomes using a regionalized, dynamic computable general equilibrium and microsimulation model.	agricultural growth trends driven by larger-scale farmers and by crops grown in only a few regions of the country. The slow expansion of food crops and livestock also explains the weak relationship between agricultural growth and nutrition outcomes

Annex 1.



Source: Presentation by Mywish Maredia at AfrEA - 3IE workshop, April 2009, Cairo.

Annex 2. Impact Pathway

Impact pathway for a yield-increasing germplasm improvement – Example for consultation at the Impact Assessment Focal Point Meeting, Nairobi 5-7th October 2006.