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Learning From Others: Increasing Agricultural Productivity for Human Development in Sub-Saharan Africa

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A. Introduction - Agriculture and human development: SSA and lessons from elsewhere

Why is agricultural progress crucial for human development in sub-Saharan Africa?

Human development - the advancement of people's capabilities and functionings - depends on human resources, constraints, and capacity to make and implement considered choices. All these depend on income, nutrition (especially in children), and access to and conditions of work. All these are usually likelier to be inadequate or insecure for the poor. So, for human development, access by the poor to more, better and safer income, nutrition and work has high priority anywhere, but perhaps above all in sub-Saharan Africa (SSA):

Severe absolute income poverty (income below \$1.25PPP₂₀₀₅/person/day)² affected about 51% of people in SSA in 2005, only a small fall since 1981 (54%). Meanwhile, poverty incidence had fallen from 84% to 16% in China, and from 60% to 42% in India. In 1981-2005 real average income of the poor was static at 73c/day in SSA; in China it rose from 67c to 94c, and in India from 84c to 93c (Table 1).

Undernutrition in SSA, while less prevalent than in South Asia, is not improving. Of 42 African countries with a post-2000 and an earlier national survey of the proportion of children underweight, 18 show at least a 2% fall, 14 at least a 2% rise, and 10 no notable change (in Asia, with 25 national repeat surveys, comparable numbers are 14, 1 and 10). Of 29 African repeat national surveys of child stunting, 12 show improvement, 11 deterioration, and 6 no notable change (Asia 20: 13, 1, 6) [UNSCN 2010: tables 21-3].

The World Bank's 'Survey-based Harmonized Indicators Program' has measured 'underemployment'³ in ten SSA countries between 1995 and 2005. It is well above 20% of workforce in Cameroon, Ghana, Malawi and Mozambique, and over 10% elsewhere - higher among young people and (usually) in rural areas [World Bank 2009: 6-7]. At the same time, most of Africa's rural poor, especially women working a 'double day', do long, arduous, unskilled work for low, uncertain rewards. Child labour is pervasive.

²In this paper, 'poverty' means severe income poverty, i.e. income below \$1.25/person/day in 2005 purchasing-power parity. This is not to belittle the importance of other components in the UNDP's 'human poverty index', but to distinguish them from severe income poverty.

³'Unemployment' is an inappropriate concept to measure inadequacy of work and income in informal sectors, especially developing rural areas.

Table 1. Proportion of people below \$1.25/day and their average real income, 1981-2005, by region (% of people below \$1.25 a day, and their mean income, \$ at 2005 international purchasing power parity)

Region		11981	1984	1987	1990	1993	1996	1999	2002	2005
East Asia, Pacific	% < \$1.25	77.7	65.5	54.2	54.7	50.8	36	35.5	27.6	16.8
	Mean income	0.68	0.79	0.81	0.83	0.85	0.88	0.87	0.89	0.95
China	% < \$1.25	84	69.4	54	60.2	53.7	36.4	35.6	28.4	15.9
	Mean income	0.67	0.79	0.82	0.82	0.84	0.88	0.86	0.87	0.94
East Europe, Central Asia	% < \$1.25	1.7	1.3	1.1	2	4.3	4.6	5.1	4.6	3.7
	Mean income	0.72	0.7	0.7	0.68	0.69	0.7	0.7	0.72	0.73
Latin America, Caribbean	% < \$1.25	11.5	13.4	12.6	9.8	9.1	10.8	10.8	11	8.2
	Mean income	0.82	0.82	0.78	0.79	0.8	0.79	0.77	0.78	0.77
Middle East, North Africa	% < \$1.25	7.9	6.1	5.7	4.3	4.1	4.1	4.2	3.6	3.6
	Mean income	0.99	0.99	0.99	0.9	1.01	1.01	1	1.01	0.98
South Asia	% < \$1.25	59.4	55.6	54.2	51.7	46.9	47.1	44.1	43.8	40.3
	Mean income	0.84	0.86	0.87	0.88	0.91	0.91	0.92	0.92	0.93
India	% < \$1.25	59.8	55.5	53.6	51.3	49.4	46.6	44.8	43.9	41.6
	Mean income	0.84	0.86	0.88	0.89	0.91	0.92	0.92	0.93	0.93
Sub-Saharan Africa	% < \$1.25	53.7	56.2	54.8	57.9	57.1	58.7	58.2	55.1	50.9
	Mean income	0.72	0.7	0.7	0.68	0.69	0.7	0.7	0.72	0.73
Developing World	% < \$1.25	51.8	46.6	41.8	41.6	39.1	34.4	33.7	30.6	25.2
	Mean income	0.74	0.8	0.82	0.82	0.84	0.85	0.85	0.86	0.87

Source: Ravallion and Chen [2010]

Why does this make agricultural conditions and progress central to human development in SSA? Because its people, especially its poor, rely on agriculture for three determinants of HD: income, food and work.

As for income, in SSA 70% of people in severe income poverty in 2003 were rural. Unlike other areas, urbanization is slow and is not reducing poverty. Most of SSA's poor will be rural 'for many decades' [Ravallion et al. 2007: 1, 25-7, 38]. Though some 30-40% of rural income in SSA is from non-farm activity, the proportion is smaller among the poor, and - as both Asian and African experience show - rural non-farm activity tends to prosper only in the wake of growing farm incomes. Reducing African poverty will long depend on raising and stabilizing the poor's currently low and fluctuating agricultural incomes.

As for work, agriculture is the main source for about 70% of the economically active, on official data (Table 2). Careful field surveys in 15 SSA countries suggest, contrary to received wisdom, that proportions of young workers are even higher [World Bank 2009: 8], as they are among the poor. Despite the migratory urge to leave agricultures that remain pre-scientific and impoverished, for a big majority of SSA's populations neither minerals nor manufacturing have so far offered much by way of affordable employment alternatives, especially to the unskilled poor.

Table 2. Agriculture in the labour force, SSA, 1994-2007 (countries with > 1m active in agriculture in 2007)

	No. of economic actives in agriculture (mn)			% of total economic actives	
	1994-6	2006	2007	1994-6	2007
Angola	3.95	5.26	5.41	73	70
Benin	1.31	1.58	1.61	59	47
Burkina Faso	4.08	5.89	6.12	92	92
Burundi	2.72	3.4	3.52	91	90
Cameroon	3.32	3.63	3.61	65	51
Central Afr. Republic	1.13	1.24	1.25	76	66
Chad	2.23	2.89	2.92	80	69
Congo, DRC	11.07	13.66	13.85	65	59
Cote d'Ivoire	2.92	3.05	3.06	54	41
Eritrea	0.94	1.4	1.43	79	75
Ethiopia	20.5	28.77	29.73	84	79
Ghana	4.22	5.52	5.66	58	55
Guinea	3.02	3.67	3.73	86	81
Kenya	9.41	12.38	12.6	78	72
Madagascar	4.59	6.37	6.43	77	72
Malawi	3.67	4.68	4.8	85	80
Mozambique	6.29	8.04	8.2	84	81
Niger	2.66	3.76	3.9	87	84
Nigeria	12.61	12.34	12.31	38?	27?
Rwanda	2.18	3.79	3.88	92	90
Senegal	2.69	3.54	3.64	75	71
Somalia	1.86	2.28	2.32	72	67
South Africa	1.58	1.31	1.29	11	7
Sudan	5.89	6.68	6.8	65	54
Tanzania	12.26	15.38	15.76	83	77
Togo	1.06	1.35	1.38	63	55
Uganda	7.6	9.95	10.24	82	76
Zambia	2.5	3	3.06	72	65
Zimbabwe	3.2	3.13	3.11	66	58
(cp. India)	223.81	256.52	258.64	61	56

Source: FAO 2009

As for food, in 2007-9 cereals and starchy roots provided two-thirds of energy (kilocalories) in sub-Saharan Africa (Table 3) - almost certainly over three-quarters for the poor. Over 75% of cereals, and almost all starchy roots, consumed in SSA came from national agriculture, not from net imports (Table 3); globally 86% of staples in poorer areas come from lo-

cal sources' [Zoellick 2011, my italics]. So, especially for the poor, local agriculture largely determines the availability and security of dietary energy supply.⁴

Table 3. Sources of dietary energy and local provision, 2007-9.

	Cereals		Starchy foods		All foods
	Kcal/per person/day	Imp/Exp % supply	Kcal/per person/day	Imp/Exp % supply	Kcal/per person/day
Eastern Africa	1018	14.1	327	0.2	2045
Middle Africa	608	31	667	0.2	1860
Southern Africa	1560	27.2	78	6.5	2918
Western Africa	1244	18.1	486	0.1	2649
Northern Africa	1757	46.7	61	-0.2	3016
India	1398	-3.5	50	-0.3	2352

Source: <http://faostat.fao.org/site/368/DesktopDefault.aspx?PageID=368#ancor> accessed 1900:12/01/2011.

So the condition and progress of SSA's agriculture are central to growth, poverty reduction, access to employment income, and food security. Agriculture also greatly affects other major components of SSA's human development.

- Health: in SSA nutrition before the age of 5 largely determines healthy growth of children, and greatly affects resistance to middle-age infections and to degenerative diseases of old age and affluence as the nutrition transition proceeds [Lipton 2001]. Child nutrition depends on interactions between infection, care, and timely and adequate food. The latter depends mainly on whether nearby agriculture provides enough income from work and land, and enough affordable food, for the poor. Also, the farm product-mix and the path to agricultural growth greatly affect water-borne parasitic disease (especially malaria, Africa's greatest curse) [Asenso-Okyere et al. 2009], work accidents, and water pollution [Lipton and de Kadt 1988].
- Education is affected by the timing and pattern of farmwork, especially child labour: 70% of working 5-14-year-olds, more in SSA, are on the farm, and while such "experience can be positive" it interacts with inadequate, dispersed and badly-timed rural schools to discourage education [ILO, n.d.]. However, a growing, scientific agriculture, as in much of India and China, increasingly demands educated farmers and workers.
- Self-esteem is affected by whether farming provides rural people with agency: a share of power, control and decisions at work. Probably the main determinant of agency is a reasonable level of secure access to land.

Apart from affecting human development in SSA, agriculture is affected by it. Healthier, better educated [Jamison and Lau 1982], more self-reliant, less poor people produce more

⁴The work of HarvestPlus shows that much of the African poor's (inadequate) vitamin A, iron and zinc, too, come from local staples.

from a given farming system, and will be readier to accept and manage risks of dynamic farm innovation.

Such 'virtuous circles', and hence progress in human development, can be sustained only if agriculture is itself managed sustainably. In much of SSA it has not been. Soil quality has been depleted, partly by the spread of crop farming into low-quality land which is not significantly replenished by fertilizers, and partly by unprotected wind and rain erosion. Thus in 2002–03 40 per cent of farmland was losing over 60 kg/ha of main plant nutrients each year and 95 million hectares were severely depleted of soil nutrients [Henao and Baanante 2006].⁵ Farm water access in many areas is little more sustainable. SSA's very scant irrigation (see below) accompanies widespread lack of farm water control; water diversion to growing cities; and, due to climate change, increasing evapotranspiration and, at least in West Africa, growing unreliability of rainfall in the Inter-tropical Convergence Zone.

The centrality of agriculture for human development, and the relatively weak agricultural progress and sustainability in most of SSA (sec. 2), suggest that SSA's human development prospects might be improved by learning from agricultural success - and failure - in countries that have reduced poverty faster, often alongside economic growth sufficient to move out of low-income status. City-states apart, most of these countries have experienced rapid technical progress in agriculture. Global experience, evidence and theory agree on three things about such 'green revolutions'. (1) They are usually necessary (though not always sufficient), and with care sustainable, to kick-start rapid human development and GDP growth. (2) They are also feasible if employment-intensive and smallholder-based, but also science-led and high-input. (3) They require the public sector to devote much higher proportions of spending, investment, research and effort than have so far prevailed in most of SSA.⁶

The key role of prior, rapid agro-technical progress is brought out by experience preceding both Europe's industrial revolution (for example, growth of English and Dutch agriculture in the years prior to 1770-1880: Wrigley 20xx) and Asia's 'miracle' (1985-2010). The voluminous debates about that miracle hardly mention its main cause: sharply accelerated (but regionally selective), science-based farm growth in 1965-85 - the GR (GR), mostly in smallholdings and in many cases, notably China from 1977, with major land reform. 'The natural progress of opulence' into industry and services first requires agricultural advance enough to release a surplus: 'it is the surplus produce of the country only, or what is over and above the maintenance of the cultivators, that constitutes the subsistence of the town, which can therefore increase only with the increase in the surplus produce' [Smith 1776: 286].

Many African scholars and leaders, seeing widespread prosperity (and power) in the industrialized East and West, suspect such arguments. They see them, at best, as agricultural fundamentalism or starry-eyed 'sector advocacy' of farming; at worst, as a neo-colonialist effort to lock Africans into roles as 'hewers of wood and drawers of water'. Indeed, the normal path of human development, migration and preference takes people out of farming. Human history is the story of cutting the time that is required to get food, and using

⁵ For a detailed case-study in Ethiopia, see Haileselassie et al. [2005].

⁶ South and East Asia, before and during the GR of the 1960s, typically devoted over 20% of public expenditure to agriculture; the proportion in SSA is little above 5% [Lipton 1968].

that time for other economic or leisure activity. However, before that can bring development, a low-income, agriculturally underdeveloped country normally needs to release rural savings, water, land, food, and workers for urban and non-farm development. Achieving that release by force has a monstrous, brutal and largely unrelieved history of failure. The alternative, successful in both East and West, is science-led, broad-based, rapid agricultural productivity growth.

In the USA, 98 per cent of workers are outside farming. Yet it provides far more than enough to satisfy high per-person calorie consumption, and a large surplus of food exports over imports. In SSA over two-thirds of workers are engaged mainly in agriculture. Yet it provides less than 80% of calorie consumption, which is inadequate despite substantial net food imports (Table 3). Can SSA make significant progress towards US farm output per worker? Not by following past US methods, farming rapidly expanding areas with machinery. Rather, SSA needs agro-technical 'green revolutions' to raise staples⁷ output per hectare, per unit of capital and machinery, and per litre of water. Except in a few areas of semi-humid West and Central SSA, area expansion can contribute little. Fuelled largely by population growth,⁸ people in search of rural income and employment in 1950-2010 already expanded arable area to, and in many places past, the bounds of sustainable cultivation.⁹ SSA's GRs have to be based on yield expansion, not area expansion. They also have to use SSA's plentiful, underemployed and increasing rural labour supply, and not draw too heavily on scarce capital and savings - also the reverse of the US experience.

Three underlying circumstances - population pressure, increasing land scarcity requiring farm growth to be yield-based, the need for high labour-to-capital ratios - applied to most of Asia during its GRs, as they do in most of SSA now. It is often asserted that SSA is "different" because highly variable in its agricultural conditions and possibilities, with some areas, initially at least, ill-suited to seed-water-fertilizer-based GRs of the South or East Asian type. That is true, but such variability - and its policy consequences - applied at least as much within China or India, let alone Asia, before and during their GRs. Indeed, that is why China and India, despite much growth and poverty reduction, have left substantial regions and groups behind. While a country should normally launch GRs where chances of success (and hence of spread to other areas) are best [Lele 1989], SSA governments can learn by avoiding Asian errors. That means not prematurely writing off rural areas that initially seem somewhat recalcitrant, but, rather, incorporating them soon into rural progress:

- Regions such as North Bihar in India lagged in farm production due not to recalcitrance but to long relative neglect. When the neglect stopped, agriculture made faster progress. Indeed, there is evidence that by the 1980s it was efficient for growth, as well as poverty-reducing, to shift towards some agriculturally 'backward'

⁷This is not to denigrate cash crops. Most of SSA's farm output comprises them (p. Xx). Income from growing them allows millions to buy their staple more efficiently than by growing it themselves. But local food security, based on staples, is usually needed *before* farmers risk more reliance on cash crops.

⁸SSA's population in 2010 was 4.7 times the 1950 level and in 2050 is projected to be 9.6 times that level [UN 2009].

⁹Arable land, plus area under permanent crops, between 1961 and 2007 increased by 65% in Western Africa, 62% in Eastern Africa, 22% in Middle Africa and 18% in Southern Africa. The increase in China was 16% and in India 5%. In all African regions the extra cropped area dwarfed the net rise in total agricultural area [FAOSTAT 2011]. So most extra cropped area came from reduced grazing or forest area.

areas much larger shares of appropriate farm research,¹⁰ water control, and market access.

- Other 'difficult' regions may benefit most from non-farm advantages such as Special Economic Zones. In China these continue to be located mainly for overseas access, e.g. near ports, not in 'difficult' regions.
- If a region within a country is disadvantaged (high-cost) for most or all farm and non-farm production lines, the response is normally emigration.¹¹ Prospects of success here usually require better education.

While SSA's farm prospects and land-water conditions are highly variable, they are not, as sometimes claimed, more 'fragile', and thus less susceptible of rapid science-based improvement, than were Asia's during its GRs. Almost any widespread soil-terrain-water conditions in SSA have close counterparts in India¹² or China (let alone 'Asia'). What SSA has lacked (with a few exceptions) has been large, sustained efforts to expand smallholder-friendly irrigation, fertilizer use, and improved seeds. Since 2003, however, there have been large, ongoing and Africa-based efforts in this direction, partly co-ordinated by CAADP and AGRA respectively.¹³

These efforts can apply Asian lessons about how, and often how not, to manage fragility in GRs. Many Asian irrigation schemes have suffered from too little public or social management of, or private incentive for, recharging and conserving fragile resources of surface water and groundwater [Hussain 2005; Lipton 2007]. In some Asian green-revolution lead areas, notably in China but also in parts of India's Punjab and Haryana states, excessive nitrogenous fertilizer has been used, with inadequate concern and incentive to complement it with humus, or to safeguard soils from nutrient imbalance, and drinking water from nitrate and nitrite pollution. As yet, SSA's problems of resource fragility are largely due to grossly insufficient irrigation, fertilizer and farm science, not to excessive or mismanaged inputs.¹⁴ Nevertheless, Asia's lessons of neglected fragility have to be recalled in SSA too. Further, the world is moving inexorably to a regime of dearer oil, gas and therefore nitrogenous fertilizers - and, with climate change, of less reliable rainfall and faster evaporation. New GRs in SSA will have to concentrate, more heavily than did their Asian forerunners, on seed varieties and farm input systems that - apart from simply responding to more water,

¹⁰By the late 1980s (and probably much earlier), extra public spending on agricultural research - as on education and irrigation - had more effect on both poverty and net production in many 'backward' areas than in the GR lead areas [Fan et al. 2000, 2000a].

¹¹A country so disadvantaged can seek, often to its great benefit, to specialize in products where it has least comparative disadvantage.

¹²For example, cyclic bush fallowing in West Africa is similar to jhum cultivation in Assam.

¹³Under the African Union's Comprehensive Africa Agriculture Development Programme (CAADP), 22 states have pledged to raise agriculture's share of their national budget to 10%. The Alliance for a GR in Africa (AGRA) has begun to expand research support. By early 2009 \$84 million, or over a quarter of AGRA receipts, had been granted to 13 countries to deliver improved varieties and inputs. CAADP has more resources, country coverage and aims: to mobilize African resources to invest in sustainable land-water infrastructures (mainly through irrigation), to improve infrastructure for market access, to increase food security, but also to promote research [Hunt and Lipton 2010].

¹⁴257 kg/ha of NPK equivalent, the East Asian 2008 average, suggests excess (subsidized) N application, especially in China. However, 10 kg/ha, the SSA average, is hugely deficient [http://faostat.fao.org/site/575/DesktopDefault.aspx?PageID=575#ancor accessed 11:13 25-10-2010].

fertilizer and other inputs - economize on such inputs by raising their conversion efficiency into food (or into cash-crops exchangeable for food) [Conway 1997].

From the standpoint of human development, GRs raise two crucial questions for SSA regarding equity. First, is agricultural growth - in particular if technology-led - pro-poor? Second, are pro-poor paths of agricultural growth more efficient than other paths? The answer to both questions is "Yes, unless undermined by very unequal, unreformed land distribution and/or by systems of research, and of access to inputs and output markets, that are very unresponsive to poorer farmers' needs". Outside a few countries in Southern and Eastern Africa (where land reform is a priority), land distribution in SSA is less unequal than in Asia, and much less unequal than in Latin America. Typical SSA countries, with not too unequal farmland, should be much better than Mexico or even Indonesia at converting GRs into poverty reduction and human development. The problem, rather, is to achieve those GRs. Research and market-access systems are weak in many SSA countries, and need strengthening to achieve rapid agro-technical progress. Once such progress is rolled out, the predominance of smallholders - and the widespread success of private intermediation between them and large markets (e.g. for seeds, processing and supermarkets) - suggests that with suitable policies rapid agro-technical progress, where it happens, will spread to the poor as well as rich at least as successfully in SSA as has happened in most of Asia.

There are two types of evidence on the poverty-reducing impact of extra growth from different sectors of the economy: comparisons among areas or times within developing countries (e.g. South Africa, China, India, Indonesia, Philippines), and cross-country regressions among developing countries. Both types of evidence show that \$1mn of extra GDP, especially but not only in early development, normally leads to substantially more poverty reduction if the growth is in agriculture rather than other sectors. Only in Latin America, with very unequal land and typically well over 75% of employment outside agriculture, are exceptions found [Byerlee et al 2005; Eastwood and Lipton 2002]. A recent review concludes that typically an extra \$1mn output reduces poverty incidence over 3.5 times more if derived from agriculture rather than from other sectors. This poverty-reducing advantage of agricultural growth is also robust in SSA: changed output-per-person in 'agriculture is responsible for about 60% of the evolution of poverty'. The SSA-wide data place the main blame for SSA's much slower progress in poverty reduction than Asia's upon 'insufficient attention to the needs of the agricultural sector, rather than lack of participation by the poor' [Christaensen and Demery 2007: 25-6, 30, 70, 76].¹⁵

In this paper, we discuss how countries in SSA can raise yields and thus achieve poverty-reducing agricultural growth. A 1% rise in agricultural yields appears to reduce the number of poor people by about 0.7% in African countries - even more than the 0.5% found in Asian countries [Thirtle et al. 2003]. It is sensible also to ask whether agricultural growth, and its translation into poverty reduction, can be achieved by area expansion, rather than yield growth. Simply showing that land is in principle suitable for farming does not prove that it pays farmers or governments to make it so. They appear unconvinced in Southern and Middle Africa: in 1981-2008, area under arable and permanent crops expanded by less than

¹⁵Exclusion of the poor from agriculture is a big cause of poverty, however, where land is very unequal. Within Limpopo province, South Africa, the sub-region with widespread land access offers far better prospects, for the poor, of local farm and non-farm income [Eastwood et al. 2006].

0.2 per cent per year. Expansion has been somewhat faster in Eastern Africa (1.0%/year) and Western Africa (1.6%/year) and this can help the poor. For example, Ghana's fast rural poverty reduction since 2000 is due mainly to expansion of (largely smallholding) cocoa area [World Bank 2008: 47]. For such area expansion to raise farm output and cut poverty, however, there are two requirements. First, it must be consistent with poor people's existing land rights, as well as profitable, to break new farmland. Second, the income from the newly worked land must be generated in employment-intensive ways that benefit the poor, in SSA usually as farm operators. Unfortunately, in most of SSA, area expansion for poverty-reducing farm growth is less and less *sustainable*. From 1950 to 2011, SSAs population more than quintupled [UN 2009]. In that process, even many forest lands, and land sustainable only in low-density grazing, have been brought into use. Unused land, which can be broken for farming at low cost and with returns comparable to existing farmland, has become ever harder to find. Area expansion is less and less economic and/or environmentally sustainable, so the source of poverty-reducing farm growth must increasingly be yield increases. So-called empty land is usually used periodically, but labour-intensively, by farmers, or communities, with informal rights. In Africa as elsewhere, such rights are seldom adequately considered, or their owners consulted, in large government-to-government or government-to-company land deals [Cotula 2011].

Why does an initial surge in farm output in low- and middle-income countries usually reduce poverty more than the same value-added outside farming? Probably there are three main reasons. First, extra farm output may bring more, cheaper, and perhaps (as stocks grow) more reliable nearby staples, which loom largest in the budgets of the poor. Cash-crop production is also widespread among African smallholders, and sales for cash also provide income to buy staple foods. Second, the main asset in farming, land, is usually much more equally distributed than capital, the main asset used for non-farm production. Third, especially when farming is done in small and not-too-unequal units as in most of Western and Middle Africa, there are advantages to farmers from producing employment-intensively rather than capital-intensively. In brief, in agriculture - especially smallholder agriculture - as compared to other sectors, a larger part of growth in value-added comprises returns to (employed or self-employed) labour. Hence the overall pro-poor effects of, at least, early GRs [Lipton and Longhurst 1989; Kerr and Kohlavalli 1999; Hazell and et al. 2000]. These effects usually benefits rural labourers as well as farmers, partly because smallholder-led growth raises overall demand for labour and hence employment and/or wages, partly because of secondary benefits when extra farm income is spent on locally made non-farm output [Hazell and Ramasamy 1991].

The data suggest that agriculture's large superiority to other sectors as a source of pro-poor growth is greatest in the poorest countries.¹⁶ Why? The early stages of green-revolution-led farm output growth, e.g. in India around 1966-85, are very labour-intensive. Extra output is generated by higher-yielding seeds, but in combination with more water applications, drainage, and irrigation management; more fertilizers; pest control; and harvesting the resulting larger crop output. All these normally need more on-farm labour, as was the case in Asia. That should apply at least as strongly in SSA, given its generally greater dispersion of land into small, labour-intensive farms and its much lower pre-green-revolution level of fer-

¹⁶ This superiority 'decrease[s] as countries become richer' [Christaensen and Demery 2007: 30].

tilizer and irrigation inputs.¹⁷ However, after 20-30 years, output expansion based on GRs tends to become less labour-intensive at the margin, and therefore less pro-poor. That is mainly because labour-intensive input growth - irrigation and fertilizer expansion - slows down in face of diminishing marginal returns. The sources of output growth shift towards improved use, mix, timing and application of existing water and nutrients, a much less labour-intensive process. For example, agricultural employment is much less responsive to agricultural growth in India than in 1965-85 [Singh 2005: 108-9].¹⁸ However, on earlier Asian evidence - and if accelerated agricultural growth is feasible - much of SSA can enjoy 20-30 years during which each \$1m of economic growth generates much more employment and poverty reduction if it comes from agriculture. But SSA will increasingly need to rely on yield enhancement, not area expansion, for farm growth to be attainable or sustainable; and on fairly equal smallholdings, not large farms (let alone government-led deals for large-scale land alienation), for farm growth to be poverty-reducing. There is, fortunately, no conflict between efficiency and poverty reduction. Because rapid, smallholder-led, rapid growth in farm yields provides income mainly to the working poor, not only more is it more poverty-reducing than other early development paths; it also makes fuller use of a poor, developing nation's abundant and underused resource, labour, while economizing on its scarce resource, capital and saving.

What of alternatives to agriculture in SSA's experience? Minerals-led growth – the 'resource curse' apart [Collier 2007] – has usually generated little employment, poverty-reduction, regional spread, or human development. Manufacturing-led growth, with few exceptions (e.g. textiles in Mauritius and Ghana), has not proved much more promising, and has faced higher skilled-labour unit costs than Asian competitors. The experience of many Asian countries, including Bangladesh, China, Malaysia and Vietnam is borne out by some African cases. It is that successful, fast, labour-intensive farm growth - accompanied by expanded rural education - later releases labour resources in numbers, and with skills, to drive successful and internationally competitive manufacturing growth.

Agricultural growth as a source of poverty reduction will be weaker - as it was in Latin America - in those parts of SSA where, due to unreformed and very unequal land distribution, a large proportion of farmland is in large farms [Eastwood and Lipton 2002]. Large farms have much higher labour supervision cost than small farms. Therefore, large farms are usually much less labour-intensive [Booth and Sundrum 1985; Lipton 2009, ch. 2]. That applies even where rural labour is plentiful and capital scarce, as in most of rural Africa.¹⁹

¹⁷In 2008 fertilizer application (NPK nutrient equivalent) was 10kg/ha in SSA, as against India's 134kg/ha. Irrigation reached under 3% of arable plus-permanently-cropped land in SSA - under 1.3% if we exclude Madagascar, South Africa and Sudan - as against South Asia's 44%

[<http://faostat.fao.org/site/550/DesktopDefault.aspx?PageID=550#ancor> accessed 18:56 28-10-2010].

¹⁸However, the very low (sometimes negative!) time-series-based numbers widely cited for the elasticity of employment (i.e. demand for labour, including self-employment) to farm output in much of Asia, especially India, are gross underestimates. Observed 'employment' is the number of worker-hours where labour supply equals labour demand. Farm (rural) labour *supply* is falling in most of Asia, so time-series-based estimates of 'employment' (labour *demand*) elasticity of farm output growth are heavily biased downwards. With farm (rural) labour supply rising at over 1.5%/year in most of SSA, these very low, biased estimates should not delude analysts to expect weak employment responses to SSA farm growth.

¹⁹Rural work force is rising in most of SSA despite urbanization. Urbanizers frequently return in harvest season if there is any sign of labour shortage.

During agro-technical progress large farmers often choose capital-intensive ways of delivering extra farm output, such as centre-pivot irrigation in South Africa. Hence, if extra farm output comes mainly from large farms, one would expect less favourable poverty impact. That may happen where land is very unequal as in Kenya, or where governments alienate land in large units to foreign companies or governments, as in several parts of SSA [Cotula and Vermeulen 2009]. SSA countries, embarking on feasible policies for accelerated agricultural growth, may expect good results for employment, real wage-rates, and hence poverty reduction and human development. But such impact will be more favourable, in the more land-unequal "settler economies" of Eastern and Southern Africa, with careful prior land reform.²⁰

It may be equitable for farmland, and in particular a GR, to be dispersed among many small and fairly equal farms. However, that may not help human development if small-farm development is not an efficient path to agricultural and overall growth. Some analysts and statesmen believe it is not. Sometimes they have a picture of large, profitable settler farms in Africa, and believe that this path is efficient for African farmers too. Yet where these settler farmers succeeded with large-scale farming, it was not only by skill and effort (though these were often ample), but also thanks to otherwise damaging actions by the colonial State: repression of competitive smallholder sales (e.g. cotton in much of West Africa, maize in South Africa); hidden subsidy (e.g. to irrigation in South Africa); forced supply of artificially cheap African labour (e.g. through cattle head-taxes in pre-independence Zimbabwe); or tolerance, or even State rounding-up, of near-forced labour (e.g. in the former Belgian Congo). In post-colonial times, with such racial interventions gone, many field studies - in SSA as well as Asia and Latin America - show that annual output per hectare is normally more on smaller and family farms, mainly because of their lower supervision costs of labour, so they use more labour per hectare.²¹

It has been shown that usually it is middle (seldom large) farmers who can access, and risk, the earliest adoption of new farm inputs in GRs. This makes a case for avoiding land redistributions that completely equalize landholdings. However - unless the extension, input distribution or subsidy system is very biased towards large farmers - any advantage they have over smallholders from prior adoption of new inputs is short-lived and soon reversed. After two or three seasons it is again the smaller farmers who, per hectare, use more of these inputs (notably fertilizers: Hossain 1988) and support them with more labour. Further, severe land inequality at village and national levels has also been found to damage prospects for rapid growth; quite separately from the on-farm effects, this further militates against the social efficiency of large, very unequal landholdings [Lipton with Longhurst 1989; Bardhan and Mookherjee 2006; Lipton 2009, ch. 2; Eastwood et al. 2010]. Hence smaller, more equal farming is not only equitable, but also socially efficient, in SSA.

²⁰Simulations during the early GR showed that land redistribution would raise hired labour demand by 19-24% in Bangladesh, Pakistan, Thailand and the Outer Islands of Indonesia, but by only 8.6% in Java, where initial land distribution was less unequal and more dispersed among small farms, and initial labour use per hectare much higher [Booth and Sundrum 1985: 100-109, 279-80].

²¹Conversely smaller farmers face higher unit costs of borrowing and of managing equipment, and hence use less capital per hectare. This gives the large farmer some advantage in developed countries, with ample rural capital and scarce rural labour. That corresponds to the small farmer's advantage in developing countries, where (as a rule) higher labour/capital ratios are efficient because rural labour is in surplus and rural saving and capital scarce and costly. See Lipton [2009], ch. 2.

In a few parts of SSA, farmland is highly unequal. That reduces the poverty-reducing gain from agricultural growth, including yield growth and GRs. Even in such circumstances, smallholders eventually adopt the new inputs, and benefit from extra outputs. However, gains for the poor may be few: smallholders have little land and other critical resources, while largeholders play down labour-intensive approaches due to supervision cost. To obtain swift or large poverty reduction from agricultural growth, in a few SSA countries (such as Kenya and South Africa) substantial land redistribution into smallholdings²² is required. It is a challenge to address this in a politically acceptable way. Fortunately, in most countries of SSA, land is less unequal than in most of Asia (except China and Vietnam) and far less unequal than in Latin America. Hence SSA's GRs -if feasible - can combine growth, poverty reduction and human development, because small farms get higher yields than large farms by choosing more employment-intensive use of scarce resources. This needs supportive pro-poor policy, both through state action and through an 'enabling environment' so it pays private firms to provide resources for the smallholding poor (e.g. in irrigation management and in market access for outputs and fertilizers).

Sharply accelerated farm growth in SSA will have to come mainly from higher crop yields. This section has shown that - if feasible - such acceleration is the most promising approach to poverty reduction (via increased food access and employment income), as well as to economic growth. With due attention to the impact of agricultural change on health and education, GRs - again, if feasible - are the main hope for faster improvement in the very low human development indicators prevailing in most of SSA. Before turning to the key issue of whether this can be done and if so how, we summarize three sets of observations.

I. In low-income areas with 60-80% of labour on farms (most of SSA now, S and E Asia from 1950, NW Europe from about 1740):

(i) Human development (including health, nutrition, schooling and participation) normally first accelerated largely due to technology-based crop yield growth on smallholdings. This led to more productive farm employment, and higher food entitlements and security for the poor.

(ii) Fast economic growth and poverty reduction, needed for long-term human development, were kick-started by rising farm output, employment and productivity, especially for food on smallholdings; paradoxically, only this (not 'minerals or industry first') permits further human development by timely, sustainable and humane industrialization and urbanization.

II. In most of SSA in 2010-2060, as in most of South and East Asia in 1950-2000:

(i) Fast-rising farm and food output requires big rises in yield, with little extra cropped area.

(ii) Rising human numbers can worsen food insecurity and resource depletion. GRs bring productive workplaces, food, and soil nutrients to win space against these threats. By 2010 in most of SSA, the demographics are allowing small-farm growth to act more positively. Falling birth-rates are bringing a 30-50-year surge in the ratio of workers to dependants (sec. xx.) This is a 'window of opportunity' for poor people's employment and income, and

²²Despite its record in the USSR and China, collectivization still exerts fatal appeal in SSA. Where enforced, as in parts of Ethiopia and Mozambique in the 1980s, the record was terrible. Where a voluntary part of land reform, it was inferior to smallholder alternatives for 'human development' [e.g. Valente 2008].

for environmental management as population stabilizes [Eastwood and Lipton 2011]. Small-farm productivity growth is the best prospect to create the demand for labour that can turn opportunity into reality.

III. SSA can learn - positively and negatively - from Asia's smallholder-based GRs:

(i) Overall, irrigation/fertilizer-based food crop yield growth tamed the threats and realised the opportunity.

(ii) Sometimes this left big gaps (e.g. lagging regions and groups; nutritional issues) and worrying side-effects on human development (e.g. the effect of irrigation on malaria) and sustainability (e.g. groundwater depletion in the Indian Punjab, faster desertification in parts of China).

(iii) Massive, sustained, largely home-financed public spending on agricultural and institutional infrastructure, including research and irrigation - and appropriate incentives, regional policy and regulatory regimes - were needed for Asia's GRs and are starting in SSA.

B. What has happened to SSA farming? What does it produce now?

In the last 61 years SSA's population more than quintupled. In 1962-2008 alone, it rose 3.6-fold - while cultivated area rose only 52 per cent, slowing down after the early 1970s.²³ Thus, to maintain domestic supply of food staples per person, yields would have had to rise 2.4-fold. At all-SSA level, cereal²⁴ yields less than doubled, from 0.8 tons/ha to 1.5. Meanwhile South Asia raised yields from 1 to 2.6t/ha, and East Asia from 1.5 to 5.4t/ha.²⁵ Thus in 2007-9 Eastern Africa's cereal yield was only 1.53 times 1961-3 levels, Western Africa's 1.74 times and Middle Africa's 1.24 times. There is as yet little sign of an upturn in these regions. Since staples loom large in farm output, sluggish yields - alongside increasingly constrained growth of crop area and fast population growth - made SSA the only major region where farm output per person fell substantially from 1961-3 to 2007-9: by a quarter, while it more than doubled in South Asia and more than tripled in East Asia.²⁶ Despite a sextupling of SSA's net food imports between 1967 and 2005, food security suffered as falling farm output per person restricted the employment and income of the rural poor: malnutrition stayed stubbornly high (p. xx above).²⁷

²³Data in these paragraphs from <http://faostat.fao.org/site/377/DesktopDefault.aspx?PageID=377#ancor> and <http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor> (accessed 12:34 27/10/2010, 10:40 8/11/2010, and 17-28/1/2011) unless otherwise stated. All data are 3-year averages.

²⁴In 2008 cereals provided 50% of calorie intake in Eastern Africa (starchy roots 16%), 53% (3%) in Southern, 47% (18%) in Western and 33% (36%) in Middle Africa. In India it is 59% (2%). See Table 3. The proportions for the food-insecure are everywhere somewhat higher.

²⁵Data for starchy roots in SSA show even slower yield growth, both absolutely and relatively to Asia, but such data are everywhere problematic and in much of SSA of little value. In examining regional performance, we should probably concentrate on cereals yield.

²⁶The rises were 136% and 217% respectively. In SSA only Western Africa recorded a rise (8%) but data are even worse than elsewhere in SSA. Nigeria - with most of the region's crop area and output - reported maize area as exploding from 0.5m ha in 1980-82 to 5.3m ha in 1982-4 (a rise of 226% a year); and cassava, hardly less amazingly, from 1.5m ha in 1988-90 to 2.7m ha in 1991-3 (a rise of 22% per year). Cf. [ECE/Eurostat/FAO/OECD 2001].

²⁷This, alongside the explosion of net staples imports, confirms that staples output in the Western, Middle and Eastern regions of SSA did *not* grow much faster than the data series suggest. We need such confirmation, because most SSA estimates of smallholder staples output are weak and unreliable.

To understand SSA's performance, it helps to look at an exception: South Africa. Its cereals yields tripled between 1961-3 and 2007-9 - better than South Asia, and not far behind East Asia.²⁸ This was a GR, based on large-scale, capital-intensive maize farming. Is it relevant for the rest of SSA? Not, of course, in its origins: it was initially made possible under apartheid by price subsidies, repression of African smallholder competition, and the focusing of irrigation, other inputs and research on fewer than 2 per cent of farm operators, part of a racially privileged group of white farmers with over 80 per cent of the land. Even if there had been no racial focusing, the resulting rapid growth in cereals yield - being based on artificial advantage for large, capital-intensive farms - is not an efficient use of scarce resources. Nor does it much advance the employment income, purchasing power, and hence food security of the rural poor. These are a majority of the poor even in South Africa, and hugely so in most other parts of SSA. There, the reliance of the poor on farm employment, the consequently high availability of farm labour relative to rural capital, and the much less unequal access to land, further diminish the relevance of South Africa's success. Indeed - partly because extreme land inequality leaves the poor with little land, so they find farm-work unattractive - South Africa has a rural labour shortage: agricultural workforce has shrunk rapidly in this millennium. Nevertheless, South Africa's striking yield performance is relevant elsewhere in SSA in two key respects.

- South Africa's maize yield surge depended partly on more, and better, water control, including irrigation; fertilizers; and research and delivery of new seeds. That was also the base of Asia's GRs, in hybrid maize as well as wheat and rice. It is feasible for many of SSA's mostly small-scale, labour-intensive farms.
- South Africa's maize surge shifted its nature after 2000. Maize area (4.3m hectares in 1961-3 and 4.9m ha in 1972-4) fell from 3.6m ha in 1999-2001 to 2.6m ha in 2007-9. However, yield - having risen at solid 'South Asian' rates, from 1.4 t/ha in 1961-3 to 2.5 t/ha in 1999-2001 - soared to 4.1 t/ha in 2007-9. In the 1960s and 1970s maize had spread to marginally-watered grazing areas; this was reversed, sharply so after 2000. This further raised yields, as did the spread of genetically modified varieties to about half the maize land; increased irrigation; and perhaps the concentration of maize on areas suited to low-till agriculture [Vink 2011]. Much of this does have lessons for staples production elsewhere in SSA. A shift of crops, especially maize (and above all of unfertilized crops) out of unsuitable marginal lands is widely needed to address soil nutrient depletion.

Why, for fifty years, have Western, Middle and Eastern SSA raised staples yields so much more slowly than South and East Asia (and Southern Africa)? It is often asserted that SSA missed out on the GR largely because it grew the wrong crops. Most of Asia grows and eats mainly rice and wheat, where semi-dwarf, highly fertilizer-responsive varieties transformed cereals yield; SSA's main staples are maize, millet, sorghum, cassava, bananas and plantains. However, Asian maize, and even millet and sorghum, yield trends - and the spread of

²⁸Cereals *area* fell sharply in South Africa due to shifts towards higher-value crops, but rose elsewhere in SSA due to population pressure for food, plus sluggish yields. So, despite Southern Africa's much better *yield* performance, its cereals *output* (in constant 1999 international dollars) fell from 21% of the combined output of West, Middle and Eastern Africa in 1961-3 to 12% in 2007-9. (In both periods South Africa produced over 95% of both cereals and agricultural production in Southern Africa.) [<http://faostat.fao.org/site/612/DesktopDefault.aspx?PageID=612#ancor> accessed 03:24 17/2/2011]

maize hybrids in Kenya, Zimbabwe and South Africa - testify that yield breakthroughs have spread far beyond rice and wheat (Table 6 below). In Asia, local GRs have spread from country to country, area to area, year to year, and crop to crop. In most of Western, Eastern and Middle SSA, such progress has been less durable and extensive. Yield growth *in each major staple*, including coarse grains, roots and tubers, has been much slower since the early 1960s than in most of Asia.²⁹ Further, in 1965-85, when rice and wheat showed faster yield growth than other crops in Asia, farmers shifted land into these crops, away from pulses, millet, sorghum and maize. Such shifts also happened towards hybrid maize in Kenya and (colonial) Zimbabwe in the 1960s, but recently, with a few possible exceptions,³⁰ have been rare in most of SSA. This was partly because of limited access to high-yielding varieties or complementary fertilizers. Shifts to improved varieties of new staples for sale to cities - away from traditional crops for local consumption - may also be reversed for another reason. In Ethiopia the high-yielding 'Sassakawa' maize hybrids replaced much traditional teff and enset in Wollaito province in 1996-8, but the maize output price collapsed when the sudden surpluses could not be moved swiftly to deficit regions due to poor transport; much land then reverted to traditional crops for local use. Similar sequences have been widely reported in SSA.

The nature and course of farming in SSA's regions appears in tables 4-6, with appropriate Asian comparators.

Table 4 shows the 2007-9 allocation of farmland among main crop groups - together, typically occupying about 90% of cropland - in Eastern, Middle, Southern and Western SSA, and (for comparison) India. Table 5 shows gross 'real' output (in dollars of 1999-2000) of crops, agriculture, and cereals in 1961-3 and 2007-9, for main SSA regions and (for comparison) Southern and Eastern Asia. Table 6 shows how yields and areas differ among main staples crops, and as between 1961-3 and 2007-9, for these regions. These data are reported by governments (and standardized by FAO), but must be treated with great caution, especially for yields of staple crops on smallholdings.³¹

We give some general observations for 2007-9, before using tables 4-6 to discuss changes in SSA farming.

- Crops provided over 80% of gross farm output value in Middle and Western Africa, and over 70% in Eastern Africa. Partly due to tsetse, only in Southern Africa (51%)³² do non-crops, mainly livestock, loom large. The role of crops for poor people's income and nutrition, and hence for human development, is even greater than these numbers suggest: the poor can seldom lock up capital in cattle, and not often in

²⁹Of claimed recent exceptions, Nigeria's cassava 'revolution' is based on questionable data (n. 27), and the spread of 'New Rice for Africa' (NERICA) - a cross between West African 'red rice' (*Oryza glaberrima*) and Asian semi-dwarf varieties - has been slow [CGIAR 2008]. In SSA the course of nutrition and net staples imports seldom supports claims of major, widespread yield breakthroughs.

³⁰Some (rather weak) data suggest recent shifts into higher-yielding Nerica rice and cassava varieties resistant to tobacco mosaic virus and spider mite.

³¹ See n. 27. Most Asian countries have long estimated staples yields through fairly reliable, cross-checked crop-cutting sample surveys. In SSA, farmers' reports soon after harvest can, with careful interviewing and calibration, yield at least as reliable results [Verma et al. 1988], but most countries, including several of the main farm producers (DR Congo, Ethiopia, Nigeria, Sudan), lack trained, supervised, motivated cadres to gather and process smallholder staples yields. Such data, especially over short periods and for single countries, are of very limited value in most of SSA absent external supporting evidence.

³² Data are for *gross* production, but results for agricultural production net of inputs are very similar.

poultry; animal products (even fish) normally form a very small part of diets affordable at or below the poverty line.

- The crop groups in Table 4 comprise three groups of staples grown mainly for family and local consumption (cereals, roots/tubers, banana/plantain); and five groups of crops mainly, and one (fibres) wholly, sold for cash.³³ Throughout SSA (and Asia) these nine groups usually cover over 90% of harvested cropland.
- Harvested area in these nine crop groups in Western Africa (91m ha) exceeded area in the rest of SSA combined (Eastern Africa 59m ha, Middle Africa 16m ha, Southern Africa 6m ha). This contrasts with data for economic actives in agriculture, where Eastern Africa (108.3m) exceeded the combined total of Southern (2.3m), Middle (28.4m) and Western (46.3m) Africa. This last figure is at least 30m too low, due to an underestimate for Nigeria (Table 3 and n. 3), but Eastern Africa's much higher labour/land ratio is striking.
- Of area under the nine main crop groups, in 2007-9 cereals occupied about half in Middle, Eastern and Western Africa (as in India), and in Southern Africa two-thirds. Yet cereals comprise barely a tenth of crop value, gross or net, in Middle Africa, a fifth in Eastern and Western Africa, and 25-30 per cent in Southern Africa. This contrasts with one-third in Eastern Asia and 40 per cent in Southern Asia. SSA has much lower value-to-area ratios for cereals, relative to other crops, than Asia. One major cause - reflecting SSA's relatively low exposure to Asian-style cereal-based GRs - is that SSA (outside South Africa) lags far behind Asia in cereal yields, but less so for cash crops. One main consequence is that, since cash crops dominate farm value added, they have to be employment-intensive and smallholder-friendly if agriculture is to fulfil its pro-poor potential. GRs start with staples, but agricultural contributions to SSA poverty reduction and human development must encompass cash crops too.
- Non-cereals loom much larger in staples areas, volumes, and diets in Eastern, Western, and above all Middle Africa than in Southern Africa or South or East Asia. In 2007-9, area under roots and tubers was almost 60% as much as cereals area in Western Africa and about a quarter in Eastern and Middle Africa. Since yield in tons-per-hectare is 6-9 times higher than for cereals, the relative contribution of roots and tubers to nutrition, especially among the poor, was substantially higher - see Table 3 - even though each ton provides many fewer calories (and even less of other nutrients) than cereals do. In Eastern and Middle Africa, bananas and plantains add a further 13 per cent of non-staple area to the hectareage under cereals. Historically, a major cause of SSA's heavy reliance on non-cereal staples has been that they normally need less labour per 1000 calories than cereals. That accords with SSA's many past centuries of scarce rural labour per hectare. Then, too, the higher weight/value ratios of root and tuber crops mattered less, as local rural self-sufficiency left little need for long-distance food transport. Now, root and tuber de-

³³Data are scanty, but observation suggests that all main cash-crop groups are substantially - in Western and Middle Africa mainly - grown on farms below 3ha. So are staples, outside South Africa. There, exceptionally, over 90% of maize is marketed; but marketed shares of staples have been rising (with urbanization) throughout SSA. Even cassava, crucial for the poor because largely a subsistence crop left in the ground as a reserve, has shifted in Nigeria towards commercial operations linked to processing into gari. One cannot estimate the size of such trends because subsistence production data in SSA are so weak.

pendence sits uneasily with SSA's present realities: intensifying agriculture, diminishing spare land, urbanization.

Table 4. Main crop groups: area harvested (000 hectares, and as percentage of cereals area), SSA regions and India, 2007-9 (3-year average)

	Area harvested, 000ha, average 2007-2009					Per 100ha cereals, 2007-09: hectares of crop group stated				
	Eastern Africa	Middle Africa	Southern Africa	Western Africa	India	Eastern Africa	Middle Africa	Southern Africa	Western Africa	India
Cereals	27351	7421	4128	45451	100393	100	100	100	100	100
Fruit (excl. melons)	4186	1048	326	3208	5469	15	20	8	7	5
Roots, tubers	6277	4390	143	12876	2180	23	59	3	28	2
Banana, plantain	3595	860	9	1367	683*	13	12	(<.5)	3	1
Sugarcane	577	231	369	150	4864	2	3	9	(<.5)	5
Fibre	2039	417	24	1672	10595	7	6	(<.5)	4	10
Oilcrops	6332	301	835	13783	39073	23	2	20	30	39
Pulses	7536	1497	150	11858	22562	28	20	4	26	22
Vegs, melons	1084	589	132	2470	6520	4	8	3	5	6
Total main crop groups						215	220	147	203	190
Cereals (% of main groups)						46	45	68	49	53
Crls, rts/tbrs, bna/pl (% of main groups)						65	78	70	65	61

Source: FAOSTAT at <http://faostat.fao.org/site/612/DesktopDefault.aspx>

Table 5. Gross production (international \$M. of 1999-2001), SSA regions and South and East Asian comparators, 1961-3, 2007-9 (3-year averages)

	item	mn const. \$ 1961-3	mn const. \$ 2007-9	Growth of real output, % year 1961-3/ 2007-9
Eastern Africa	Agriculture	11572	33050	2.31
	Cereals	1859	5095	2.21
	Crops	8009	23814	2.4
Middle Africa	Agriculture	4127	9362	1.8
	Cereals	350	878	2.02
	Crops	3449	7517	1.71
Southern Africa	Agriculture	4567	10332	1.79
	Cereals	899	1643	1.41
	Crops	2163	5281	1.96
Western Africa	Agriculture	12166	49825	3.11
	Cereals	2094	8251	3.03
	Crops	10502	43263	3.13
Eastern Asia	Agriculture	76959	304539	3.04
	Cereals	27441	82921	2.43
	Crops	67223	289602	3.23
Southern Asia	Agriculture	69018	252942	2.86
	Cereals	22540	69279	2.47
	Crops	51712	171398	2.64

Source: FAOSTAT at [http://faostat.fao.org/site/612/DesktopDefault.aspx? Page II](http://faostat.fao.org/site/612/DesktopDefault.aspx?Page II)

Table 6. Yields (tonnes/hectare), SSA regions. 1961-3 and 2007-9, with South and East Asian comparators (3-year averages)

Crop		Eastern Africa		Mid Africa		Southern Africa		Western Africa		Eastern Asia		Southern Asia	
		1961-3	2007-9	1961-3	2007-9	1961-3	2007-9	1961-3	2007-9	1961-3	2007-9	1961-3	2007-9
Cassava	Yield (t/ha)	4.4	8.75	5.51	8.81	--	--	7.63	11.27	12.03	16.4	7.16	13.26
	Area (m ha)	2	2.9	2.2	3.5	>0.1	>0.1	1.5	5.7	1	0.3	0.3	0.3
Maize	Yield (t/ha)	0.99	1.35	0.74	0.94	1.33	3.78	0.78	1.73	1.2	5.32	1.09	2.54
	Area (m ha)	5.8	13.5	1.6	3.7	4.5	2.9	2.6	8	15.1	30.5	6.1	10.8
Millet	Yield (t/ha)	0.71	1.07	0.64	0.54	0.34	0.27	0.56	0.97	0.89	1.83	0.43	0.94
	Area (m ha)	1.6	1.7	0.8	1.2	0.9	0.3	8.9	16.3	0.8	0.9	19.4	21.2
Rice	Yield (t/ha)	1.74	2.14	0.91	0.94	2.09	2.39	1.01	1.71	2.73	6.5	1.55	3.37
	Area (m ha)	1	2.4	0.2	0.6	<0.03	<0.03	1.4	5.9	32.6	33.4	47.6	61.3
Sorghum	Yield (t/ha)	0.78	1.13	0.69	0.91	0.65	1.67	0.76	0.97	0.97	4.27	0.49	0.92
	Area (m ha)	2.6	4.4	1.1	1.4	0.6	0.2	7.6	14.7	6.8	0.6	18.8	8.2
Wheat	Yield (t/ha)	0.75	1.72	1.09	1.59	0.58	2.92	1.62	1.76	0.72	4.67	0.84	2.57
	Area (m ha)	1	1.8	<0.02	<0.01	0.2	0.7	<0.02	<0.05	25.6	24.3	24.2	46.7
Cereals	Yield (t/ha)	0.89	1.36	0.71	0.89	1.08	3.25	0.69	1.21	1.54	5.43	1.01	2.67
	Area (m ha)	15.2	28	3.6	7.4	6.8	4.1	21	45.4	99.2	91.6	120.8	141.8
Rts/tbrs	Yield (t/ha)	4.6	7.55	5.39	8.16	1.08	6.55	7.13	9.67	8.41	17.5	7.22	18.71
	Area (m ha)	2.8	6.3	2.6	4.4	0.1	0.1	2.9	12.9	12.7	9.2	1.1	0.5

Source: <http://faostat.fao.org/site/567/default.aspx#ancor> accessed 15:39 04-02-11.

Note: Underlined areas indicate crops covering over 2m hectares per year in a region in 2007-9

Building on these facts, we can now address what has happened in agriculture in the last 50-60 years in Eastern, Middle and Western SSA (tables 5-6), before turning to the implications for human development and for policy.

- Large rises in farm output have been achieved, close to South Asia's but below East Asia's - but much slower rises in some of the largest countries (DR Congo, Ethiopia).
- Unlike the situation in Asia, farm output rises have been much slower than population growth, or even rural population growth or the numbers economically active in agriculture.
- Third, again unlike South and East Asia, output rises have been achieved mainly by area increases rather than yield increases: this has become more the case over time, with worrying environmental results. Despite some claims, post-2000 staples yield trends do not improve on past performance [Hunt 2011], on either (weak) output data or (better) indirect data for net food imports and, from WHO, on malnutrition.
- Further, in nine aspects of farm practice, the balance in most of SSA is very different from that of Southern or Eastern Asia.³⁴ These features are only to a small extent explained by SSA-to-Asian differences in agro-ecology.
- While common cultivation is rare in SSA and Asia alike, common tenure without title (but with family rights supported by local sanctions) is much more widespread in SSA, applying to over half the cropland.
- Most cropped area is unfertilized in SSA, but fertilization has been long the norm in Asia - for centuries mainly with natural manures, which are still much used, but increasingly with inorganic fertilizers.
- Water management, while practised by SSA farmers when they can, seldom uses either methods traditional in Asia (and North Africa, including the Sudan) - e.g. hand-pumped groundwater, animal-lifted surface water - or modern irrigation, which accounts for well over 35% of cropped area, and most farm output, in South, East and West Asia, but barely 3 per cent of cropped area in SSA.
- Most of SSA has for centuries been mainly hoe-cultivated, with little animal ploughing in many areas; recent decades have seen direct, in some areas rapid, transition from hoes to fairly large tractors. Animal ploughing remains widespread in Asia, with little hoe-ploughing, and transition, almost complete in the most developed agricultural areas, to tractors, often in the form of small mechanical cultivators.
- Shifting cultivation - ley systems with alternated years (or more) of crops and grazing, and long fallows - while retreating, are still found in much of SSA. Data are scarce, rough and oldish, but around 1984 over three-quarters of cropland in West Africa was in shifting cultivation or rotational woody-bush or bush-grassland fallows, rather than permanent or floodland cultivation or mixed farming [FAO 1984?].
- Intercropping is much more widespread in SSA,³⁵ and may be farmers' principal means of reducing weeds and insect pests - in Asia still widely done by hand-weeding and manual control of egg masses, but increasingly by agrochemicals and selection of appropriate resistant or tolerant plant varieties.

³⁴South Africa is distinct from both. Some other SSA countries, such as Ethiopia, are in some ways closer to Asian than African agro-technical norms.

³⁵In the 1980s intercropping provided 80% of SSA's bean production [Cardona 1990], about half SSA's cassava production [Leihner 1983: 6] and in Malawi 94% of total cropped area and 94% of maize production [Ngwira 1990: 154]. Only for maize would one expect significantly lower proportions in 2011.

- Crop varieties are also commonly mixed, and are often land races rather than formally identified varieties.
- As indicated, crop-mixes differ substantially. Farmers (especially smallholders) in most of SSA have long had somewhat higher proportions of acreage, and of crop value than Asian farmers in: staple crops; non-cereal staples (cassava, banana, etc.), as against cereals; crops consumed in the household, or nearby, as against crops marketed to the city, or for exports; and local or minor crops such as enset ('false banana') and teff in Ethiopia, cocoyams in West Africa, and various fonio millets and minor vegetables.³⁶
- Not only such 'orphan crops', but all the above characteristics, lead to less research and extension (per unit of output or per hectare) in SSA than for the Asian norm: mainstream staples and cash crops, fertilized and often irrigated, unmixed in a single field, fully sedentarized farms, and individual tenure.
- Despite many exceptions, these are general differences between Asian and sub-Saharan African agricultures. The differences reflect rational - but now often outdated - individual and group responses to long farm experience of different economic circumstances and political systems. Except for the last generation or so, most SSA farmers have experienced rural labour shortage; an extensive margin of croppable land; small, remote and badly-connected towns; and polities and macro-economies offering almost no support in emergencies. Hence, in most of SSA, far more than in most of Asia, rural institutions evolved to support farming methods and systems that economize on labour use; expand land area readily; produce mainly for local or foreign consumption; and choose crops and farming systems more to cut and spread risk than to enhance yields. In the past one or two generations, the farming world, even in SSA, has become more 'Asian'. Populations and workforces have soared; land has got much scarcer; towns have greatly increased their shares of people, connectedness, and market demand; and polities and macro-economies have begun to provide basic emergency relief. However, rural institutions – and liked interests, powers and customs – built over centuries to support one sort of farming world often do not, over a single generation or even two, fully change to accommodate (for example) a doubling or tripling of labour/land ratios, and new global sources of radically different farm knowledge. South and East Asia have been facing for two millennia³⁷ conditions increasingly requiring intensification of land use, especially irrigation and increased fertilization, and focus of even staples production upon city as well as rural markets. SSA's much more recent encounter with such conditions accounts to a considerable extent for its slower progress and less advanced GRs.

In particular, only since about 1950, often later, in most of SSA - but in most of Asia slowly for 2000 years or more, and rapidly for at least 500 - have most rural families been moving

³⁶ Most SSA counties (conflict regions excepted) almost certainly show declining shares of area and output intercropped, non-marketed, comprising non-cereal staples, in orphan crops, and/or in shifting cultivation. This implies a shift from systematically under-estimated products, to products where mis-estimation is random. This imparts an upward bias, of unknown size, to estimates of farm output growth in SSA.

³⁷ Many irrigation works in South and East Asia, some (like the Giant's Tank in Mannar, Sri Lanka) still in use, are over 2,000 years old. Land levelling and sometimes terracing [Ishikawa 1968], needed to make irrigation pay, have been done long ago in much of Asia – as in Rwanda, but few other parts of SSA.

out of land abundance and labour scarcity, into the 'noose' of increasing labour abundance and land scarcity.³⁸ Yet in SSA that noose, though so recently felt, has been tightening faster than was the case in most of Asia, due to SSA's faster population and workforce growth, alongside sluggish non-farm and urban earning opportunities, and rapid natural-resource loss [Eastwood and Lipton 2011]. Long experience in SSA has led to the creation of capital - physical (land-water systems), institutional (tenurial, research, and input/output market delivery systems) and human (acquired farm knowledge) - suitable to land abundance and labour scarcity. Of course, farmers, service providers, and even politicians and administrators learn to adapt to the transition from land abundance to labour abundance.³⁹ But that takes time. And change is clogged by types of capital, institution, and farming custom built up over centuries - and creating, around them, people (including elites) that benefit from their continued provision and administration. Lagged and conflicted response to recent, rapid rises in person/land ratios - accompanied by lack of modern inputs - are the main explanations of the above 'SSA characteristics', but there are other contributory causes for many of them. For example, in many areas, tsetse prevents cattle ploughing and reduces access to manure; and plant intercropping remains a sensible response to many local pest-nutrient-water conditions. The challenge is to bring in scientific, smallholder-friendly and sustainable cropping methods in consultation with local farmers, responding to their specific needs, yet sufficiently rapidly to respond to rural Africa's crisis of low yield, resource depletion, and inadequate and low-productivity employment.

C. Explaining farm shortfalls in Middle, Eastern and Western Africa: scant inputs, underlying causes

Until late in industrialization, human development - through employment, nutrition and poverty reduction - normally requires that crop, especially staples, output (a) is accessible, through smallholding and to some extent hired farm labour, to the poor, (b) rises well ahead of population and workforce. In Middle, Eastern and Western Africa, (a) is largely met, but not (b). Uniquely among major world regions, food and farm production since 1950 has lagged far behind population growth. Why? What can be, and is being, done? Will it enhance human development?

Output rises must come from more land or higher yields. SSA's growing populations and workforces have found decent new land increasingly scarce. So output rises depend increasingly on yields. Yet main crop yields since 1950 have been much lower and more sluggish than in South and East Asia. That is because the median hectare of land in Middle,

³⁸Land abundance is access to extra, nearby land that can be brought into cultivation at low cost, and with subsequent returns to land, labour and capital not much lower (indeed sometimes higher) than on earlier, long-farmed land. Land abundance does *not* mean that rights in unfarmed land are absent, costless or uncontested. Labour abundance is availability of extra labour (family or hired) at incentives little, if at all, above those for existing labour.

³⁹Boserup [1965], partly based on West Africa, saw rising population as inducing a series of sharp, discontinuous farming intensifications, from settlement through long fallows to short fallows, sedentary farming, irrigation, and GRs. Tiffen et al. [1994] marshal evidence from Machakos district, Kenya, that terracing and water control can make even the later stages of such adaptation environment-friendly. However, as Boserup recognized, there are limits - and in any locality, or even in most cases, such adaptations may not be smooth, good for human development, or even feasible. Also intensification can and does happen with slow or zero population growth, and may be eased by the extra savings-per-person that this makes available [Lipton 1991].

Eastern and Western Africa receives below 5kg of main plant nutrients (NPK) from fertilizer, as against well over 100kg in South and East Asia. Rapid and sustainable yield increases with 5-10kg of NPK from fertilizer are, with few exceptions, infeasible.⁴⁰ Such low inputs compel farmers to survive by mining nutrients from old land without replacing them, and/or extending crops into forest and grazing land. Both paths are unsustainable. Nor are they made sustainable by high saving, which in Asia financed investment to replenish or replace lost natural capital [Eastwood and Lipton 2011]; in most of SSA saving and investment face unattractively low returns [Caselli and Feyrer 2007], largely because lack of farm progress impedes non-farm development and jobs.

Fortunately, African experts, institutions and governments are increasingly recognizing that the problem can be, and has elsewhere been, solved. As indicated, the proximate cause of low crop yields in most of SSA is grossly inadequate fertilizer.⁴¹ We first ask: why do farmers and deliverers - all seeking more income - not raise fertilizer inputs? What can SSA governments and institutions do to change this situation, and what are they doing?

Farmers need other appropriate inputs to make much more fertilizer worth using.

Controlled water: Absent reasonably secure, timely rain or irrigation, fertilizers often raise yields only modestly, and nitrogenous fertilizers may even 'burn' the crop. Absent drainage, much fertilizer will wash off.

Quality planting material: Tall straggly plants, like India's wheat and rice before 1965, turn much fertilizer into stalk, not grain, and may fall down if heavily fertilized. Seeds replanted from last year's harvest, especially of op-en-pollinated crops such as maize, lose vigour. High-yield, fertilizer-responsive maize hybrids are often intolerant of 'abiotic stress', e.g. slightly late rains.⁴² Plant varieties may fail to tolerate 'biotic stress' from insects, fungi and viruses; or at shading or competing with weeds. All this wastes the farmer's money if she buys a lot of fertilizer.

Responsive seed research systems: Pests evolve new biotypes to attack new seeds. That demands breeder-farmer co-operation to warn of new problems fast, and adaptive, funded national and local research to meet them.

Reliable information: Crops, varieties, water regimes and soils greatly affect best-practice amounts and mixes of nitrogenous, phosphoric and potassic fertilizer,⁴³ and distribution of applications between basal and top-dressing. Mistakes in such matters cost farmers dearer, as rising energy cost raises fertilizer prices. Yet agricultural extension – not much use when there is little to extend, but crucial to fertilizer management for a GR – is underfunded and often maligned; and in parts of SSA one still finds a standard compound fertilizer distribut-

⁴⁰Not because they cannot be achieved, but because almost no farmer will find achieving them worth the cost, risk and effort.

⁴¹In parts of West Africa (e.g. montmorillonite soils), organic manure must be added, to create enough humus for plants to absorb much extra nitrogen from inorganic fertilizer. Why don't many farmers, despite extension pressure, add much organic manure? Because there isn't quality planting material, water control, or inorganic fertilizer to make this hard, nasty work worthwhile. Gardeners know that 'green wars' between manure and fertilizer lobbies are ridiculous.

⁴²If so, SSA's almost wholly unirrigated semi-arid farmers will stick to lower-yielding, unfertilized, but safer maize (and millet and sorghum) varieties.

⁴³One lesson for SSA from Asia errors: high NPK fertilization and yields may require addition of micronutrients (e.g. zinc) to pre-empt soil depletion.

ed with public subsidy (or even direct supply) to farmers with widely differing crops, soils, and hence soil nutrient needs.

Deliverers, too, require appropriate inputs, if they are to provide fertilizers on time and at attractive prices.

Adequate road infrastructure alone can cut transport costs. Yet SSA's road density is as low as India's in 1950.⁴⁴

Joint action by small SSA countries to bulk-up, and to mitigate the effects of landlocking, is needed to cut unit costs of getting fertilizer from the point of import⁴⁵ to the farmer.

Hence *limited offtake*, due to the need to recoup costs through high prices to farmers, reduces (a) incentive to each supplier to obtain more fertilizer, (b) number of suppliers, perhaps offering farmers a choice of nutrient-mixes.

In most of Eastern, Western and Middle Africa fertilizer constraints on farmers - and low profitability for deliverers - are binding on yields, and hence farm output, work, poverty and human development. There are three ways for African governments, and pan-African institutions such as CAADP and AGRA, to lift this constraint.⁴⁶

- Semi-forced input expansion: Government-controlled farming is a dangerous chimera. Most countries, in SSA and elsewhere, have painfully learned to avoid it, but 'get the large to lead' is little less chimerical.
- The short cut: Asian and some SSA experiences show that subsidization can contribute substantially to initial expansion of fertilizer use if other issues are tackled too, but is dangerously addictive.
- The long path: for governments to address the main constraints now impeding farmer demand and deliverer supply of fertilizers: constraints on water control, plant research and extension, and market access. To create such an "enabling environment" requires more government action, not less; but the approaches of the 1970s - extractive marketing boards and government input delivery systems - will not work.

We now look briefly at these three options in the context of recent public-sector initiatives in SSA.

Semi-forced input expansion and centralized 'modernization' through State or collective farming is not a viable route to SSA's essential fertilizer-based transformation. The record of this approach is so terrible, its abandonment so universal - in SSA as well as in the former Soviet Union and elsewhere - as to need no rehearsal here. More attractive, perhaps, is leadership of input-based yield take-off in SSA not by the State as such, but by State empowerment of large commercial farmers through contracts and land rights [Collier 2008].

⁴⁴This also constricts demand for fertilizers: if they allow a farmer to produce output above local needs, she must incur high costs to market it.

⁴⁵Asian experience warns against early encouragement of import replacement in SSA. Economic fertilizer production normally requires capital-intensity and large scale, best achieved in rich economies. India's efforts at self-sufficiency in the 1960s and 1970s, far from supporting the GR, brought a big excess of fertilizer prices over import costs, with the gap borne first by farmers and later by burgeoning subsidies.

⁴⁶Despite occasional successes, neither low-external-input agriculture nor organic farming offers an alternative path to rapid and sustainable yield growth. Most African farmers have for centuries done LEI farming perforce; that's why output growth has fallen far behind population growth. Organic horticulture for niche export markets has its successes, notably in Kenya, but cannot meet the income and employment needs of more than a handful of the rural poor.

This covers not only foreign 'land grabs' [Cotula 2009] but also claims of success of large commercial farmers⁴⁷ with over, say, 500 ha in achieving fast, input-led yield growth in Zambia, Angola, Mozambique and elsewhere. The analogy to large-farm growth in Latin America, which has some agro-ecologies close to those found in Western and Middle Africa, is often drawn. However, leaving aside the fact that in Latin America it is small farmers who normally achieve higher yields [Lipton 2009: 70-71], there are special problems with the big-farm-led approach in SSA. Unlike Latin America - where in several countries fewer than 15% of farmers control over 80% of cropland - in most of SSA (and in all fifteen most-populous countries except South Africa) farmers with over 500ha control at most 5-10% of cropland. Input-led yield breakthroughs on these holdings, while very welcome, would not transform their countries' agriculture unless smallholders were willing and able to follow. This is impeded because 500-hectare farms not only have better access to inputs (and to subsidizing politicians) but also choose much more capital-intensive methods, often unsuited or uneconomic for smallholders. These methods, moreover, mean that large-farm-based, input-led transformation of farming in SSA, even if it worked, would not address the key human-development issue: how to provide decent labour income to a poor workforce, currently over 65 per cent engaged in agriculture, and growing at over 2% per year until 2040-50 (see part xx). This is less relevant to Latin America, where in most countries, and all the most populous ones, fewer than a quarter of the workforce gets income mainly from agriculture. In SSA a path for agriculture, even an input-based yield transformation, begs the question if it fails to 'transform' income from land and employment, and thus basic food entitlements, for the mass of the poor.

Subsidizing inputs: The GRs of South and East Asia in the 1960s and 1970s were led by subsidized fertilizer, irrigation, farm power (manly for tubewells), and credit – all to incentivize the poor farmer⁴⁸ to use much more such inputs, in support of initially unfamiliar rice and wheat varieties that responded much better to them. The approach was rejected as market-distortive in 'the Washington consensus' of 1980-2000. Since then, however, 'smart subsidies' for selected farm inputs have made a comeback, especially in SSA. Malawi's fertilizer subsidy programme avoided many of the leakages and distortions of past programmes, and is partly responsible for three years of substantially increased smallholder maize output and fertilizer use [Dorward and Chirwa 2010]. While the assumptions underlying market-fundamentalist opposition to farm input subsidies are unacceptable, some cautions are needed. In other cases in SSA, such as Kenya, it was fertilizer market liberalization (alongside roadbuilding to improve market access), not subsidies, that raised smallholders' fertilizer uptake – and in both Kenya and Malawi small-unit packaging was crucial [Hunt 2011: 19-21]. Subsidy provision is a fiscal burden, and sets up strong vested interests against future reduction. In India, subsidies, in the 1960s justified to kick-start the GR, have become politically untouchable, drawing scarce agricultural funding away from investment such as irrigation maintenance and research/extension. In China, subsidy to nitrogenous fertilizers – initially justified to increase offtake – has been retained long enough [Hui Liao 2008] to encourage gross, environmentally risky overuse in some areas. None of this, however, weakens the strong case for short-term subsidies to increase initial smallholder

47Often these are former commercial farmers from South Africa, Zimbabwe or sometimes South America.

48In the early years of the GR, large parts of such subsidies leaked to 'bigger' farmers (which in most of South and East Asia means above 10ha, not above 500ha!) but later it was smallholders who used more fertilizers-per-hectare.

offtake of unfamiliar inputs, especially fertilizers, in cases in SSA where they support fertilizer-responsive new crops or varieties. But they cannot work if planting materials and water conditions militate against fertilizer uptake. And, even if they do not, there is a real withdrawal problem.

The long route: This requires public action and finance to correct the gaps in information, infrastructure and policy which undermine incentives to fertilizer use – action and finance for seed research and extension, water control and management, physical and institutional infrastructure, and market access. Both public sectors and donors have increasingly pledged such action since about 2000, but the action (and finance) themselves have been slower and more fitful. The rhetoric is set to reverse the slow collapse in 1980-2003 in public support for SSA farm yield growth. The reality is beginning to follow.

D. What can be done? What is being done? African agencies, governments, and donors

Pan-African and regional agencies: Two major pan-African agencies are seeking and supporting commitments from African governments. The **African Union's Comprehensive Africa Agriculture Development Programme (CAADP)**, at a meeting of African Ministers of Agriculture in 2003, obtained support for the Maputo Declaration: a general pledge to raise agriculture's proportion of public expenditure from the then typical level of 5% to 10%; yet the typical share of public expenditure going to agriculture in the mid-1960s, at the dawn of the GR was over 20% [Lipton 1968] and only a handful of SSA countries has so far met even the 10% commitment. In January 2011, Zambia became the 24th country to sign a specific 'compact' detailing to CAADP how that commitment would be met [Agricultural Consultative Forum 2011]. However, only twelve countries have produced investment plans, and apparently only three (Gambia, Ghana and Rwanda) have completed preparations [CAADP 2011: 1] needed for CAADP to undertake its next task, also agreed in 2003. This task is to turn aid offers into on-the-ground agricultural investment by matching them with at least as much domestic funding for agricultural investment to strengthen four "pillars": land-water management, food supply and reduced hunger, market access and agricultural research. Substantial aid has been pledged to support these pillars, notably by USAID. However, progress reports [CAADP 2011 and documents therein] focus on process – roundtables, compacts, etc. Eight years after Maputo, one can learn little about investment in progress, perhaps because much of it, especially for the big-spending 'land-water management' pillar, needs regional co-operation. Commitments, by African countries and by donors, often cannot be disbursed until countries in a region have completed their preparation, leading to a regional compact.⁴⁹ The great strengths of CAADP are its rooting in African governments and (to some extent) civil societies, and its support for all the main requirements of rapid farm progress in Africa. Its corresponding problem is that many activities apparently must move at the pace of the slowest member.

⁴⁹Under Pillar 1, the TerrAfrica Initiative has mobilized US\$1 billion for investment in country programmes for sustainable land and water management through the Global Environment Facility (GEF) Strategic Investment Programme. Initially, GEF provided US\$150 million; a further US\$900 million was invested by the Initiative. The design of country programmes and disbursement of funds is *already under way* [CAADP 2011] Pillar 1: Land and Water Management, updated to Jan 2011, at <http://www.caadp.net/pillar-1.php> accessed 10:45 24-2-2-10. My italics.)

The **Alliance for a GR in Africa (AGRA)** has more limited aims. Its funds are smaller and less 'African' than CAADP's - mainly a grant from the Bill and Melinda Gates Foundation - but its staffing and accountability structure are clearly Africa-centred. It is easy to identify AGRA's work on the ground: mainly to expand research support, usually for plant breeding. The list of ongoing grants for 2007-13, mostly below \$2 million each, is focused and specific [AGRA 2011]. By early 2009 \$84 million, or over a quarter of AGRA receipts, had been granted to 13 countries to deliver improved varieties and inputs. AGRA's Programme for Africa's Seed Systems has 4 main sub-programmes: Agro-dealer Development, Education for African Crop Improvement, Fund for the Improvement and Adoption of African Crops, and Seed Production for Africa. In Mali, Malawi, Kenya, Tanzania, Rwanda and Nigeria, AGRA promotes credit provision through local traders for seed and fertilizer purchase in packages of 1-5 kg, substantially reducing the distances that farmers must travel to buy these inputs. Credit is funded with bank loans and credits from agri-business, and AGRA guarantees the loans [Hunt 2011].

AGRA, CAADP, several UN and CGIAR bodies, and many other regional institutions - being explicitly, though not exclusively, committed to focus on smallholders and staple crops - can help SSA agriculture towards human development goals. Such institutions play two main roles. First, they can capture scale economies, which in some policy areas (notably crop research) inhibit SSA's many small countries from spending large sums. Second, pan-African and sub-regional bodies can help deal with cross-border interactions, planning requirements, externalities and tensions, for example in water basin development. However, so many of these institutions have been started, with overlapping remits and memberships, that they can create fresh losses in the very areas - scale economies and cross-border effects - where they are, in principle, best placed to provide 'international public goods'. In any event, only national governments and civil societies can undertake the main public actions required to support agricultural development, and to provide briefing and backing for cross-national institutions.

Mainly national action: planting materials and research

Heavy fertilizer use, vital to rapid agricultural progress, pays only alongside decent planting materials. Self-protection and corruption apart, governments seldom do things that their people do not care about or demand. Why do so few SSA farmers demand radically improved planting material from formal supply systems?

What farmers demand is sometimes illustrated by what they steal (all professions have their dishonest minorities). Crop varieties in the field at agricultural research stations are often vulnerable to theft. India's Punjab Agricultural University, Ludhiana, and Sri Lanka's Agricultural Research Institute, Peradeniya, are so renowned for releasing steadily improved varieties that they sometimes face theft, for on-farm planting, of experimental varieties, not fully tested but rumoured to perform well. Sierra Leone's Rice Research Institute, Rokupr, in the 1980s and 1990s had a different theft problem. RRI had scant and unreliable government support. Researchers could seldom visit field plantings. Farmers came to assume that the RRI could not deliver well tested improvements. Their thefts were for food, not planting material [Lipton 2008]. Critical to developing a successful country-level GR is farmers' experience and expectation that researchers will be trained, enabled and incentiv-

ized to deliver seeds sufficiently improved to meet farmer needs with more profitable and safe varieties, and to respond with timely new ones to new pest biotypes. Otherwise there will be neither trust in new releases nor political support for finance to research them. That is why – though farmer demand for seed research was a critical component of Asia's GR - in much of SSA farmers have come to expect low research performance, due to decades of scanty, unreliable funding. If governments 'get religion' and start to favour agricultural research, they have a hill to climb to persuade farmers that the results are worth having. Why has such research in SSA not, so far, done the persuading?

Varietal and related research in SSA, as elsewhere, has shown high economic returns, not decreasing over time [Alston et al. 2000]. But SSA has had too little. Total expenditure in SSA in 2000 was \$1.46 billion (2000 prices), some 6 per cent of global agricultural research expenditure, about a quarter of it in South Africa, and about a third donor-funded. [Pardey 2007]. 'Worldwide, [in 2000 prices] public investment in agricultural R&D increased by 51% ... between 1981 and 2000 ... to \$23 billion ... It grew faster ... the developing world ... [but in SSA it] remained largely stagnant' [Lele et al 2010: 53-4]. This situation, which is not markedly different today, leaves Eastern, Middle and Western Africa with far lower publicly supported⁵⁰ agricultural research, per agricultural or crop hectare and per farmworker, than any other region in the developing world. This was not so in the 1980s, but quality and support, then as now, were weak [Lipton 1988]. As for quality, in 2000 only a quarter of SSA's estimated 12,224 full-time equivalent researchers held doctoral degrees. As for support, real spending per scientist – already well below Asian or Latin American levels in 1971 - halved between 1971 and 2000 [Pardey 2007].

Agricultural research is an area where donors – private (like the Gates Foundation), public, and multinational – have shown real preparedness to support SSA, especially since 2000. However, SSA governments finance over two-thirds of varietal, and related, research, and (like regional and pan-SSA institutions) are increasingly willing to spend on it. Can they learn from its role in Asia?

First, it was **adequately and reliably financed systems of maintenance breeding**, perhaps more than breakthroughs that made and sustained Asia's GR. The GR did require breeding breakthroughs, above all short-strawed cereals that responded to heavy fertilization without falling over, turned them into food rather than stalks, and thus boosted yield per hectare and per litre. Other changes in plant architecture improved, for example, plants' response to changing day length and cloud cover. This delivered - with proper backing, and researcher-farmer communication – a series of staples varieties that (a) in conjunction with substantially increased fertilizer use, doubled or tripled smallholder yields over huge areas, (b) attracted smallholders through better profits and security - and (c) were then spread to new areas, and secured, by maintenance breeding against successive new pests and soil/water threats. The breeding breakthroughs do have analogues in SSA: SR-52 hybrid maize and its successors in Zimbabwe and Zambia; cassava varieties, especially in Uganda, resistant to mosaic virus and spider mite; perhaps the NERICA rices in West Africa. However, too many SSA breakthroughs have not been sustained. The Asian experience shows is

⁵⁰Over 90 per cent of agricultural research in developing regions – over 97% in SSA (excluding South Africa) – is publicly funded.

that a sustained GR demands maintenance breeding, to meet farmers' varying and changing needs, new locations for the crop, and evolving pests.

Second, though SSA and many countries within it stretch across several agro-ecologies and many microclimates, Asian and some African experience shows that this does not rule out **wide-application varietal research**. Successful crop (and other) science seeks results with wide application: finding a different variety ideal for each tiny watershed and agro-ecosystem is infeasible. Some key GR varieties – SR-52 hybrid maize, Sonalika (Mexipak) wheat, IR-20 and IR-64 rice – spread fast and far, demonstrating 'farm appeal' well beyond their recommendation domain, because they were tough against pest and weather conditions.⁵¹ Moreover, the 'Borlaug principle' has been well confirmed: a variety that yields well in many different environments is, other things equal, much more likely to be robust against variations (e.g. in temperature or pest regimes) in any particular environment where it has shown good performance. This is one of the justifications for the costly policy in India and elsewhere to submit all proposed new varieties, after testing against major pests and diseases in the research stations, to *nationwide* trialling; that allows selection for release of varieties meeting Borlaug's criterion.⁵² In small countries of SSA, cross-border agreements for multi-country trialling are valuable.

Third, though 'one size fits many' is often good research strategy, it needs complementing in order to **respect the need for biodiversity**. Around 1995-2000 a single variety, IR-64, was almost the only rice in many large areas, occupying, in some seasons, over half of Asia's riceland. This could not have happened unless IR-64 was not only high-yielding and adapted to many agro-ecologies, but also with fairly durable resistance, or tolerance, to main pests. However, new biotypes can present – and have in the past presented (e.g. in 1972 to maize in the Americas and, as tungro virus, to rice in SE Asia) – sharp and unexpected threats. Capacity to meet them with new cultivars, fairly rapidly, is essential. This makes the case for (a) good collections of rice varieties and wild relatives - huge areas of rice in Asia would have been wiped out by grassy stunt, if IRRI had not traced resistance – absent in rice, *O. Sativa* – to a long-collected variety of a wild relative, *O. Nivara*; (b) breeding for moderate resistance or tolerance, so as to reduce the evolutionary 'incentive' to the pathogen to select new, virulent biotypes – especially with less biodiverse post-GR plant populations; (c) where a desired characteristic depends on other single genes, to introduce alternative genetic sources. This often requires transgenics. Rice dwarfing was almost entirely dependent on a single dwarfing gene (from rice in China, Taiwan) until a new gene, obtained from wheat, was transgenically introduced into rice at the John Innes Institute in 2002.

Fourth, **national research and extension systems need to interact with farmers** (e.g. through participatory breeding programmes), and to adapt GRs accordingly. In Sri Lanka, after success in the Dry Zone followed by levelling off of yields, a policy shift towards Wet Zone crops in the 1980s was initiated by national researchers' findings and re-

⁵¹ IR-20 rice spread even to typhoon-prone areas of Bangladesh, because its shortness resisted gales [Lipton 1989].

⁵² The policy also allows recommending varieties for agro-ecologies where they show unexpected benefits, i.e. extending recommendation domains. National trialling, however, should not be made a reason for blanket rejection of varieties that do exceptionally well over a limited agro-ecological range.

sponses to farmers' representations. Integrated national research-and-extension systems are vital in GR spread. It is fashionable to stress that innovations dramatically raising farm profits or safety spread themselves, mostly farmer-to-farmer. However, it was the Indian districts with more experience of, spending on, and penetration by conventional extension workers and systems in pre-GR times - when such systems could supply only modest gains to farmers – that later spread GR seeds and fertilizer/management practices faster [Evenson and Kislev 1976].⁵³ Also, well managed extension systems can help to correct the anti-poor, anti-small bias in initial spread of new seeds and practices. The gradual entrenchment, often during fiscal pressures, of poor status, pay and incentives in extension services - and (as in Sierra Leone in the 1980s) the politicization of postings and promotions - slows and maldistributes benefits from GR innovations in many countries, Asian as well as African.

Fifth, Pardey [2007] emphasizes the very low salience of universities in agricultural research in SSA. Some agricultural universities were instrumental in advancing NARESs in India and other Asian countries. Not all worked, and of the successes not all are applicable across Asia, let alone SSA. But the tools for developing successful NARESs, and the lessons from successes and failures in Asia's GR, requires attention.

Fifth, a human-development focus requires more integration of nutrition into agricultural research. And SSA can learn from Asian errors. As GRs accelerate varietal change, it is feasible and desirable to screen – and sometimes to cross - new cultivars for higher levels of bioabsorbable iron, zinc and provitamin A. The severity and prevalence of anemia in West Africa makes high-iron staple foods of extreme importance, especially for pregnant women. More generally the implications of varietal choice for health and nutrition (as well as plant yield and robustness) need representation in both policy processes and research institutes. The very slow decline of child stunting and underweight-for-age during the GR in North India, despite rapid agricultural growth and considerable poverty reduction, would have been faster with better integration of nutritional and agricultural research staff and planning. Kesari dal (*lathyrus sativus*) lentils are robust and rather high-yielding in drought-prone areas, and after being largely eliminated in Bihar, India, spread into Ethiopia; so did increased incidence of lathyrism.

Sixth, GR plant researchers - even more so during climate change - should work with soil and water scientists and economists, and adapt recommendations to anticipate impacts of varietal and crop choices on soil-water sustainability. Although the GR avoided much more environmental damage in Asia than it caused,⁵⁴ it could have done far better with less compartmentalized research. In much of North India and Pakistan, GR wheat-rice double-cropping and subsidized water/tubewell regimes brought widespread salinity, waterlogging, non-recharge, and drinking-water pollution. While wise warnings before the event were many, incisive interdisciplinary research was rare. SSA can improve on Indian and Chinese performance here, by early integration of GR research with natural-resource disciplines, especially hydrology, and with soil-water resource economists.

⁵³ R. Evenson and Y. Kislev, *Agricultural Research and Productivity*, New Haven: Yale, 1976.

⁵⁴By reducing water, nutrient and pesticide needs per 1000 staples calories; and by mitigating the pressure to expand cropping into marginal lands.

Finally, the GR in Asia required **well-functioning systems for distributing plant materials**, and, as in SSA, was often held back by their inadequacy.⁵⁵ Governments can sometimes work with seed companies to ensure access to improved seed: note the contrast between disappointingly slow diffusion of NERICA rice in West and East Africa [CGIAR 2008] and the much faster uptake of a rust-resistant pearl millet hybrid (HHB67) released in southern India in 2007, with seed companies involved in 'aggressive marketing' from the outset.⁵⁶ In Kenya, where the main maize surplus areas have relatively good infrastructure, big seed companies have been involved in the introduction, also in 2007, of a striga-resistant maize hybrid.⁵⁷ Such involvement is less likely where growing conditions and/or market access are less favourable: there, initial efforts to kick-start markets in farm inputs and services (knowledge, credit, insurance) must be largely public-sector, with inputs also from NGOs and civil society.

National action: water control and irrigation

The differential adoption of fertilizer and HYVs, and the differential success of the GR in Asia and SSA, is substantially due to differences in water control. In Asian countries in 2008, typically 35-40% of cropland was irrigated; in SSA, 2.6 per cent – if we exclude South Africa, Madagascar and the Sudan, barely 0.7%. CAADP's welcome "first pillar" initiative and fund-raising recognize that, as in Asia [Ishikawa 1968], land-water development must normally precede major farm intensification. Yet many African governments seek to reduce agriculture's water offtake, so as to accommodate the water demand from urban and residential expansion, mining and industrialization. This requires rethinking. First, to use water is not necessarily to use it up, nor to divert it from other uses: with sensible drainage and attention to water quality, much water used by crops later recharges surface or groundwater systems and can be used again; and much river water, if not used by farmers, would flow into the sea. Second, while efficient water use matters, in agriculture as elsewhere, GRs normally mean more crop per litre. Systems and incentives for water control in semi-arid areas (irrigated or not) should be designed and implemented to this end: but more crop per litre may well make it efficient, in water terms and overall, to use more litres rather than fewer for irrigated farming.

Third, few countries with 0.7% of cropland irrigated will enjoy GRs any time soon, even though:

- The GR has reached rainfed cropland in much of Asia, and can in SSA. Many unirrigated semi-humid and humid areas have enough water, and prospects to control water and drainage, to benefit eventually from a GR.⁵⁸

⁵⁵ This paragraph (including notes) draws on Hunt [2011].

⁵⁶ Regional harmonization of seed regulation would enable seed companies to market seeds that are "allowed" in more than one or two countries.

⁵⁷ *Striga* affects 3.6 million hectares in Kenya and can lead to yield losses of over 30 percent. It is difficult to control, especially on poor soils. A partnership between AATF, BASF, CIMMYT, national research stations, local seed companies, NGOs and farmers has contributed to the development of 5 cultivars of imazalinalone-resistant maize, coated with the herbicide imazapyr, with over 15,000 demonstrations already implemented [Hunt 2011].

⁵⁸ Though irrigation is usually needed to double-crop - and it is dry-season irrigated production where GR yield gains in Asia have been fastest.

- In much of SSA's cropland (as of Asia's) irrigation will never be economic, or necessary, or in some cases feasible. Wide-impact GRs need to allow some of these areas, too, to enjoy big rises in per-hectare fertilizer use and hence crop yields.

However, the spread of GRs to unirrigated areas in Asia almost always happened after breeders and farmers pioneered green-revolution innovations on irrigated land. Rapid varietal, fertilizer, and yield enhancement in rainfed areas in Asia usually involved adapting - sometimes adopting - cultivars that had first proved their worth in more predictable, lower-risk irrigated conditions. African countries with less than 5-10% of cropland irrigated will find few farmers to take the initial risks of much higher fertilization alongside new, fertilizer-responsive varieties.

Global warming and resulting increased evapotranspiration will make water even scarcer in future, but this is not an argument against controlled irrigation. Climate change raises crop prices, not only water scarcity. It raises incentives for farmers (and irrigation managers) not to waste water by providing it free or heavily subsidized, as in Sri Lanka where scarce, but ludicrously underpriced, dry-season irrigation water is overused to drown weeds; and not to neglect recycling and drainage.

Thus SSA can learn much from Asia's failures and successes in irrigation for GRs. The failures of management and maintenance, which threaten the sustainability of much surface- and groundwater irrigation, are only now, and painfully, being remedied. However, the main lesson of irrigation in Asia is its success not only in initiating farm growth through GRs, but in reducing poverty. This is in large part because in Asia the proportion of irrigated cropland is higher on smaller farms, raising income both for poor farmers and (due to labour-intensive operation) for farmworkers. In eight Asian countries, command areas of major irrigation systems enjoyed much more rapid poverty reduction than nearby unirrigated, but otherwise comparable, areas [Hussain 2007; Lipton 2007]. Such irrigated land as exists in SSA tends to be on larger farms (South Africa, Kenya, Sudan, Niger Delta). As SSA expands irrigated area - as is needed for GRs - stronger smallholder-orientation is required.

Regional equity is a further human-development issue where Asia's irrigation experience is important for SSA. Agriculture (and much else) has not taken off - and poverty has not fallen sharply - in unirrigated areas of NW and SW China, and of India's East-Central 'poverty square'. Where such areas contain a small minority of the population of an otherwise booming economy, migration from them is a conceivable solution, but much less so where a country has very little land is irrigated and slow non-farm progress. Farming in some of these areas has inherently low productivity, but others have simply been neglected in public research and irrigation activities. These areas, in both India and China, by the 1990s offered higher economic return (as well as more poverty reduction) per \$1000 of new irrigation investment than did the 'lead areas' [Fan and Thorat 2000, 2000a]. Some of the poorest areas of South Africa (Eastern Cape), Nigeria and Ethiopia contains many water bodies with few obvious non-farm uses and apparent irrigation potential. The Asian experience is that supply of irrigation - private or public, major or minor - can be pro-poor and sustainable, as well as kick-starting GRs.

Market access and market development

Much more fertilizer use is needed for GRs – and indirectly for any leaps in human development – in SSA, but this depends on markets that get fertilizers to farmers, and food to consumers, without huge costs or losses. This requires, above all, remedying SSA's extremely low levels – per hectare of cropland, per person, and per unit of farm output – of rural feeder roads, railways, and (less familiarly) warehousing capacity (for data see [Omamo 2009, cited in Hunt 2011].)

Appropriate policy for enhancing input markets⁵⁹ varies according to local conditions. In Malawi since 2006, where fertilizer markets were seriously underdeveloped, subsidies - to encourage farmer innovation and reduce risk - were organized to support development of the private sector, through an expanded role for private traders in input and credit supply; this almost certainly was mainly responsible for three years of substantially expanded maize production, mostly by poor smallholders (p. Xx). In Kenya around 1990, many farmers already used improved seed and fertilizer, and state intervention in input and output markets in 1970-90 had an inefficient record. From 1990, combining market liberalization (abolition of price controls and fertilizer import quotas) with increased state investment in public goods (yield-enhancing crop varieties and, especially from 2003, rural transport infrastructure,) improved fertilizer use, maize productivity and maize consumption. 1990-2007 saw increased competition among suppliers, reduced margins between fertilizer import and wholesale prices, increased density of the input distribution network, reduced retail prices, and reduced costs to farmers of accessing fertilizer. In 1996-2007 the proportion of farmers using fertilizer on maize in the main season rose 25%. In Kenya's high potential maize zone, NPK/ha averaged 187 kg – above rates for rain-fed grains in South and East Asia [Ariga et al. 2010]. However, such gains are fragile: in 2008-9 political violence, which destroyed infrastructure in Western Kenya, drought, and surging world fertilizer prices threatened this success story. Political stability and further public investment (e.g. port facilities, rail maintenance) are needed, if margins are to remain attractive to suppliers of fertilizers without price surges that slash farm offtake.

GR offtake also depends on whether big rises in farm output can be transported, at reasonable cost, to a choice of markets - on *output market performance*. This too is damaged by weak road and warehousing infrastructure. In 2001–02, improved seed and fertilizer, plus good weather, resulted in a bumper maize harvest. In many areas, roads to urban markets were appalling; alongside an 80 per cent price fall, 300,000 mt was damaged in farmers' fields [Omamo 2009]. In Nigeria, improved cassava yields due to improved varieties were also followed by local market gluts, weak and costly transport out, and price falls. Kenya's Rural Feeder Roads Programme partly addressed such issues by engaging local labour, with hand-held tools, to upgrade rural transport infrastructure, but major rural transport arteries need increased central government resources [Hunt 2011].

An increasingly pressing issue of output market performance is: to what extent can smallholders sell to, and prosper with, new market institutions?⁶⁰ Most, in SSA as in Asia, are deficit farmers - producing less than enough to feed their households, and filling the gap by

⁵⁹This paragraph draws on Hunt [2011].

⁶⁰This paragraph draws on Reardon and Berdegue [2007] and Lipton [2009: 88-91].

income from non-farm work. Nevertheless, very few, even among deficit farmers, are that theorist's delight, 'the subsistence farmer'. Instead, they sell significant amounts of cash-crops - and after the main harvest even of staple crops, buying them back later in the year. Can such sellers compete, as food chains are transformed by the new institutions forged by liberalization and globalization: agro-processing, supermarkets, export horticulture, and associated grades and standards? In South Africa (as in Latin America and East Asia), supermarkets in 1990 made 10-20% cent of retail food sales in 1900 – but 50-60% in the 2000s and 10-20% by 2003 in several other SSA countries, with significant growth since, and outreach even in rural areas [Reardon and Berdegue 2007]. Outreach is less, but still increasing, for staples in the forms traditionally preferred in rural areas, and overall in Middle and Western Africa. Smaller farmers' natural advantage of cheaper labour supervision for direct production - low-cost family work over a small area – can be overwhelmed by disadvantageously costly labour supervision as supermarkets and horticultural exporters increasingly insist on timely crop collection; uniform product; 'grades and standards' on matters from insecticides to child labour; and bulking-up to container-size quantities, picked up at a few collection points. All these can be harder to supervise at small-farm level, not (as is direct production) cheaper and easier. However, this is not a new problem. Cotton all over West Africa, cocoa in Ghana, and tea in Kenya have long featured highly competitive smallholders; intermediation by crop collectors, large farmers, co-operatives, or factories; and large-scale processing or marketing forward. Similar intermediation has allowed massive smallholder participation in supermarket sales (China, Indonesia, Western India) and in many cases, including some fruits and vegetables in Kenya, in export horticulture. However, there are also cases, especially in SSA, where formerly market-orientated smallholders are extruded from these modern markets by intermediation failure. The growth of supermarkets, export horticulture, and grades and standards will continue, and past experience has many lessons for SSA public and private sectors and civil-society groups aiming to raise poor farmers' participation and bargaining power [Lipton 2009: 90-1].

(c) Links these facts to weak 'human development' - health and education - but also identifies an underlying cause: weak demand for, and supply of, political commitment to agriculture by governments (and 'Western' sources of farm and farm-input trade, and of aid). (d) Indicates recent encouraging signs of Africa-generated change.

Land issues and institutions

Most of SSA has a huge advantage over most of Latin America, and some of Asia, in turning Green Revolutions into mass poverty reduction. Outside a few countries, land is not very unequal. Not only is most land therefore concentrated in labour-intensive smallish farms, which raises output per hectare; also, gains from GRs do not substantially 'leak' to either landlords or large owner-farmers. However, a few of the 'settler economies' (e.g. South Africa, Namibia, Kenya) demonstrably have very unequal control over farmland. In several others (Uganda, Angola) the same reality may well be concealed by weak farm size data. The case of Zimbabwe shows that prolonged neglect of such extremely unequal and socially inefficient farm-size regimes, followed by explosive policy responses to them, disrupts both farm output and social development. The difficult political task is to seek farm property regimes with much less unequal (not merely patrilized from rich whites to rich blacks) control of farm production, yet retaining the valuable farm services and finance available in

large farms. Many types of land reform, from ceilings redistribution with partial compensation to stimulation of appropriate tenancy regimes, have handled such situations in Asia and elsewhere, with much more land transfer to the poor, much less disruption, and much better results for production than is often alleged [Lipton 2009: 274-297].

SSA differs from other continents in that communal tenure of cropland (not communal or joint farming) is common, perhaps commoner than individual tenure, though gradually giving way to it. It is often argued that, by accelerating this change, policy for formal or informal titling can increase farmers' security and investment, and thus speed GRs. While Asia presents cases of this [e.g. Feder et al. 1988], in SSA neither investment nor land productivity (nor even credit) is much greater in areas of communal tenure than in otherwise broadly comparable areas of individual tenure [Migot-Adholla et al. 1991]. There are cases of pro-titling movements based on resistance, by poor farmers, to land grab by a chief, a rural big man, or a corporate buy-out. But there are also cases where just such land-grabbers have sought title, and suborned politicians to get it. In support of GRs, politicians should support popular movements for title, but there is little case for stimulating such movements, or for supporting land-grab disguised by a quest for formal order in title. In any case, neither titling nor lack of it can substitute for smallholder access to farmland and farm inputs [Lipton 2009: 171-6].

E. Paths to African GRs: human development, employment priority, and the demographic override

Every government has constraints: fiscal resources, administrative capacity, public tolerance for delayed gratification, external support, environmental sustainability, and – the ultimate constraint – political energy. In SSA, perhaps the most widely neglected task of governments has been to enable farmers to transform crop yields, especially staples yields, mainly through GRs - and thereby to advance human development. There are welcome signs of engagement at African regional, national and donor level with this task, though the money and the investment have not yet fully followed the rhetoric. But seeding the GR is not governments' only task. They also need to minimize conflict, advance health and education – and keep public support. Already agricultural development in SSA is too often discussed in terms that ask governments to do impossibly much (and sometimes, even worse, at the same time to do less). Introducing human-development goals into GR and agricultural policy seems to ask governments to do more still! Can the menu be made more digestible? What are the priorities for public action to secure 'human-development-compatible' GRs in smallholder food production and avoid side-damage?

First, without huge rises in per-hectare inorganic fertilizer use, few countries of SSA will raise crop yields (especially staples yields) at GR rates, or reduce soil nutrient loss to acceptable levels. Conservation and organic manures are welcome complements to large increases in inorganics, but not substitutes. Since most land is (and will be) farmed by smallholders, greatly increased fertilizer use has to be made attractive to them, and correspondingly increased provision to their suppliers. Painstaking, locality-, product-, and soil-specific extension of correct fertilizer mixes, timings and methods is a crucial (and not costly or difficult) part of this process.

Second, fertilizers will seldom pay farmers unless they have reasonably reliable and controllable water and runoff /drainage. Parts of SSA can achieve this on rainfed lands. Elsewhere, irrigation methods – selected for efficient and employment-intensive water management – will be needed. Minor irrigation is desirable, but empirically tends to spread very slowly. CAADP has begun the long-delayed task of mobilizing investment plans and resources for large-scale surface- and groundwater development. This is essential to keep fertilizers sufficiently safe and profitable to unleash green revolutions. Pricing and/or user-group management of water, as well as (where economic) micro-techniques to reduce evaporation and seepage, are desirable to conserve scarce water, especially in semi-arid areas. In large irrigation systems, incentives to officials should favour timely and low-loss delivery and maintenance, not (as in some Asian systems) new works and corrupt water releases.

Third, farmers will buy irrigation water and equipment, and fertilizers, only to the extent that their planting materials are good and reliable enough to make such purchases pay. Most SSA countries have spent far less than other developing countries (per hectare, per farmworker or per unit of output) on researching higher-yielding varieties, better able to resist pests and water misfortunes over a range of local conditions and have supported each researcher with far lower non-wage expenditures. In parts of SSA this has started to improve, but much more public commitment is required, together with revival and integration of extension systems. Incidentally, some problems for key SSA staples (late rainfall tolerance in maize, black sika-toga disease in banana) seem to require transgenic solutions; some European special interests are acting to deny African farmers and consumers crucial research readily available to their US counterparts.

Fourth, transport of inputs to farmers, and of outputs from farmers, needs to be made much less expensive. Rural feeder and market roads and warehouses, properly maintained in peak seasons, need more public money, perhaps at the cost of intercity roads and intra-city official transport.

These five priorities – much more fertilizers; spread of water control and irrigation; faster, better and more responsive research and extension of improved planting materials; better farm-to-market transport – need to be implemented in ways favouring smallholder offtake. Most of SSA, happily, has not-too-unequal access to farmland, which is a huge advantage for yields, employment-intensity, and hence human development – but this advantage will be dissipated if the sinews of the Green Revolution are supplied disadvantageously to smallholders.

Recent demographics [Eastwood and Lipton 2011] offer SSA a huge opportunity, but also a huge threat. Population growth peaked in SSA at a faster rate than in Asia, and about twenty years later, in 1985. But fertility is now falling, so there is a reduced dependency burden of children. In 1965-2005, a similar reduced burden brought Asia a big 'demographic gift': as the proportion of people of working (and saving) age increased, it contributed an extra 1-1.5 per cent of income per head each year. In much of SSA, a similar demographic

gift can be enjoyed until about 2040 in much of SSA.⁶¹ However, extra workers per dependant, though a splendid *potential* gift of extra GDP per person, bring an *actual* gift only to the extent that these extra workers find productive work at real incomes no lower – if possible higher – than before. Asia managed this, mainly thanks to the Green Revolution: hundreds of millions of smallholders and farmworkers faced rising demand for their labour, largely to produce products that restrained the price of their main staple foods. Later many parts of Asia parlayed this into rising rural non-farm production - most notably in China and Malaysia – and then into massive releases of rural migrants to higher-income urban work. These developments continued the great employment-creating, poverty-reducing thrust of the Green Revolution, though not its impact in restraining inequality.

This is the human-development story of the twentieth century. Alongside unprecedented gains in longevity, health and education, the proportion of people in extreme poverty fell by more in the forty years 1965-2005 than in the previous forty *decades* and probably *centuries*. This was due to a smallholder-led, employment-intensive Green Revolution that permitted the realization, and widespread sharing, of a substantial demographic gift. Much of SSA is well placed to do as well or better, but only if the necessary reconstruction of the basic requirements for fertilizer use water management and irrigation, better planting materials and linked research, and rural market linkages starts now. Around 2040-2050 the demographic window will close, as SSA's population ages and the ratio of workers to dependants begins to fall again.

⁶¹This will work better if SSA's fertility declines can be accelerated. They are currently slower than in Asia 20-30 years ago. This, plus SSA's higher peak fertility, mean that SSA's *per-year* demographic gift will generally fall short of Asia's, but *duration and total* gift will be more [Eastwood and Lipton 2011].

Appendix: a mystery

1. The non-implementation mystery: limits to consensus and progress; 'political economy'?

Three conclusions of this paper, taken together, leave a mystery. We report (a) widespread, though far from total, **consensus** on the causes of low agricultural productivity in SSA, and on feasible solutions (with agro-ecological and polity-specific variations); (b) crops and countries with substantial, but often not sustained, **progress**; (c) improved efforts to lower the **political-economy** barrier to broad-based, durable agricultural advance: new institutions such as CAADP and AGRA; new resource availability from aid and domestic funds; and reduced farm growth deterrents, from civil conflict to State repression of farm prices.

The mystery is this. If there are widely agreed feasible solutions, examples of their success, and better socio-political environments, why hasn't SSA yet followed the GR path of many Asian regions to widespread, fast and (at least in 1965-90) sustained growth in farm productivity - especially where it is likeliest to transform the poor's income, nutrition, and hence human development: in labour-intensive and/or smallholder-based food staples? What part of the preconditions for implementation is missing? What are the institutional or political-economy constraints? What more is needed?

Part of the answer is that (a), (b) and (c) above, while broadly right, mask crucial weaknesses.

(a) **The consensus**: Though the thrust and technical means to higher farm productivity are largely agreed, two disagreements, though often tacit, subtly paralyze action.

First, in SSA many politicians and civil servants, and some scholars, deny - or, more often, privately distrust - one aspect of the consensus: the claim that in developing countries smaller and/or family farms are normally at least as productive, efficient and innovative as big commercial farms. The analytical and statistical evidence, from SSA as well as Asia and Latin America (Eastwood et al (2010), Lipton (2009)), is overwhelming, but undermined by both casual observation and propaganda. Casual observation notes the *appearance* of well-functioning, shiny big farms and scratch-a-patch smallholdings, but misses much of the reality: the cost of the big; the home-consumed outputs of the small; and the policies that discriminate between them. Propaganda - building on real, but localized and special, successes by large, organized commercial farms in SSA - seeks private and public funds to expand farm area in photogenic, well-groomed and big production units, similar to those that most funders know best. Small family farmers lack funds, skill and time for public relations.

If a politician or senior civil servant farms, it is not on small family holdings, but on a commercial farm carved out of them. No wonder that open, and (more usually) tacit, advocacy of large-scale commercial farms is common in SSA. Yet only a small minority of scholarly papers that claims that such farms are more efficient than small family farms in SSA; one or two well-reasoned special cases apart, such papers are seldom by agricultural economists, and hardly ever cite, let alone refute, the mass of counter-evidence.

Disagreement on optimal farm size does not weaken the argument that equity, employment, efficiency and human development need larger shares of SSA public expenditure and investment in agriculture. However, the disagreement impedes a common front among those favouring this policy, and can be exploited by advocates of other sectors despite their usually lower private and social returns.

Second, especially in the NGO community, there is a sense that agricultural development is necessarily a conspiracy against the environment. Indeed - while needed to provide growing populations with food, and until late development with incomes and employment - agricultural development *does* normally reduce biodiversity and deplete water and soil nutrients. However, the prospects to reduce such damage are better from farm growth via productivity-enhancing intensification than via the only feasible alternative, further farm expansion into areas with marginal, fragile land-water systems.

These two gaps in the consensus impede the implementation, by public and private sectors alike, of largely agreed technical and (even more) institutional remedies for low farm productivity. Improved fertilizer delivery systems, and even more credit provision, require somewhat different actions for smallholders and for large commercial farmers. Higher water use efficiency requires somewhat different private and public inputs, if very high priority is given to long-run sustainability rather than medium-term productivity growth.

Coherent policy to increase the salience of agriculture, while good for human development, is further hampered by the fact that 'big-farm' and 'environmentalist' dissenters undermine part of the 'GR consensus', yet underpin another part. Advocates of large-scale farming seldom see agricultural development as an attack on the environment, and normally back policies to increase science-based inputs. Those who see agricultural development as mainly a threat to environment normally support small-scale farming, but are skeptical about fertilizers, major irrigation and genetically modified plants. Yet, as AGRA stresses, African green revolutions need much larger *science-based inputs on smallholdings* incentivized and helped towards greater sustainability. This case, commonplace in Asia, is a consensus among scholars in SSA too, but assailed from all directions, and often given lip-service only.

(b) **The progress:** Why is there less learning from, and generalizing of, GR-style technical progress across SSA than across Asia? One impediment is that, as a rule, innovations, such as improved crops, crop-mixes, varieties, or recommendations for fertilizer or pest management, tend to be less transferable within SSA than within Asia. Some claim that this is due to SSA's inherently more variable climates or agro-ecologies. That claim, if true, would durably limit spillovers, transferability, and hence SSA-wide returns to local spending for agro-technical progress. However, no evidence supports the claim. It is less hard to reduce the actual impediments to spreading, learning and transferring innovation (and GR success) across SSA, as compared with diffusion across, say, South Asia or East Asia.

(a) Above all, Asia - like much of North Africa, but unlike SSA - has many developed land-water systems: in deltas; by rivers upstream; and based on groundwater.⁶² Such systems are often sufficiently similar for agro-technical progress in one system to be transferable to some others (after local testing and probably adaptation). This helps explain the very wide outreach across Asia of, for example, two very different innovations: treadle pumps and IR-64 semi-dwarf rice. SSA's shortage of land-water development, especially sustainable major irrigation systems, hampers adoption of locally successful innovations across SSA.⁶³ *If backed by well-considered projects*, CAADP's first (and costliest) 'pillar' will do much for land-water development and therefore the spread of innovation in SSA.

(b) CGIAR institutes, and new pan-African organizations such as AGRA and FARA, have only recently started to remedy SSA's lack of *wide-area*, cross-regional area trials of the economic (as well as technical) worth of new varieties, pest control methods and fertilizer recommendations.

(c) Farmers' suspicions of cross-regional adoption are fuelled by a lingering (but again remediable) propensity of some African governments to use cheap credit - or even force - to spread, across large and diverse countries or regions, uniform fertilizer-mixes, and even new varieties, *not* trialled widely.

(d) Cross-national innovation spread among farmers and extension workers is delayed by SSA's weak, though improving, east-to-west transport links - impeding crop trade and farmer and expert movement - and by varying national rules about plant movement and use.

(e) Finally, large parts of Asia and North Africa enjoy a lingua franca (such as Arabic, Hindi, Mandarin or Urdu) in mass use among farmers and extension workers (not just post-colonial elites). Except for Swahili in some areas, SSA lacks such means of cross-national communication of farm messages.

(c) **The political economy:** The mystery of persistently low public effort in support of agriculture in most of SSA (as compared with other developing regions), despite some consensus for such action and some progress, is partly explained by the above gaps in both consensus and progress. However, there may be another set of explanations. New formal institutions in SSA, especially at supra-national level, may not do much to change the 'political economy'. Every country has its structures of power, popular influence, and implementation, and values that affect those structures. Are these structures or values systematically different - as between most countries in SSA and in South Asia, East Asia, Latin America and North Africa - in ways that help explain why SSA has, by and large, experienced slower transition from largely agreed *knowledge* about the causes of agricultural productivity growth, to *action* based on that knowledge?

This is the 'political economy' question about agricultural performance in SSA. Whether it suggests general explanations for SSA's lower support levels for agriculture is questionable. Political economies (like agro-ecologies) probably vary more *within* any large region, such as SSA or East Asia, than *among* large regions.

⁶²In India these are exemplified, respectively, by the Krishna-Godavari delta; the Kosi-Ganges irrigated systems of North Bihar; and the tubewell-fed rice-wheat systems of the Punjab and Haryana.

⁶³Ishikawa [1968] was perhaps the first to demonstrate the primacy of land-water development for GRs in Asia.

However, some ambitious efforts have been made to explain Africa's farm experience (and the disappointing results, for human development as well as for economic growth) in terms of political-economy characteristics that are much commoner inside SSA than in other developing regions. Bates [1981] argued that post-colonial states in SSA were especially prone to twist markets against agriculture in favour of industry, with costs to efficiency as well as equity. Lipton [1977] had shown that quantitative indicators suggested much more 'urban bias' in SSA than elsewhere, and that this bias operated at least as much through direct State allocations of public expenditure as through Batesian price twists. Indeed, economic needs and globalizing political pressures substantially reduced State-led anti-agricultural price twists and biases after the early 1980s, yet in other policy areas (from shares of public expenditure to health and education priorities and outcomes) urban-rural and farm-nonfarm disparity remained substantially more in most of SSA than in most other developing countries [Eastwood et al. 2000]. Why has urban and anti-farm bias been much larger, in (most) countries, for SSA than for other main regions? Why have the biases been more entrenched, harder to shift despite growing evidence of the necessity, feasibility and methodology of rapid, broad-based farm progress?

This is a researchable question, but far too large to be engaged here in any detail. One alleged political-economy characteristic, possibly relevant to the weakness of many *national-level* systems of agricultural support in SSA - from price-policymaking to research - is 'neo-patrimonialism' [an excellent field based discussion is Sango Ndeh 2009]. This is the tendency of political leaders and groups to distribute benefits to (and expect support from) their immediate clients, usually defined by tribe or region, rather than to seek 'national' goals beneficial to all. This tendency is allegedly greater in SSA because of the youth of modern states and hence the strong survival of personalized or family power rooted in the tribe or region. Arguably, neo-patrimonialism damages implementation most in agriculture. It most hampers and distorts efficient, sustained provision of necessary public goods in agriculture, because that sector is dispersed among tribes and regions with conflicting, but locally strong, claims, leading to patrimonial, rather than efficient or sustained, allocations. And neo-patrimonialism induces allocations of private-sector-mediated farm inputs and outputs in response to local pressures and solidarities rather than to profit-seeking, let alone to efficiency or equity at national level. However, for neo-patrimonialism to explain SSA's relatively slow implementation of agreed agricultural development policies, it has to be especially prevalent in SSA. Does it run deeper (as opposed to being 'different') in SSA than in, say, SE Asia or indeed 'the West'? The definition of politics as 'the conduct of **public** affairs for **private** advantage' was not inspired by contemporary Africa, but came from a US satirist (Ambrose Bierce) in 1911.

To account for explain SSA's relatively weak lobbies for higher shares of agricultural spending and effort in political-economy terms, it may be worth revisiting ideas from 1960-90. For this is a prolonged problem: unrealized claims of 'top priority for agriculture', alongside severe, sustained anti-rural and anti-farm bias, date from patterns set (or carried over from colonizers) in the early post-colonial years, and perhaps persisting still. Hyden [1980], based on work in Tanzania in the 1970s, argued that prolonged extraction from farmers, plus top-down 'mobilization' into unwanted forms of organization, led them to withdraw into an 'uncaptured peasantry', resistant to subsequent public policy even if benign; note, however, that Scott [1985] identifies similar processes in Malaysia, despite substantial shares of pub-

lic effort, investment and expenditure going to agriculture. Lele [1989] argued that SSA's generally greater rural equality, in many ways an advantage, has deprived farmers (and rural people generally) of sufficient non-poor, educated leaders who can risk pressuring city-based governments for more agro-rural public goods.

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