

# Growth Research Programme

## Raising agricultural productivity in sub-Saharan Africa

Event report

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## CONTENTS

Summary .....	3
Introduction.....	4
<i>Setting the scene</i> .....	4
<i>Obstacles to productivity</i> .....	6
Expert opinion.....	9
Commentary.....	16
References .....	23

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# Summary

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In October 2014, DEGRP and ODI gathered together researchers from the fields of economics, sociology and geography to speak at a [panel event](#) exploring how to raise agricultural productivity in sub-Saharan Africa. Speakers included:

- **Ruth Meinzen-Dick** - Senior Research Fellow, International Food Policy Research Institute (IFPRI)
- **Agnes Andersson Djurfeldt** - Associate Professor, Lund University
- **Chris Udry** - Professor of Economics, Yale University
- **Doug Gollin** - Professor of Development Economics, Oxford University

This report brings together discussion highlights from the event, incorporating both researcher viewpoints and topics addressed in the audience Q&A. It also provides contextual information on past and existing challenges to increased agricultural productivity, ending with post-event reflection in the form of a commentary from economist **Professor Michael Lipton of University of Sussex**.

# Introduction

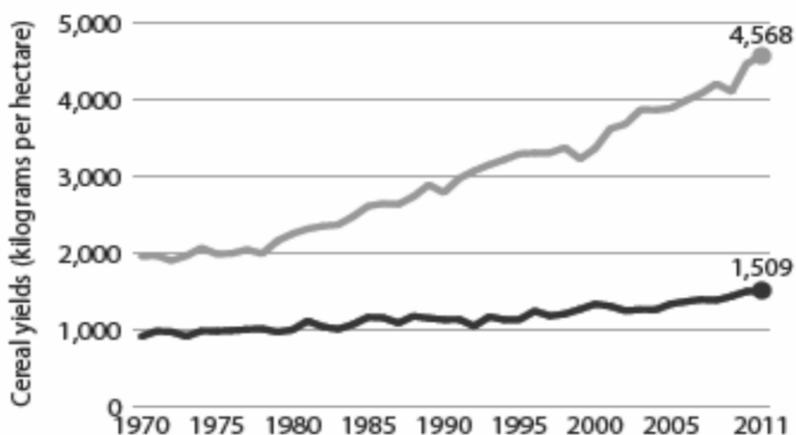
## SETTING THE SCENE

Productivity in farming in much of Africa has long been a concern, both on account of the (very) low levels of land and labour productivity across much of the continent, and because increases in productivity have been slow. This concern has grown with the resurgence of interest in agricultural growth in Africa seen since the 2003 Maputo Declaration and the spike in cereals prices on world markets in 2007–08.

More recently, interest in agricultural productivity has coincided with discussions about overall economic growth across many African countries, where the welcome news of renewed growth has often been tempered by observations that economies are growing, but not transforming. Growth has been largely in primary production, buoyed in the latter half of the 2000s by higher commodity prices, with only small changes to the structure of economies — and with correspondingly weak development of manufacturing and high-value services. Moreover, productivity increases seem to have been limited in primary sectors and low-value services. Indeed, the 2014 African Transformation Report (ACET 2014) sees agriculture as an example of slow productivity growth. Cereals yields, for example, have grown far more slowly in Africa compared to those seen in ‘earlier transformers’ — industrialised countries in Asia and Latin America (Figure 1).

The example of land productivity may not be quite as relevant to much of Africa as it is to Asia, Africa being less densely settled than parts of Asia, but even in the light of more detailed assessments of African agricultural productivity (see Box A) it is clear that productivity, whether of land or labour, has grown only modestly since the early 1990s.

Figure 1. Cereals yields, sub-Saharan Africa and early transformers, 1970–2011



Early transformers: Brazil, Chile, Indonesia, Malaysia, Singapore, South Korea, Thailand, and Vietnam.

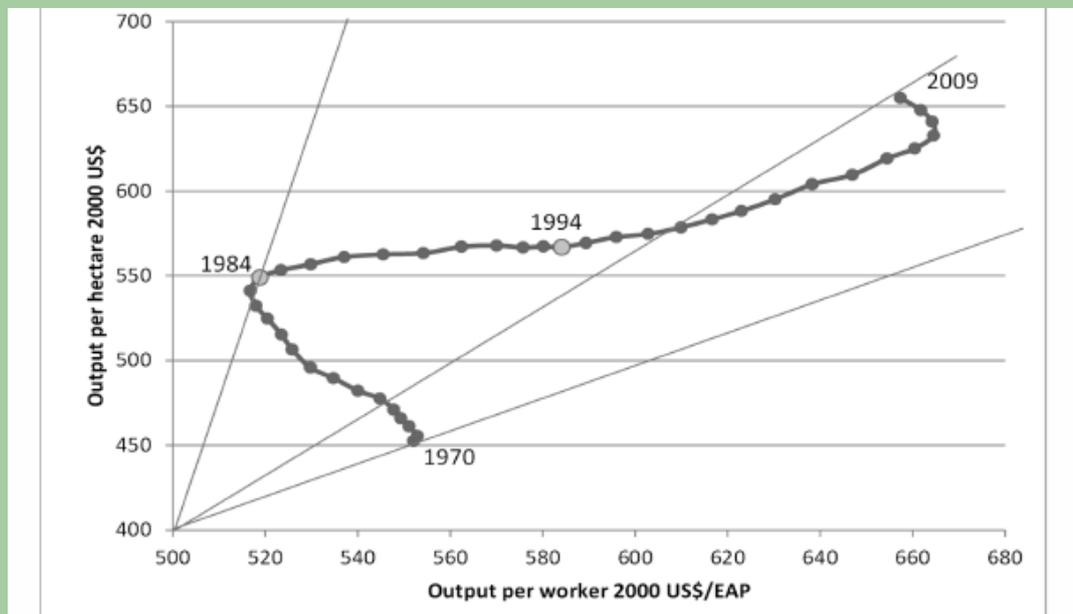
Source: ACET 2014, Figure 1

**Box A: How poor is agricultural productivity in African countries? Is it improving?**

Africa’s agricultural growth has been markedly higher since 1990 than in the 1970s and 1980s. How much of that growth, however, has come from increased productivity as opposed to using more land and labour?

Partial measures of productivity of land and labour provide some insights. From 1970 to 1984 yields per hectare rose in sub-Saharan Africa, but output per worker [economically active in agriculture] fell. Subsequently yields increased slowly until 2000 after which they have grown more rapidly. Labour productivity, however, rose considerably from 1984 through to the mid-2000s, since when it has apparently fallen back a little (Nin Pratt et al. 2012) (see Figure 2).

Figure 2. Productivity of land and labour in agriculture, sub-Saharan Africa, 1970–2009



Source: Figure 4.7, Nin Pratt et al. 2012, using data from FAOSTAT. Labour taken as the economically active population in agriculture.

Total factor productivity (TFP) is a more comprehensive measure than these two partial statistics. From 2000 to 2010 agricultural output in sub-Saharan Africa grew by 3.3% a year, but TFP only by 0.99% (Fuglie 2010). Most of the growth has come from more land, labour, livestock and inputs. Other estimates of growth of TFP in Africa (see Rezek et al. 2011) show growth of productivity in the 1960s, halted by reversals in the 1970s, followed by renewed growth subsequently. Decomposing productivity change into technical change and efficiency shows that technical change has long been positive, but has been accelerating since the mid-1980s, while efficiency follows the pattern of TFP, with varying growth since the early 1990s, in the range of 0.1–0.9% a year.

Modelling the determinants of TFP in Africa, Fuglie and Rada (2010) found very high returns to public agricultural research, both national (29%) and international (58%). Favourable policy for agriculture improves productivity; while conflict and the prevalence of HIV and AIDS reduces it.

# OBSTACLES TO PRODUCTIVITY

Why isn't agricultural productivity in Africa higher, and growing faster? A first possibility is the lack of more productive technologies appropriate to local farming systems and focused on crops typically grown in Africa. Many farming systems in Africa are rainfed, cultivation often occurring in semi-arid marginal lands and on relatively infertile soils, in marked contrast to the irrigated, alluvial floodplains for which the first round of improved Green Revolution crop varieties were bred. Similarly, farmers in Africa produce a wide variety of crops, some of which — roots and tubers, millets and sorghum, plantains and ensete — were little researched in the early stages of the Green Revolution. Most countries in Africa have under-invested in agricultural research and have probably not used funds allocated to best effect (Lipton 1989, 2012).

That said, since the original Green Revolution, researchers *have* broadened their work to address rainfed systems and less common crops, which means that improved varieties and better techniques have been developed for many of Africa's farming systems. Consequently, much higher yields than are typically obtained can be achieved by using improved varieties, fertiliser and better control of water (Larson et al. 2010 on potential increases in rice yields in Africa; Nin-Pratt et al. 2011). Moreover, village surveys often reveal large variations in yields from different farmers' fields, which also suggests that many farmers obtain lower yields than technically can be achieved in local conditions.

If low productivity is not primarily due to lack of technology, then economic, social and institutional factors must be hindering the adoption of proven improvements. At least five potential reasons have been proposed:

1. that returns to more productive technologies on farms are lower than expected;
2. that the risks of adoption are too high;
3. that markets for inputs, credit and insurance work imperfectly;
4. that insecure rights over land deter investment (Udry 2010);
5. that technical knowledge is not getting to farmers.

Let's examine these in detail.

## 1. Low returns

Most technologies to raise productivity involve intensification, through the use of more inputs, labour, machinery or irrigation. In some circumstances, these may not pay off, even if they increase production. High transport costs raise the cost of external inputs and reduce output prices at the farm gate, thereby reducing the returns on investments. Unit road transport costs are high across much of Africa, often several times higher than in Asia (Livingston et al. 2011). In Uganda, for instance, reducing rural transport costs could substantially boost agricultural output (Gollin and Rogerson 2012). Improved, all-weather roads in rural Ethiopia, for example, would reduce poverty by almost 7 percentage points and raise consumption by more than 16 percentage points, according to estimates by Dercon et al. (2009). In the 1970s and 1980s many African countries implicitly taxed agriculture heavily thereby deterring investment: fortunately, after the economic reforms of the 1980s and 1990s such cases are much less common today (Krueger et al. 1991; Lloyd et al. 2009).<sup>1</sup>

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<sup>1</sup> Much of the high effective taxation of farmers in the 1970s resulted from strongly overvalued exchange rates and industrial protection. Reforms often devalued exchange rates, and in some cases left the rates to float, while industrial protection was reduced; so that on both accounts the effective taxation of farmers eased.

### 2. Adoption risks

Investment in better technology carries the risks of harvest failures caused by bad weather, pests and diseases, or lower than expected output prices, any of which could cause unacceptably high losses for relatively poor smallholders. When farmers are averse to risk this can lead them to forgo profitable options. Crops with lower mean returns but with lower variance may be preferred to those with higher returns but higher variance. Farmers may be reluctant to invest in better seed and fertiliser that would generally raise net returns, if there is a significant risk of harvest losses. In Ethiopia, farmers restricted their use of fertiliser owing to the risk of poor weather, leaving them with poor harvests, net losses, and lower consumption as a result (Dercon and Christiaensen 2011).

### 3. Imperfect markets

Risk aversion might not be so important if farmers were able to insure against hazards. But few can, because insurance markets barely exist. This is one example of a wider problem, of missing and imperfect rural markets for inputs, credit and insurance. Information to farmers about products and services, and to suppliers and bankers about farmers' character and competence, is scarce and costly to collect. These costs deter would-be suppliers from offering services, while limiting potential demand for them from farmers (Poulton et al. 2006). As a result, many smallholders cannot obtain inputs locally that are appropriate, of good quality and at a price that reflects costs of production plus distribution margins (Omamo 2003). It is virtually impossible for most small farmers in rural Africa to obtain formal credit, since banks see too many risks and high administrative costs in serving them (Meyer 2015). Until recently, insurance against agricultural risks was similarly unavailable across most of Africa. Failing rural markets thus threaten to trap farmers in poverty, even when the technical means for them to raise production and incomes exist (Carter and Barrett 2007).

### 4. Land rights

Insecure property rights could also deter investment either because farmers cannot be sure they will be able to recoup the value of their improvements, or because the absence of a formal title prevents land being pledged as collateral against bank loans. Much of the land farmed by smallholders in Africa is cultivated under some form of collective tenure where farmers have usufruct rights that apply so long as they are resident and use the land, but do not have rights to dispose of the land since ultimate ownership resides with the community (Berry 1993).

The security of collective tenure in Africa and its effect on investment and innovation has frequently been studied, but with differing conclusions. Some do not see collective tenure as deterring investment (Place and Hazell (1993) on Besley (1995) on Ghana, Kenya and Rwanda; Brasselle, Gaspart and Platteau (2002) on Burkina Faso; and Place and Otsuka (2002) on Uganda). Others, however, report collective tenure to be an obstacle. In southern Ghana, for instance, farmers were reluctant to leave land fallow to restore soil fertility, owing to fears of loss of rights to land not being actively farmed (Goldstein and Udry 2008). Farmers in Uganda have invested more on the plots they own compared to those for which they have only the right to occupy (Deininger and Ali 2008). Since collective land rights vary from place to place in the degree of security they offer, diverging observations are probably to be expected.

### 5. Knowledge deficit

Finally, farmers may not know about or fully appreciate some innovations. Formal, public extension may either be absent or convey messages inadequately. Various models for extension have been tried with

## Raising agricultural productivity in sub-Saharan Africa

varying success: farmer field schools represent one of the more recent models to be promoted (Davis 2008). Informal channels may transmit innovations, for example, farmers may learn about techniques from their more successful neighbours, as seen in the case of pineapples in southern Ghana (Conley and Udry 2010). In other cases, however, little may be learned from neighbours, as applies for maize in Western Kenya (Duflo et al. 2008).

None of these potential explanations excludes others: on the contrary, it is likely that limitations apply in combinations, with differing factors being more or less important depending on the farming systems and individual farmers. Nevertheless, policy-makers need to judge the importance of these different factors in order to deploy scarce resources to best effect in raising yields.

# Expert opinion

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Speakers at the DEGRP panel event were each asked two questions relating to raising agricultural productivity given the challenges just mentioned:

- What are the main obstacles to higher agricultural productivity?
- What are the most promising ways to help Africa's farmers produce more?

Their answers proved diverse, perceptive and stimulating. What they said follows, together with a commentary from DEGRP advisory committee member Professor Michael Lipton and a short rejoinder from speaker and DEGRP researcher Agnes Andersson Djurfeldt.

## RUTH MEINZEN-DICK

Senior Research Fellow, International Food Policy Research Institute (IFPRI)

Taking the case of irrigation, where only a small fraction of potential has been tapped in Africa, Ruth stressed that innovation was largely a function of institutions, in the sense of 'rules of the game'. These include property rights that allow people to invest. Equally, however, collective action may be necessary for some investments, above all those that require coordinated actions across areas larger than individual farms, as applies to watersheds managed for irrigation. Moreover, some investments pay off only in the long run.

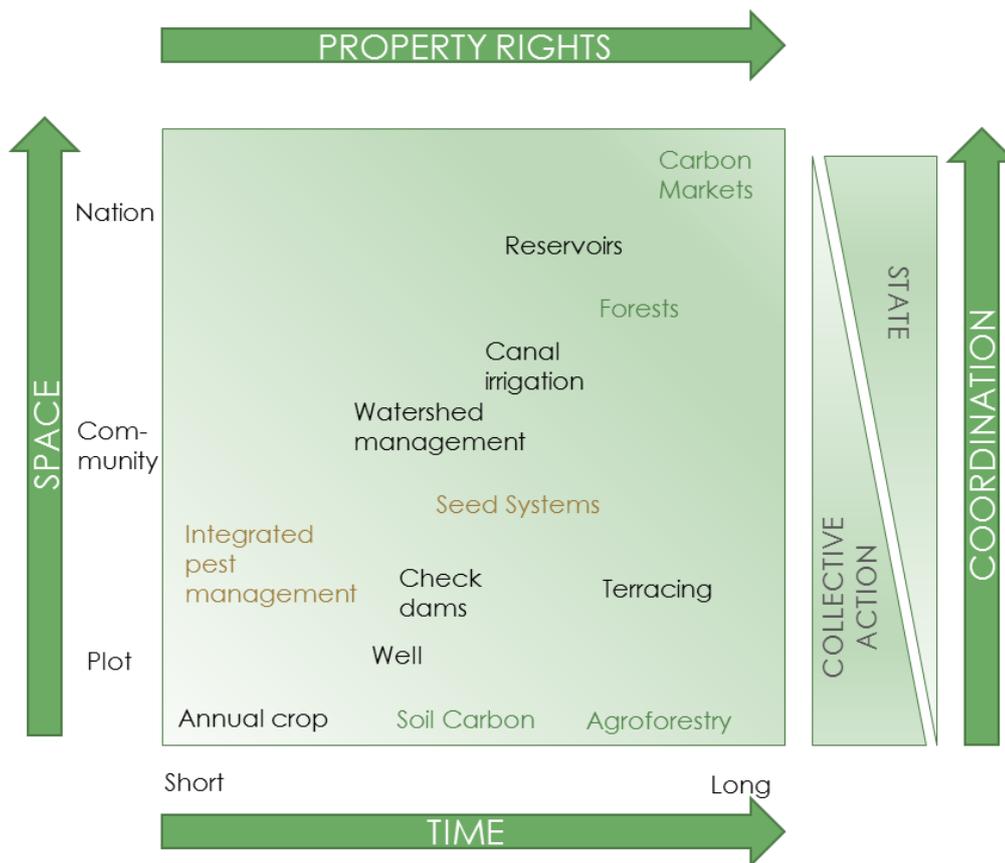
Hence different investments can be seen to have two dimensions — the degree to which collective action is needed and the length of time for investments to repay (Figure 3).

Simple solutions to problems of collective action are, however, elusive. For irrigation, the favoured approach of the 1960s and 1970s was for the state to plan, build and operate irrigation schemes. Then, when it became clear that central management of schemes ran into problems of incentives for staff to work effectively and for farmers to respect operating rules, the favoured solution switched to management by the water users. Since that did not lead to sufficient investment and improvement of operations, now the private sector is expected to invest and innovate.

In reality, all parties — farmers, private firms, public agencies — have roles to play. These are guided by institutions of all kinds, from those that steer action passively, such as property rights, to those that allow active coordination between parties, such as forums and committees. Ideally, multiple and overlapping institutional arrangements are needed, as Eleanor Ostrom proposed, although there are generally gaps in institutions.

## Raising agricultural productivity in sub-Saharan Africa

Figure 3. Space, time and collective action for investments in natural resources



Many problems in development arise from the search for simple solutions. Panaceas do not exist for most challenges. Nor can all changes be socially engineered. Institutional change is a case in point: it is an organic process and path-dependent — that is, historical context matters. In sum, we need to invest in developing institutions and to recognise the value of doing so.

## AGNES ANDERSSON DJURFELDT Associate Professor, Lund University

Agnes presented findings from the African Intensification of Food Crops for sub-Saharan Africa (AFRINT) longitudinal study taking place in nine countries — Ethiopia, Ghana, Kenya, Malawi, Tanzania, Zambia, Nigeria, Mozambique and Uganda — across the maize and cassava belt. Those studies, from 2002 and 2008, showed gaps of 51%–66% between realised and potential yields. Yields actually fell over the six years for three of the crops, while yield gaps were closing slowly or not at all over the six years (Figure 4). Moreover, farm sizes had become smaller, few farmers were using improved seeds and fertiliser, women farmers were disadvantaged in access to land and other resources, and some households were increasingly under pressure to support family members who had migrated to towns.

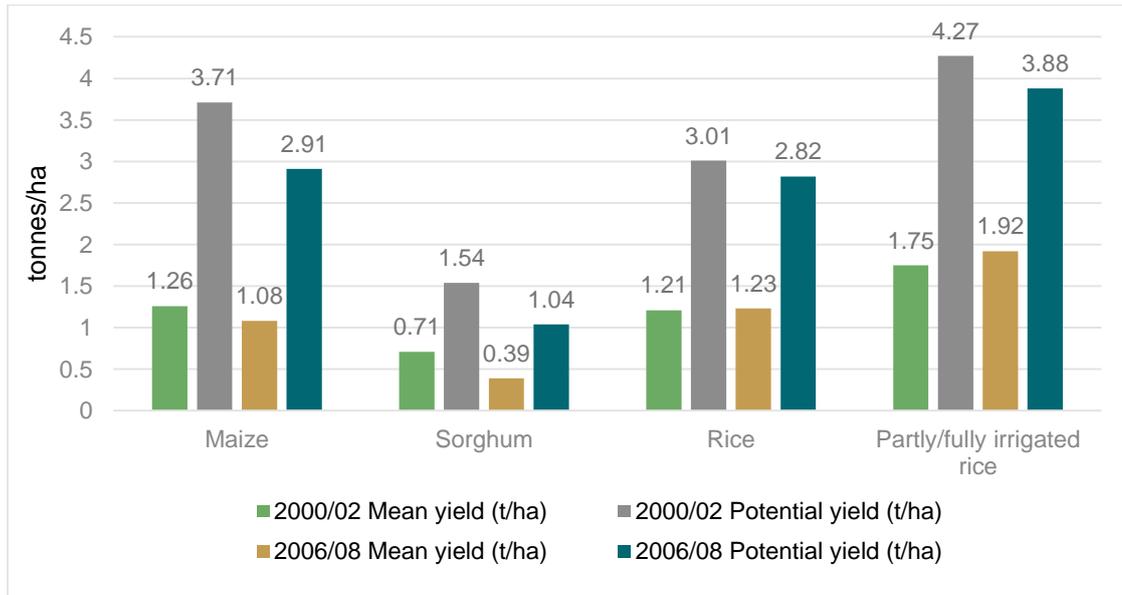
But the broad — and gloomy — picture may be deceptive. Marked spatial differences can be seen, arising from variations in soils and climate, access to urban markets, and local institutions that give access to land and water. Three stylised areas can be picked out, for which different policies should apply:

- **Well-connected, peri-urban areas of intensively farmed high-value crops** — needing extension and education to meet production standards, market coordination, irrigation and the like;

## Raising agricultural productivity in sub-Saharan Africa

- **Grain-based mixed-farming areas with potential for higher productivity** — needing technology for rainfed agriculture, small livestock (especially for women farmers), micro-finance and opportunities other than grains; and,
- **Marginal areas with less scope for intensified farming** — where food security is the priority, accompanied by social policy, cash transfers, and health and education services to enable at least an intergenerational movement away from these areas.

Figure 4. Cereals, mean yields, tonne/ha, 2002/02 and 2006/08, AFRINT surveys



Source: Jirström, Andersson et al. (2011)

Notes: Potential yields come from village level: yields from top 5% of farmers.

Pockets of dynamism could be seen, although highly concentrated, in just 14 of the 1,000 or so villages surveyed. Spatial differences trumped social differences: context of access to market, land, climate and soils were critical.

## CHRIS UDRY

Professor of Economics, Yale University

Lack of incentives to invest and innovate, too little public investment in roads and infrastructure, and imperfect markets and institutions, can all deter investment and innovation. The prime obstacle, however, is the technology that generates returns to investment. Farmers innovate and adopt new technology when they gain from doing so. Hence generally when they do not, it is, above all else, because the available technology is inappropriate. This is not surprising, given the vast under-investment in agricultural research in Africa going back decades.

When there are opportunities to make substantial profits, farmers usually find a way to overcome obstacles, including poor roads and bad institutions, to adopt technologies. Cocoa farming in early twentieth-century Ghana is an outstanding case. Developing cocoa meant making risky investments for long-term pay-offs. It involved migration, restructuring households, creating new settlements and

## Raising agricultural productivity in sub-Saharan Africa

clearing forest. Markets were imperfect, property rights ambiguous. Despite the scale of the challenge and daunting obstacles, all of this took place because the potential returns were very substantial. Other, more recent, examples include pineapple in Ghana, cotton in Burkina Faso and Mali and potato growers in Malawi.

While better technology needs to be developed, marginal gains can be made in the meantime. In the Agricultural Technology Adoption Initiative (ATAI) we use randomised controlled trials (RCTs) to study ways to mitigate obstacles to adoption, such as lack of liquidity, high risks and lack of information. In general, ATAI looks at failures in markets for credit, insurance, information, inputs, outputs, land, labour and externalities.

Success depends in large part on location: what works in one place will not necessarily work elsewhere. Changing circumstances over time also affect returns, and there are even large differences in returns between households living in the same community. It is, therefore, unrealistic to envisage simple solutions that apply everywhere. Instead, policies need to embrace heterogeneity. Markets do this already - the public policy equivalent is decentralised administration that allows adjustment to local conditions.

### DOUG GOLLIN

Professor of Development Economics, Oxford University

Responding as discussant, Doug emphasised that history shows that African farmers are very willing to adopt new varieties, and even new species of crops – maize, for example, is not indigenous to Africa. Given that history, if adoption of new technology is slow, then it raises the question of whether the technology is appropriate – an issue that the impact assessment group at the Consultative Group on International Agricultural Research (CGIAR) is considering.

Heterogeneity, as Agnes and Chris have argued, is also important: few other sectors of the economy are as heterogeneous as agriculture, since farming depends so much on varying local conditions.

Changes in agricultural productivity, however, are not driven only by agricultural research and policy – changes in the rest of the economy can lead to change on farms. When the non-farm economy thrives, rural labour may move from farm to non-farm jobs, thereby prompting changes to farming. The importance of off-farm changes varies by country and region. Agnes makes the distinction between well-connected and other areas: in the latter, non-farm opportunities may be more important than agriculture itself.

A surprising feature of African agriculture is that so many farm households produce a wide variety of crops, much of them for home consumption. Economists since Adam Smith have documented the way that specialisation can raise productivity, so why do we observe such diversified farming? Is it that returns to scale are constant?

Much research and learning on agriculture in Africa has taken place in the last 30 years. We are much more aware of the nuances of our understanding, and particularly aware that apparent solutions do not apply everywhere and every time. It is not always clear that some donors share this perspective.

Even given progress, it is striking how much evidence is still lacking on so many issues, for example on the uptake of technology and changes in productivity. Measuring levels and changes in productivity can be demanding. Indeed, identifying technical change can also pose challenges. The CGIAR impact

## Raising agricultural productivity in sub-Saharan Africa

assessment group has been studying the genetic composition of crops in fields by analysing DNA. Many farmers, it seems, wrongly identify the varieties they have planted.

## Q&A DISCUSSION POINTS

Questions from the audience helped to broaden the discussion. Among the points raised, and responses from the panel were:

### Gender and women farmers

Yield may not be the primary concern of women farmers. Their priorities may be innovations that relieve their workload, such as varieties that can be more rapidly cooked and so also require less firewood. When women farmers choose crops, they may favour a diversified mix, with more indigenous vegetables, since this may lead to a more varied and nutritious diet. In Bangladesh, increases in rice productivity tended to replace wild leafy vegetables, which ultimately led to impoverished diets. Researchers are finally recognising the importance of encouraging agriculture to make a large contribution to sound human nutrition.

Women may also have a better appreciation than men of the various ways in which to use plants: women farmers in Kenya, for example, identified plants that agriculturalists thought were weeds as having medicinal properties.

Two contrasting visions of women as innovators were presented. On the one hand, women are less likely to know about technology; and even when they do, are less likely than men to adopt it. Women were not thought of as farmers and extension systems were failing to reach them. On the other hand, during AFRINT research in Zambia, focus groups of men farmers reported that they were reluctant to try innovations since they would be embarrassed if they failed. Hence they preferred to send their wives to extension meetings and let them experiment with new ideas.

External inputs are sometimes provided in forms more appropriate to men. For example, herbicide containers may be too heavy for women. With less schooling and literacy than men, women farmers are often unable to read labels on the containers about hazards and safe handling.

### Does formal agricultural research neglect indigenous crops?

Yes, in the past some crops have been neglected. Incredibly, only a few years ago the entire public research budget for cassava was less than the budget of the Economics Department of Yale University. More recently, some neglected crops, such as teff and fonio, have started to be formally researched, which suggests that these crops may have much unrealised potential.

### Land tenure and labour leaving the land

In the long term, people will leave the land for better-paid jobs in other sectors and often in urban areas. Thus, in the long run, mechanisation will be part of the answer. Collective tenure that confers usufruct but not the right to transfer land ownership has brought great benefits in that few people are landless, but it could impede out-migration if people lose their rights if they leave the land.

## Raising agricultural productivity in sub-Saharan Africa

That said, land titling is not necessarily the answer. Titling may create opportunities for elites to capture the land rather than greater security for poorer farmers.

Moreover, unless there is urban growth and jobs for people to go to, land consolidation would be counter-productive. Nor is it simply a matter of land; the rural population needs to acquire better skills in order to find good jobs in urban areas. In India, children who grew up in rural areas tend not to get the better urban jobs because the quality of rural schooling can be so poor. Those who succeeded had gone to secondary schools in towns and cities. More needs to be done to encourage studying in rural areas, including providing libraries so people can read and broaden their horizons.

### Links from rural areas to towns and cities

It is curious to see how little articulation there can be between town and country in Africa. Urban economies do not always drive rural productivity. Many cities, such as West African coastal capitals, rely on imported food, such as rice and frozen meat, thus reducing the demand for domestic produce.

On the other hand, most urban Africans live in secondary cities and towns and have less demanding tastes, and are less prone to replacing locally produced food by imported foodstuffs. Small towns may also be more accessible to rural areas, which means that their links to the surrounding countryside may be stronger and more productive.

### If everything is so heterogeneous, then can research produce insights?

A key purpose of research is to understand the variations that arise in order to understand the factors that create heterogeneity. We need to appreciate why farmers differ; why one community is marginal, while another is not. The answers may lie with natural conditions, with policy, or with something else. This underlines the importance of long-term studies in order to understand the causes of change through time.

There is also a need for credible agricultural data since so much that ministries of agriculture produce is not sufficiently reliable. The Integrated Surveys on Agriculture (ISA) that are now being added to Living Standards Measurement Surveys promise to improve the quality of national statistics, a key public good.

### Other points

Several people raised questions of **governance**, of how to get governments to give agriculture its due importance. While none of the panellists could give a detailed reply, since the early 2000s many governments have given more attention to agriculture than they did in previous decades. Even the disputes regarding fertiliser subsidies indicate that agricultural debates have moved towards the top of the political agenda.

On the role of the **private sector** and more particularly agri-business, local dealers can play an important role but they face challenges in identifying appropriate, good quality, unadulterated products and anticipating farmers' demands. Private supply is still struggling to emerge from the remnants of former state supplies.

**Crop chemicals** can be more important for farmers than fertiliser, particularly where herbicides are used to save labour and to control weeds that previously would have been limited by fallowing.

## CONCLUSIONS AND POLICY IMPLICATIONS

What might be the policy implications of these discussions?

On the question of agricultural research, it seems that while there are useful ideas that remain to be adopted by many farmers, there is a need for more research, given the diversity of farming systems in Africa and the previous neglect of indigenous crops. While this may be interpreted as special plea for research funds, the costs of agricultural research are low compared to investments in, for example, schools or roads. Moreover, most studies show high returns on previous research. It would be odd were that not to apply in future, especially when current researchers can take advantage of notable advances in biotechnology.

Institutional matters featured heavily in the meeting, from how to remedy failings in rural markets for finance, insurance and inputs to how to facilitate collective action at village, district and national levels to confront processes that apply beyond the individual farm and that play out over the long run.

Much was said about the importance of rural–urban interactions, and on how the future of farming depends on prosperous cities that not only create demand for local farmers, but also provide jobs for those who leave the land.

More generally, geography matters. The pockets of agricultural dynamism reported by AFRINT can be found in rural areas well connected to (thriving) cities. Its dependence on natural conditions that vary in different regions means that agriculture is a heterogeneous sector that requires a range of solutions.

# Commentary

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Professor Michael Lipton, present in the event audience, later commented on the synthesised discussion points above. Discussant Agnes Andersson Djurfeldt also provided a rejoinder to points about the productivity of women farmers.

## MICHAEL LIPTON

Professor of economics, University of Sussex

### On the danger of relying on smallholder food output data in sub-Saharan Africa

*'Cereals yields, for example, have grown markedly more slowly in Africa compared to the yields seen in "earlier transformers" — Asian and Latin American countries that have industrialised (Figure 1)'.*

*'Box A: Agricultural growth in Africa has been markedly higher since 1990 than in the 1970s and 1980s'.*

*'Figure 2: From 2000 to 2010 agricultural output in sub-Saharan Africa grew by 3.3% a year, but total factor productivity only by 0.99% (Fuglie 2010). Source: Figure 4.7, Nin Pratt et al. 2012, using data from FAOSTAT.'*

The sharp turning points of productivity growth in Figure 2 reflect no obvious events. They, and the smooth, good fits, raise the question: are data measured, or do they reflect national or local reports of 'last year plus 2%' or 'things are getting worse, make that -1%'? FAOSTAT must report national output numbers, often with little basis in sub-Saharan Africa (SSA), sometimes none. Unlike Asia's or Latin America's, GDP and aggregate-farm-output data across SSA do not permit us to say that, or when, these things have been rising or falling.

Aggregate, country-level data on smallholder output — and, for this and other reasons, GDP — for SSA are of little value for most countries, and worthless for some of the largest (DRC, Sudan, Nigeria and, surprisingly, Ethiopia). Biases are many, varied over space and time, and partly unknown; but near-random numbers are useless, even if unbiased. For most African countries the data are not even uniform, but have *deteriorated* since the late 1960s, alongside the decline in the fiscal capacity of many states and the diversion of very scarce statistical resources from GDPs to the Millennium Development Goals (MDGs). An aggregate (national-level) evidence base for most statements about agricultural production, yields, and productivity in SSA simply does not exist.<sup>2</sup>

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<sup>2</sup> See Morten Jerven, *Poor Numbers*, and my review article in *Journal of Development Studies* December 2013.

## Raising agricultural productivity in sub-Saharan Africa

Most of SSA's poor are smallholders. If there had been a substantial rise in smallholder staples production since 2000, as most official data suggest, that would probably show in improved nutrition. While World Health Organization (WHO) anthropometric measures (*not* Food and Agricultural Organization (FAO) nutrition guesses) reflect both changes in health as well as the availability of food, they are quite reliable. Between 1980 and 2010, they show *as many worsening as improving* SSA samples in each sub-period and overall. This is almost certainly inconsistent with a surge in staples production in SSA as a whole in 2000–2010, though there are weak signs that 2011–14 anthropometric outcomes show slightly better trends.

### Labour in agriculture

Beware of the argument that, due to urbanisation and the rise of the rural non-farm sector, agricultural employment (and productivity) have become much less important. Most estimates of SSA urbanisation are overstatements (Potts 2012). The level, and probably growth, of shares and numbers of economic activities in agriculture are much understated (i.e. labour productivity and Total Factor Productivity are overstated).

Agriculture is still the main source of work for about 70% of economically active persons in SSA, even according to official data (FAO Statistical Yearbook 2009). World Bank reviews of the few careful employment surveys show higher proportions than official data. For example, such official data show Nigeria as substantially de-agriculturised: FAO (2009) cited official data showing that 27% of total economic activity occurred principally in agriculture in 2007 (having fallen from 38% 1994–96). Representative micro-surveys show a wholly different result. The World Bank (2009: 12, Table 1-10) estimated that 51% of sampled members of the workforce around 2006 were mainly engaged in 'family agriculture', plus many of the 13% in wage employment. The US Department of Agriculture (2009) reports: '*Despite the rapid growth of the oil industry, agriculture still provides employment for about 60% of Nigeria's 144m people*'.

Careful field surveys in 15 SSA countries suggest, contrary to received wisdom, that even higher proportions of young people are principally engaged in agriculture (World Bank 2009).

### Yield gaps and their causes

*'Improved varieties and better techniques have been developed for many of Africa's farming systems. Consequently, much higher yields than are typically obtained can be achieved on farms by using straightforward, green revolution technology of improved varieties, fertiliser and better control of water'*.

*(later) Agnes Djurfeldt's comments: '[T]he African Intensification of Food Crops for sub-Saharan Africa (longitudinal study in nine countries ... across the maize and cassava belt (2002 and 2008) showed gaps of 51%–66%, between realised and potential yields. Yields actually fell over the six years for three of the crops, while yield gaps were closing slowly or not at all over the six years (Figure 4)'*.

Such huge yield gaps were also found in Asia before, during and after the Green Revolution – see IRRI's yield-gap study (IRRI 1979; Lobell et al. 2009). Typically, only a third of such technical yield gaps

## Raising agricultural productivity in sub-Saharan Africa

corresponded to improvements that made economic sense (i.e. enhanced net farm income), even for risk-neutral, well-informed farmers with good transport and access.

Given the realities - well-judged aversion from risk among unirrigated, food-insecure farmers; costly transport of, and limited access to, fertilizers - not much of the yield gap remains to be removed by "better" farmer information, extension and education, which anyway are not cost-free. Thus reducing the yield gap, while desirable, is not a major path to substantially higher yields in main staples. That requires in Africa now, as it did in Asia in the 1960s, much more and better public investment in rural, agricultural, farm-water, and research infrastructures, and thus new water/soil-nutrient/seed-based technical progress.

*'Moreover, village surveys often reveal large variations in yields from different farmers' fields that also suggests that many farmers obtain lower yields than is technically possible'.*

Or that plots vary hugely in water/nutrient status. Large variations in yields across "similar" plots do partly mean that farmers, like all other businesspersons, vary, in both efficiency and industriousness. But mainly these variations reflect large, usually unknown variations among and within plots in soil nutrient status, landscape, and waterscape. Again, reducing variations offers no alternative to the major government efforts required.

*'At least five potential reasons have been proposed: that returns to more productive technologies on farms are lower than expected; that the risks of adoption are too high; that markets for inputs, credit and insurance work imperfectly; that insecure rights over land deter investment (Udry 2010); or that technical knowledge is not getting to farmers'.*

Very helpful but are these (a) mutually exclusive (b) jointly exhaustive reasons for yield gaps? Re: (b) I can think of at least one extra reason: that conditions on farms do not produce the results predicted from field trials in allegedly similar but in fact standardised research-station plots (e.g. mixed cropping; rotations; water mining). Again the IRRI study may help.

*'For Uganda reducing rural transport costs could substantially boost agricultural output (Gollin and Rogerson, 2012) ... Improved, all-weather roads in rural Ethiopia, for example, would reduce poverty by almost 7 percentage points and raise consumption by more than 16 percentage points (Dercon et al. 2009)'.*

Net of negative effects on competing outputs *not* marketed far away? Such subsidies to trade (in direct proportion to its distance) also discriminate against farms producing for subsistence or nearby sale/consumption — thus now avoiding the transport costs everyone seems so keen to subsidise.

## Raising agricultural productivity in sub-Saharan Africa

*'In the 1970s and 1980s many African countries implicitly taxed agriculture heavily thereby deterring investment: fortunately after reforms such cases are much less common today (Krueger et al. 1991; Lloyd et al. 2009)'.*

At least by 2004, the evidence for falling net deterrents to farm investment, induced by urban bias, was unpersuasive (Eastwood and Lipton 2004). In Africa falls in rural–urban inequality due to price reforms did not outweigh other pressures towards rising rural–urban and agriculture–non-agriculture inequality. This suggests that gains from price reforms were at least matched by losses from fiscal pressures that disproportionately affected public effort for agriculture and the rural sector.

*'Farmers may be reluctant to invest in better seed and fertiliser that would normally raise net returns, if there is a significant risk of harvest losses. In Ethiopia, farmers restricted use of fertiliser owing to the risk of poor weather, leaving them with poor harvests, net losses, and lower consumption as a result (Dercon and Christiaensen 2011)'.*

Is risk aversion a major explanation of non-adoption in SSA? Lots of CG-type innovations for SSA, notably the mite- and mosaic-resistant cassavas, reduce risk as well as raising expected mean output. It's lack of *water control* that makes many innovations, especially those requiring more nitrogenous fertilisers, risky.

*'Many smallholders cannot obtain inputs locally that are appropriate, of good quality and at a price that reflects costs of production plus distribution margins (Omamo 2003). Formal credit is virtually impossible for most small farmers in rural Africa to obtain, since banks see too many risks and high administrative costs in serving them. (Meyer 2015). Until recently insurance against agricultural risks was similarly unavailable across most of Africa. Failing rural markets thus threaten to trap farmers in poverty, even when the technical means for them to raise production and incomes exist (Carter and Barrett 2007)'.*

If only it were as simple as curing market failure! Non-provision of rural crop and weather insurance is due to non-profitability of providing it due to information costs, moral hazard and enforcement costs. This non-provision signals market *success*. Reducing objective risk and increasing reliable information will have to be undertaken by the public (or collectively by large groups of individuals) — they are not privately profitable for an insurer, partly because competitors can capture benefits. *But* public provision of weather-linked crop insurance can show high economic rates of return (ERR) even though it loses money. This was the case for India's Comprehensive Crop Insurance Scheme (CCIS) (see Mishra 1996).

### Insecure property rights

*'Much of the land farmed by smallholders in Africa is cultivated under ... collective tenure where farmers have usufruct rights that apply so long as they are resident and use the land, but do not have rights to dispose of the land since ultimate ownership resides with the community (Berry 1993)'.*

This is usually a myth: chiefs who try to enforce it are got rid of (e.g. during the Pondoland revolt). Even in Northwest Sierra Leone where bushland may remain fallow for cycles of as long as 20 years, each family knows exactly which are 'its' lands and woe betide any violators. The variations in findings reported below are because specific land has value to the extent that it is (a) scarce (b) getting more profitable in use due to technical progress. Feder and Onchan (1987) find insecure tenure crucial to productivity, investment and profit in Green Revolution areas of Thailand; Migot-Adholla et al. (1991) the best sub-Saharan Africa study, find it irrelevant in four pairs of site comparisons in sub-Saharan Africa where technical stasis deters investment.

*'Since collective land rights vary from place to place in the degree of security they offer, diverging observations are probably to be expected'.*

Well, I think collective land rights are pretty much a myth in all modern non-force states. What does vary greatly is the profitability *and technical dynamism* of agriculture and that is what affects the relevance of tenure.

*'Finally, farmers may not know about or fully appreciate some innovations. ... In [some] cases ..., little may be learned from neighbours, as applies for maize in Western Kenya (Duflo et al. 2008)'.*

True, if 'little may be learned' means 'neighbours do different things because their objective situations differ', or 'neighbours do much the same thing', or 'little progress is profitable absent relevant new technology'. False, if it means 'neighbours don't know, or ignore, better practice on neighbours' plots'.

### Collective-action problems

*Ruth Meinzen-Dick comments: 'For irrigation, the favoured approach of the 1960s and 1970s was for the state to plan, build and operate irrigation schemes. Then ... the favoured solution switched to management by the water users ... [N]ow the private sector is expected to invest and innovate'.*

Asian experience, reviewed in the large IWMI study, is relevant for Africa (Lipton 2007).

### Structural changes as causes of yield gaps?

*Agnes Djurfeldt comments: 'Moreover, farm sizes had become smaller, fewer farmers were using improved seeds and fertiliser, women farmers were disadvantaged in access to land and other resources, and some households were increasingly under pressure to help support members who had migrated to towns'.*

'Farm sizes becoming smaller', as successive agricultural censuses confirm they are in SSA (notwithstanding land grabs), usually *increases* farming intensity, e.g. typically fertiliser use per hectare, given irrigation level, rises as farm size falls (e.g. Hossain 1988). Most research also suggests that a shift towards women's control of farmland is favourable for productivity; it may correct earlier (inefficient) discrimination against their control of cash crops. Pressure to support more household members also ought to raise, not lower, productivity.

### Lack of appropriate, profitable farm innovation in SSA

*Chris Udry comments: 'The prime obstacle is [absence of] technology that generates returns to investment. Farmers innovate and adopt new technology when they gain from doing so. Hence generally when they do not, it is, above all else, because technology is inappropriate. Not surprising to see this, given the vast under-investment in agricultural research in Africa going back decades'.*

Spot on! This is remediable, but not with the chicken-feed *real* spending (given high research costs in SSA) still going into agricultural research and its diffusion in most of SSA, as compared with Asia's Green Revolution.

*Chris Udry adds: 'The Agricultural Technology Adoption Initiative [explores] ways to mitigate obstacles to adoption, such as lack of liquidity, high risks and lack of information ... failures in markets for credit, insurance, information, inputs, outputs, land, labour and externalities'.*

Excellent both to stress these gains, and that they will remain marginal in the absence of a really serious (and really African) water-fertiliser-seed technology initiative. In the Indian Punjab in 1967, technical progress that transformed wheat yields bulldozed through such obstacles, and soon reached tiny farms too.

South Asia devoted about 20% of public spending to agriculture (much of it irrigation) in the decade or so before the Green Revolution. The SSA proportion remains closer to 5% than 10%, the Maputo Agreement notwithstanding.

*Chris Udry writes: 'It is unrealistic to envisage simple solutions that apply everywhere. Instead, policies need to embrace heterogeneity. Markets do this already - the public policy equivalent is decentralised administration that allows adjustment to local conditions'.*

True, but we shouldn't (and Chris doesn't) infer that agricultural research should always seek numerous different solutions for different types of micro-environment. Scientific progress requires generalisation. Several key high-yielding varieties were designed to be — and proved — very widely adaptable (hence the concerns for loss of within-crop biodiversity), and produced significant yield increases far beyond the water-controlled areas for which they were 'designed', often alongside *reduced* risk.

## AGNES ANDERSSON DJURFELDT

### Rejoinder on obstacles to the productivity of women farmers

While there has been much recent interest in the links between enhanced productivity and the strengthening of women's rights to land, especially in the grey literature (FAO 2011), more critical literature suggests that a preoccupation with land obscures the importance of the fact that women lack command over *other* agrarian resources as explanations for lower productivity (Jackson 2003; Whitehead and Tsikata 2003; Quisumbing and Pandolfelli 2010; Okali 2012).

The continued need to rely on male household members in securing access to technology and markets also presents an institutional explanation for lower productivity among women, especially when they sustain their own households (Okali 2012; Andersson Djurfeldt, Mulwafu et al. 2015 (submitted)). Sources of gendered differentials in productivity can also be found at the household level, where non-agricultural demands on women's time are comparatively large.

Addressing the yield gap from a gender perspective needs to take all these aspects into consideration, placing women and men in the broader context of the household as well as in relation to the local institutional set-up.

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