Africa, agriculture, aid

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Abstract

In a world that is developing fast, Africa's relative stagnation is a human tragedy that challenges the development profession. Although climate and geography, and their effect on local institutions, are not in Africa's favour, inappropriate policies (including neglect of agriculture) and weak institutions figure more prominently in the explanation of slow growth. Recent evidence, however, points to accelerated growth in many parts of Africa. Analysis of agriculture shows that adverse effects of nature can be handled effectively, that efforts to develop and apply technologies for intensification in a variety of farming systems are under way, but that sustained adoption by the mass of smallholders has not sufficiently taken place. For that to happen, a variety of time- and location-specific complementary actions – both public and private – are needed, based on a right mix of disciplinary knowledge. With positive changes in governance and a revival of agricultural priorities in Africa, favourable conditions are emerging for renewed and better targeted external aid to support agricultural development.

Additional keywords: development, governance, intensification

Introduction

During the second half of the 20th century, economic development has greatly contributed to overcoming poverty, improved food security, better access to education and health, and higher levels of welfare and choice. Spectacular advances at historically unknown rates of growth were realized in China and Vietnam, and now in India as well. As a result, millions of households were lifted out of poverty, and a new middle class is emerging all over Asia. Developments in Latin America were mixed and more modest. By any measure though, economic developments in Sub-Saharan Africa have been dismal, with many countries showing no progress for more than one generation.

Africa's economic stagnation was accompanied by growing doubts and division about the desired strategy and policies to reverse these adverse developments. The lively discussions about the mixed outcome of the economic reforms propagated in structural adjustment programmes since the 1980s raised new questions as to what constitutes *good governance*, which factors structurally hamper the proper *functioning of markets* and what consequences this has for *collective action*. Examples of these

'new' market failures are risks that cannot be covered so that futures markets and long-term contracts are absent, high information and transaction costs giving rise to alternative exchange mechanisms or institutions, or lack of social capital that causes and perpetuates exclusion.

Of growing importance is the *co-ordination issue*, which plays a crucial role in the development of technology for which critical mass is a necessary condition. But in sectors with a multitude of small producers, such a critical mass does not come about by itself and needs to be organized, but once present stimulates and attracts further research and development. In this way, the build-up of expertise generates increasing returns. Without public support, this process does not emerge.

Co-ordination has an interesting dynamic side as well, as illustrated by Hoff & Stiglitz' (2001) definition of developing countries: "regions that are on a different production function and are differently organized than high-income countries". In this structurally different configuration, multiple, i.e., low- and high-level equilibria are conceivable. However, acquiring superior technology and developing better-adapted institutions by themselves will not ensure that a higher-level equilibrium can be reached. For that to happen, a society needs to successfully co-ordinate a variety of time- and location-specific complementary actions. Designing and executing these multiple interventions is not an easy task on a continent where markets and governments often fail, and faces stiff competition from more popular and appealing generic single programmes such as malaria eradication or fertilizer distribution.

These new analytical concepts from development theory have an important bearing on agriculture and rural development as well. In this context Meier (2001) mentions the great damage that many African countries have inflicted on themselves by poor price policies and neglect of infrastructure and support services. Although the welfare cost of these policies was clearly exposed, it took a while before the political economy of gainers and losers was properly recognized. Subsequent innovations in information, risk and contract analysis at a much more disaggregate level have enriched the micro-economics of rural markets and institutions. The recognition of high transaction costs in rural commodity markets and a better understanding of complex linkages in factor markets and related institutions greatly increased the understanding of household decision-making and with it the effectiveness of outside interventions.

Not only have developments in Africa stagnated in a globalizing and rapidly changing world, the continent has in many circles an image of doom and failure, with petty incidents filling the tabloids, reminding us of the way India or Indonesia were covered half a century ago (Guest, 2004). Can we with better analytical tools available now, explain why such a geographical divide has occurred? Is the gloomy picture of Africa really true? Is there something special or inevitable about Africa's stagnation? If we find some answers, are they helpful to influence developments in Africa? In addressing these questions, the focus will be mainly on agriculture and the rural areas. It is where most Africans live and where poverty is concentrated (Zeller & Johannsen, 2004).

Reflecting these questions, this article is organized as follows. First, some explanations are offered for Africa's recent experience and disappointing performance in a more general context. Next, we focus on agriculture, discuss a number of development dilemmas typical for Africa, and contrast Africa's experience with that

of most Asian countries. Particular attention is paid to the adoption and diffusion of modern, high-yielding varieties, and it is indicated under what conditions a Green Revolution type of agricultural intensification would be feasible in Africa. We then turn to recent advances and new initiatives in agricultural development and discuss the role international aid can play to accelerate current intensification efforts, recognizing its dismal past effectiveness in Africa. The final chapter concludes.

Africa: some explanations

Neo-classical growth theory tells us that countries with similar features converge and that latecomers catch up, like Ireland in the EU. If intrinsic country characteristics are different, conditional convergence occurs, i.e., countries sharing the same group features converge, but among groups there can be divergence. As Carter & Barrett (2006) argue, if African countries would feature common growth-retarding factors, there would be divergence and no catching-up between Africa and the rest of the world. Examples of such factors abound: a low population density and diverse geography, including long distances to the sea, causing low-density and expensive infrastructure. As a result, markets are far less developed than elsewhere in the world. Complex and diverse agro-ecological and climatic conditions unfavourably affect agriculture and health, and cause large variations in yields. Historically, Africa has suffered from slavery and institutional legacies of colonial rule, including ethno-linguistic fractionalization, and more recently from cold war politics and the rapid spread of HIV/AIDS. Policies of overregulated markets, heavy taxation of agriculture, and wasteful spending of natural resource rents have been holding back development.

A second explanation rests on poverty traps related to thresholds that cause both low- and high-level equilibria given a country's characteristics. To cross a minimum threshold level of capital or income (where returns are locally increasing), one needs a jump in technology, scale or nature of activity to reach a higher-level equilibrium on another production function. Without a co-ordinated push in terms of resources and adjustment of supporting institutions, the economy remains at a low-level equilibrium. It is an often argued (e.g., Collier, 2006) and popularized (Sachs, 2005) case that financial aid to supplement resources and technical aid to help reform institutions can be effective to assist lifting a country out of a low-level equilibrium. At the aggregate level, however, empirical evidence for such a 'big push' remains scant (Kraay & Raddatz, 2007).

Poverty traps are probably more relevant at the micro-level of households where intrinsic characteristics like assets and location determine the possibilities of accumulation to reach a high-level equilibrium. Under locally increasing returns causing multiple equilibria, asset-poor households will be caught in a low-level equilibrium and unable to catch up with their better-off neighbours. Examples of increasing returns at low-income levels are plentiful: adoption of high-yielding varieties, a shift to improved dairy cattle, off-farm salaried employment, and self-employment like operating a van or a taxi. In these examples increasing returns reflect characteristics of a new technology with higher input efficiency, a minimum scale, or the ability to specialize and go for more high-risk activities. Low savings and education

levels, the inability to access credit, and different forms of social exclusion are among the factors explaining divergence among households.

The recent work by Escobal (2005) is an excellent example of the dynamic interaction between the divergent nature of a household's private assets and the provision of public infrastructure investment. Contrary to popular belief, Escobal found for the Peruvian Andes that the fruits of public investment in roads, education or health care lift the return to assets of wealthier households to a high-level equilibrium, but hardly reach the poor if their access to these public assets is not explicitly addressed. But if access is improved, there are clear synergies to be achieved, causing increasing returns when the right complementarities among different assets are sorted out, depending on time and location. Though in a different context, the approach advocated by Sachs (2005) for the Millennium villages in Africa reflects similar considerations.

Driving forces

At the macro level, growth regressions have tried to establish which factors are likely to explain Africa's slow growth. Reviewing these results, Collier & Gunning (1999) showed that lack of social capital or cohesion comes out as the most important factor; if combined with poor policies, it almost accounts for half of the growth shortfall. Ethnic diversity is important in societies lacking political rights, but disappears as an explanatory variable under more democratic regimes. Lack of openness to trade, a matter of policy as well as geography, and lack of financial services matter, but to a lesser extent. More important are deficient public services and infrastructure, which are high-cost and often poorly and selectively delivered. Public employment creation and the need to maintain an often narrow power base are at the root of this phenomenon. Climate, geography and a dispersed population create considerable volatility, to which terms of trade and policy variations can be added. Finally, though Africa received substantial aid flows, there is little evidence of a positive net effect on growth.

Moving to evidence at the micro level, Collier & Gunning (1999) observed that lack of market openness and rural social capital, the high cost of risk-coping strategies (activity diversion, consumption smoothing by holding liquid assets), and poor public services confirm the aggregate findings about Africa's stagnation. In their own words (Collier & Gunning, 1999, p. 100) "Africa stagnated because its governments were captured by a narrow elite that undermined markets and used public services to deliver employment patronage. These policies reduced the returns on assets and increased the already high risks private agents faced." As a result, Africa faced an outflow of financial and human capital, and developed internally a variety of risk-coping mechanisms that reduced growth. Traditional rural institutions that were once a rational and efficient response to physical and socio-economic constraints did not sufficiently evolve to cope with new demands. Dissemination of learning and innovations remained therefore limited, extension badly organized, and credit provision poor. The system of taxation of international trade had a detrimental effect on agriculture. Some countries banned private trade and introduced widespread controls on prices and quantities. Not surprisingly, stories of black markets, smuggling, road blocks, and heavy evictions proved a rich source for popular reporting in the media.

Although *climate and geography*, and their influence on local institutions are not in Africa's advantage, inappropriate *policies and governance* at both the macro and micro level appear to figure more prominently in the explanation of slow growth. Focusing especially on rural development Omamo (2003) and Mwabu & Thorbecke (2004) arrived at similar conclusions: the physical environment in most of Africa is marked by exceptional diversity, creating great disadvantages for Green Revolution technologies that rely on standard technical packages for monocropping under controlled water management. But despite high potential returns, investment in physical infrastructure and agricultural research to address these issues has been widely neglected.

Co-variate crop risk has discouraged credit institutions in the lowland, semi-arid areas, and savings were channelled in semi-liquid assets such as animals to maintain consumption in hard times. In such an environment, agriculture remains trapped in a low-productivity equilibrium. On top of that, the effects of policies have on the whole been detrimental to the rural areas, the more so because incentives to resist the exploitative policies were small. With weak cohesion outside local rural communities, little investment by farmers in the land, and the prevalence of user over property rights, peasant organizations have remained weak or absent.

Agriculture

Having touched on agriculture, let us elaborate a bit more the great divide between Africa's allegedly stagnating agriculture and the successful developments elsewhere, especially in Asia. Overall, most Africans south of the Sahara are hardly better off now than at the time of independence half a century ago. At that time the average income in Africa was twice as high as that in Asia. Now, the average income in South Asia is well above that in Africa, and in East Asia even three times as high.

A similar trend can be observed for agriculture: measured by cereal yields, those in Africa have slowly increased from 0.7 to 1.0 ton per ha, whereas in South Asia yields have climbed to 2.5 and in East Asia to 4.5 tons per ha. At the time of independence, African countries on the whole were self-sufficient in food, by now many are food importers and recipients of food aid. A staggering 40% of all Africans go hungry, and half of Sub-Saharan Africa is classified as extremely poor, i.e., surviving on less than 1 US$ a day.

In Africa, like in most of the developing world, poverty is concentrated in the rural areas. Though urban slums catch the eye by their visibility, three quarters of the poor live in rural areas where agriculture is a dominant but low-productivity sector, absorbing most resources. In these circumstances, gains in agricultural productivity enable an increase in food supply, reduce food prices, contribute to employment and generate resources for non-agricultural development. Net food-buying households (more than half of the rural and all urban households) gain through lower food prices, and nominal wages, important for development elsewhere, can therefore be kept in check. Net food-selling households realize income gains if price declines remain in line with productivity increases. Such developments are the more likely when agriculture growth stimulates other activities, generating additional income and food demand. If non-farm development is accompanied by a tightening of the rural labour market, even more income gains will emerge.

In the World Development Report 2008, *Agriculture for Development* (Anon., 2007), a strong empirical case is made for the comparative advantage of agriculture to reduce poverty. Econometric analysis over the last two decades for 42 developing countries shows that for the poorest deciles in the expenditure distribution, a 1% GDP growth in agriculture increases their income by more than 2.5%. A similar increase in non-agricultural growth generates less than half of this effect (Christiaensen & Demery, 2007). At higher levels of income, the agricultural growth effect on poverty decreases, but remains superior to non-farm activities. Taking cereal yields as a proxy for agricultural productivity, its role in reducing poverty marks a contrasting experience between South Asia and Sub-Saharan Africa. In South Asia, a steady increase in cereal yields during the period 1987–2001 was accompanied by decreasing levels of poverty. In Africa low cereal yields and high poverty hardly changed during the same period.

Earlier we concluded that unfavourable physical conditions and an anti-rural policy bias go a long way in explaining Africa's slow (agricultural) development. The policy bias has been aggravated by a dismal record in public underinvestment in African agriculture. Public spending on African agriculture, including investment in R&D, stands at an all-time low of less than 7% of agricultural GDP, against 11% in Asia and almost 13% in Latin America. Donor support to agriculture in Africa has dwindled from US$ 3–4 billion in the late 1980s to US$ 1 billion now. While the OECD countries are subsidizing and protecting their farmers in ways that distort world markets, African countries are denied trading opportunities equivalent to almost US$ 2 billion in lost income, twice the size of these countries foreign assistance (Gabre-Madhin & Haggblade, 2004; Anon., 2007). Policy bias is clearly not confined to Africa.

To avoid any misunderstanding, expansion of food staple production has increased in Africa, but on the whole its rate of increase has been outstripped by population growth. Given the low rate of yield increase, additional production has mainly come from expanding the area cultivated and from shorter fallow periods, largely maintaining conventional farming techniques. This is reflected by the low adoption rates of modern crop varieties: on average 22% in Sub-Saharan Africa against 78% in South Asia and 84% in East Asia (Evenson & Gollin, 2003). Fertilizer use is minimal and irrigation underutilized. No wonder soil degradation is becoming a major problem causing further productivity losses.

An African dilemma

Why then – with an African food crisis imminent – is there so little increase in crop yields, or in other words, why is a type of Green Revolution that triggers intensification not happening in Africa? A common response (summarized in Anon., 2007, Box 2.2) to this question points to Africa's low population density in relation to its land availability. Bringing more land under cultivation, i.e., *extensification*, is then a rational response at the farm level, rather than going for higher yielding, more expensive and risky inputs to increase production on existing land. However, with the current high rates of population growth and correcting for land quality, population densities in much of Africa now are approaching those in Asia at the beginning of the Green Revolution. Based on these considerations, there is no doubt that Africa ought to have its version of a Green Revolution.

Another reason relates to the earlier mentioned intrinsically diverse *agro-ecological conditions* in Africa. As a result, Africa has a wide range of rain-fed farming systems producing a broad range of staples. Asian Green Revolution technologies initially focused on irrigated rice and wheat in fairly homogeneous environments. Transfer to Africa therefore requires location-specific adjustments for a much broader range of crops to realize the potential for yield increases. Obviously, the necessary R&D to achieve this is costly and crucially depends on generous public funding from national and international sources. But even if this potential would be realized, adoption by farmers will of course depend on the effective provision of a variety of complementary public and private inputs, proper marketing and favourable policy incentives.

An important contribution to a better understanding of the process of intensification in African agriculture is the recent work by an African–Swedish research collaboration of sociologists, geographers and economists (Djurfeldt *et al.*, 2005). Based on a survey of more than 3000 households in more than 100 villages located in different agro-ecological environments of 8 African countries, and supplemented with historical accounts of earlier African efforts to intensification, the authors firmly concluded that modern varieties were and are being adopted in various countries (see also Gabre-Madhin & Haggblade, 2004; Anon., 2007). The African agro-ecology does pose constraints, but here an old adage of development theory applies: it is the response to a constraint rather than the constraint itself that matters. Technologies appropriate to Africa are more and more 'on the shelf' and returns to the development of new ones are high.

Analysing the earlier successes of high-yielding varieties in Japan and post-war East and South Asia, Djurfeldt *et al.* (2005) arrived at the conclusion that the Green Revolution in Asia was a *state-driven, market-mediated and small-farmer based* strategy to attain self-sufficiency in food grains. The latter reflected both nationalistic and international geo-political considerations, and was considered, or at least tolerated, as a condition for rapid industrial growth. Foreign aid was accepted against the background of these considerations and played an important role. Although mostly driven by authoritarian regimes, participatory strategies in agriculture were common, with successes counting heavily to legitimize the ruling regime. Providing public R&D, infrastructure and institutional support, using markets effectively to channel inputs and outputs, and reaching out to the millions of small family farms did not come without resistance. In India it took a fierce debate with the powerful planners supporting ample funding of heavy industry and import substitution. In Indonesia, policy change was only possible after a dramatic change of regime.

The three characterizing elements of the successful process of adoption of modern varieties in Asia have largely been absent in most of Africa. Historically, many present-day African states "did not develop from within and in conflict with each other, ... they function as members of the international state system" with the principle of non-interference in internal affairs as a core element (Djurfeldt *et al.*, 2005, pp. 14–15). Although most African states had no uncontested domestic power monopoly, their stability was held up by the non-interference principle and international support. Left to solve their domestic legitimacy problems, support was sought from the small urban elite, the army and large cash crop producers. The majority of the population was thus

excluded from the modernization process, and interventions were geared towards the interest of a small elite, with an urban bias in budget allocations and markets distorted in their favour. No wonder that the domestic reforms conditioned by the World Bank in its structural adjustment programmes were viewed as violating non-interference and met with fierce ideological resistance by the ruling elite. Having to rely on such a narrow power base is a far cry from the Asian development state where leadership was committed to broad-based and inclusive development on which the legitimacy of its regime was ultimately based.

Are advances looming?

Putting the evidence on staple food production together, Sub-Saharan Africa has certainly not been without growth, in particular for maize and cassava, but intensification has been patchy, largely bypassing smallholders, and has not led to a sustained increase in productivity. During and shortly after the colonial period, maize-based hybridization technologies have spread from Zimbabwe (Rhodesia) and Kenya over the sub-continent. Research on hybrid maize was initiated during the 1930s, and since the 1950s a series of high-yielding varieties were released and adopted (Djurfeldt *et al.*, 2005, chapter 5). However, after independence most African governments did not perceive food self-sufficiency as a problem, and without much effort extensification was assumed to take care of additional supply.

With steadily decreasing food prices on the world market food import became an attractive alternative and food aid could always be counted on as a last resort. Moreover, African states faced few external threats. With their limited internal legitimacy, willingness and sometimes capacity to implement reforms, governments were understandably tempted to avoid the demanding route of intensification. All this happened in the face of mounting evidence of an increasing yield gap, illustrating the high potential of newly developed technologies that were adjusted to the nature of African conditions.

The nature of this paradox has not gone unnoticed by a younger generation of the African intelligentsia and policy-makers, or by the more informed part of the international community. Numerous initiatives and changes before and around the turn of the century have resulted in profound changes in governance, improved transparency and participation, and in a more realistic view on African development (Owusu, 2003; Anon., 2007). As a result, a wave of 'positive news' is now emerging, documenting successes and emphasizing the opportunities for change. Building on long-standing policy and research work by CGIAR in Africa, the International Food Policy Research Institute (IFPRI) has made repeated efforts to make this information widely available (Schioler, 1998; Haggblade, 2004). As in the Djurfeldt *et al.* (2005) study, micro-evidence and an extensive expert survey reported by Gabre-Madhin & Haggblade (2004) show that modern varieties and improved practices are finally making an impact in Africa.

Maize breeding has had its ups and downs (following the withdrawal of fiscally unsustainable subsidies in the 1980s), but across Africa farmers are now reported to plant almost half their area to improved varieties. Improved disease-resistant clones of cassava, developed during the past three decades, have been widely adopted and have improved the lives of probably 100 million poor consumers and farm family members.

Successes in on-farm breeding of bananas in the central highlands of East Africa, cotton in West Africa, rinderpest disease control, and new common bean varieties with multiple stress resistance can be added. The New Rice for Africa (NERICA), a yield-increasing, low-input variety, released a decade ago, is now cultivated on 200,000 ha, a modest but promising start.

It is puzzling how these well-established micro findings contrast with the bleak aggregate picture of African agriculture. Others, including the Centre for World Food Studies (Keyzer & Van Wesenbeeck, 2006), have made similar observations, partly on the basis of nutritional data. Gabre-Madhin & Haggblade (2004) hypothesized that the paucity of agricultural sample frames and the difficulty of measuring minor crops as well as crop output that is harvested all year, might well create a downward bias in aggregating field data. If true, this would confirm that hunger in Africa, like elsewhere in the world, is more a problem of poverty than of deficient availability.

To sustain these successes requires both improved technologies and favourable production incentives. The IFPRI expert survey underlines in particular the widening of technological options: three fourths of the stimuli to trigger agricultural change involve the expansion of the farmer's physical opportunity set. As the most important interventions are considered – in order of importance – (1) the development of *new technology* itself, (2) improved *access* to it through superior inputs and extension, and (3) increased farmer assets, of which the latter two could be labelled socio-economic issues as well. Improved *policy and institutional incentives* account for the remaining quarter, though the social scientists in the survey come up with a substantially higher rating of around two fifths. With science-based technology as a key driver of agricultural growth (as economic growth theory incidentally tells us), the dramatic declines in agricultural R&D funding (see e.g., Anon., 2007, chapter 7) are a clear threat indeed to much needed future agricultural innovation in Africa.

Acquiring higher yields: recent research initiatives

The recent UN InterAcademy Council Report (Anon., 2004) on science and technology strategies to improve agricultural productivity in Africa is a bold attempt to specify high-yielding technologies to raise productivity in a sustainable way and contribute to improved food security. The report stresses the earlier factors that differentiate farming systems in Africa from those in Asia (diverse, mainly rain-fed systems on weathered soils, rudimentary infrastructure, weak institutions and biased policies). The diversity of farming systems and crop and livestock variety means that Africa lacks the scale advantages in the development and diffusion of new technologies, which necessitates a higher and more costly research effort. Thanks to past research efforts, adoption of new varieties is taking place, roughly now at a pace comparable with that of a generation ago in Asia (Anon., 2004, p. 160).

Out of many distinct farming systems identified by the Food and Agriculture Organization of the United Nations (FAO) – varying though across and within the major agro-ecological zones of Africa – four systems have been selected that have the greatest potential for improving productivity and reducing malnutrition. These systems are (1) a maize-based mixed system, (2) a cereal/root crop mixed system, (3) an irrigated

system, and (4) a tree crop-based system. All consist of multiple cropping systems, with livestock and off-farm activities in some. Based on a production-ecology approach, a range of technological options is then specified taking into account relevant constraints and goals. The options are translated into pilots, and due attention is paid to issues of institution building, the need for more extensive training of new African agricultural scientists, market enhancement and farmer participation. Constraints in these areas are well analysed and discussed, but do not directly influence the choice of techniques.

Research strategies and policies for Africa are realistically discussed. On the domestic front no secret is made of the lack of priority for R&D by African governments themselves. Counting the agricultural priorities listed in 24 African Poverty Reduction Strategy Papers (Roseboom *et al.*, 2004) shows that research appears in only 4 documents, only slightly better than disaster management, which comes last. (Ironically, diversification out of agriculture has one of the highest scores.) Generous past donor funding may have played a role here, but the low domestic priority accorded to agricultural research may well have backfired and given donors an excuse for complacency. This low priority is in painful contrast to the consistently high rates of returns for agricultural R&D in Africa: almost four fifths of the programmes promise returns in excess of 20% (Anon., 2004, p. 158, based on IFPRI data).

Adoption in an imperfect environment

The approach followed in the InterAcademy Report (Anon., 2004) offers an excellent window of opportunities for further intensification efforts all over Africa. It shows convincingly that high-yielding varieties appropriate to the diverse conditions of African agriculture are within reach and can be gainfully applied. However, having stated a good case how sure are we that different types of farmers working in an environment of incomplete markets and institutions and often adverse policies, are likely to adopt the proposed technologies, and if so which ones? Can we convince governments that it is in their interest to support this process, and reform their policies accordingly? It is here that the 'one-quarter' or 'two fifths' contribution of and interaction with social scientists is essential and where development economics has made major contributions.

Farm households are heterogeneous in terms of assets and livelihoods. Their ability to access knowledge, modern inputs and finance differs, some are small and subsistence-oriented, other ones hesitate to take risk, the additional produce needs more labour, and then proper marketing to prevent price falls. But even if intensification promises high returns, off-farm work and migration may be even more rewarding. Under high transaction costs in product markets and an imperfectly functioning labour and credit market, a price hike for a cash crop may have little effect on its output when the farmer cannot divert family labour out of food crops. This may happen when the farm household cannot rely on additional (hired) labour or on the food market to make up for any deficit. Intensification would help, but if that requires more cash inputs like fertilizer or brings more risk, lack of credit or the absence of fertilizer traders will stall adoption.

Empirical findings confirm this as Bagamba (2007) found in the case of banana production in Uganda: either attractive off-farm employment near the towns or failing

markets in the countryside drove farmers partly away from remunerative banana production. For Kenya, Salasya (2005) found crop output to be hardly responsive to fertilizer prices because labour was not available at affordable prices. But even where more labour was accessible, farmers were found to underuse fertilizer, in full knowledge of its beneficial effect, because of failing credit facilities.

Determining the impact of technological innovations is therefore a truly Sisyphean task that requires careful modelling work to account for all these considerations. One way to do this is to start out from observed household behaviour and to model, in close co-operation with biophysical colleagues, the agro-ecological and socio-economic conditions in so-called bioeconomic models that enable scenario analysis. Such an analysis can simulate and increase the understanding of adoption behaviour, the effect of policy interventions on technology choice, the effect of failing markets and institutions, trade-offs between goals expressing efficiency, equity and sustainability, and dilemmas such as the cost of removing a constraint, say finance, versus the adoption of a second-best technology that needs less finance for its adoption.

Multidisciplinary, bioeconomic work of this type has been applied to the humid Atlantic Zone of Costa Rica (Bouman *et al.*, 2000) with a strong focus on ecological impacts, to the semi-arid cotton zone of Mali (Kuyvenhoven *et al.*, 1998a) to better understand the relation between food security and natural resource management, and recently to the problems of less-favoured areas (Anon., 2007, chapter 8; Ruben *et al.*, 2007), home to hundreds of millions of people where the gainful options for competitive high-yielding varieties are much more limited. These and other studies (Kuyvenhoven *et al.*, 1998b) show how both agro-ecological and socio-economic factors determine the choice and effect of technology. The results are also relevant to agenda setting in national agricultural research institutes. After a socio-economic screening of the technical windows of opportunities, more focused questions about promising options can be asked. In addition, for those technologies likely to be adopted, indications can be given of the complementary measures needed to make intensification a success.

Adding supportive policies, markets and institutions

It is in the field of the necessary policy and institutional incentives for intensification that the World Development Report 2008 (Anon., 2007) makes a refreshing contribution, one that can be considered complementary to the InterAcademy Report (Anon., 2004). A few examples illustrate its relevance for the agriculture-based economies of Africa. First and foremost, Africa is poorly served by *infrastructure*, in particular roads. As a result, transportation costs are higher than in the rest of the world, reducing producer prices and incentives, making essential inputs expensive if available at all, and hence severely constraining market participation and competitiveness. Many state-run market institutions proved ineffective and have either disappeared or were reformed and privatized. But, in IFPRI's words, the road to more effective marketing has only been half travelled (Van Tilburg *et al.*, 2000; Kherallah *et al.*, 2002), leaving important market failures unresolved at great cost. As much research has shown (e.g., Fan & Hazell, 2001; Fan & Chan-Kang, 2004; Escobal & Torero, 2005), improving transport unleashes numerous new activities, greatly improves labour supply, and makes one of

the highest contributions to poverty reduction.

After the demise and reform of institutions during the period of structural adjustment, innovations needed to improve agricultural input supply have proven controversial, in particular those related to financial services, seed and fertilizer. No golden bullets from theory are on offer here and a search for best practices characterizes the current debate. *Rural credit* stands out here: high information and enforcement costs keep commercial banks at bay. Local savings and loan association may then fill the need for credit, but these associations are selective, with membership fragmented along lines of location, kin- or ethnic-based networks, or assets. The strongest members of society do not participate because they can access the bank, and the weakest are unwelcome because they increase risk. Moreover, poor farmers are often unwilling to run the risk of losing collateral. Given the seasonality in agriculture, the need to pre-finance inputs and transition requirements when moving to higher-value crops, the cost of financial constraints for smallholders in terms of opportunities foregone can be huge (Anon., 2007, chapter 6) and there is great need for institutional innovations.

Microfinance has proven successful when loans can be used for a diversity of short-term activities, but does not work well when most producers are subject to common weather risks and land markets are hardly developed. Innovations might focus on other collateral assets than land such as standing crops, or to open up the possibility to mobilize savings. In this way microfinance can then possibly be linked to conventional banking institutions through the creation of reputation collateral to improve client selection. But this does not reduce weather or price risk. Alternatively, public agricultural banks can be reformed, learning from past failures, or local financial co-operatives be strengthened.

Seed and fertilizer markets are complicated markets where demand is highly variable in time and space, and the lack of economies of scale in supply and distribution cause high logistics and financing costs in all African countries. Consequently, farm gate input prices in Africa can be three times as high as in the rest of the world. Coupled with relatively low agricultural output prices and limited credit, adoption of modern varieties will then be problematic indeed. Public interventions in seed and fertilizer markets have often failed or became financially unsustainable, so that current efforts to improve markets focus on public private partnerships in input distribution systems. Novel schemes involving (private) foundations, NGOs, public plant breeding and private seed producers and agro-dealers are being worked out in search of best practices (Morris *et al.*, 2007). New challenges are arising here as much of the research in biotechnology and genetic modification is done by the private sector, with new varieties patented and not easily accessible, if relevant, to the poor (Pingali, 2007).

Alternative approaches

Before winding up the discussion on the possibilities of yield improvement in Africa, it needs to be emphasized that its contribution to poverty reduction is one among several rural livelihood strategies. Observing degrees of farm income diversification of one third (for low-income households) to more than one half (for the richer ones), Ellis (2005) argues that these off-farm labour- and migration-led strategies are puzzling

because they are not driven by agricultural success, as conventional theory would predict, but by agricultural failure. An illustration of the latter is the extra-ordinary share of households' home consumption, and hence their limited market participation. Small domestic markets that are characterized by price instability, declining real output prices, adverse agricultural policies in the parastatal era followed by the market uncertainties and institutional vacuum after the reforms that were supposed to correct earlier state failures, have convinced rural households over the years that a strategy of food self-sufficiency and diversification would be best for them.

Diversification, Ellis (2005) claims, has gone far beyond the classical reasons of risk and seasonality and recently cash needs, and has become a paradox in development. With households opting for non-farm strategies the livelihood school argues that migration and urbanization should be supported much more actively as contributing to possible poles of rapid growth. Without vibrant exports and increasing agricultural productivity, the incomes to be generated in industry and services to sustain rapid non-food growth remain a challenge, but Ellis' criticism of an easy optimistic agricultural stance on poverty reduction is a healthy reminder that farm households have more options than farming. Better seeds compete with better mobile phones.

Without subscribing to Ellis' involution argument, the recent World Development Report 2008 (Anon., 2007) reflects these considerations in a mix of productivity-enhancing and diversification arguments. For the agriculture-based economies that characterize most of Africa, it recommends a farm strategy that facilitates market chain development, promotes smallholder competitiveness and market entry, improves the productivity of subsistence farmers and ensures safety nets, and promotes non-farm employment and migration through improved labour skills. For agriculture, this puts a heavy co-ordination burden on the shoulders of African governments and donors. It is their responsibility to develop and fund well-balanced technology and policy packages that provide better seeds, roads, credit or knowledge. To shy away from this task, as so many – including the Dutch development administration have done – is no option.

Aid

Development aid is generously provided to Africa in many modalities and for many purposes. Most of it comes, economically speaking, for free or at below-market costs, and the competition for donor funds is fierce. In a rational world, with agreed development criteria like the Millennium Development Goals, aid would be allocated where it is most needed according to the best scoring proposals so as to maximize its effectiveness. As we know, reality is different. Aid serves purposes that are not related to development, and many, including academics, doubt its usefulness. If agricultural R&D programmes for Africa argue for increased support, as they do, they face an uphill battle: on the domestic front, with donors, and with aid sceptics.

Aid sceptics and critics such as Easterly (2006) argue that aid tends to increase public consumption rather than investment, keeps bad governments in power and postpones reforms, enriches corrupt elites, perpetuates costly aid lobbies, reduces the recipient's own incentives and initiatives, creates dependency, and leads to 'Dutch

disease' through appreciation of the exchange rate that harms export. It provides a rich source of inspiration for the popular media. Aid proponents, from the passionate Sachs (2005) to the measured Collier (2007), emphasize the resource- and expertise-enhancing role of aid, and point to the numerous successes in terms of countries and programmes (the Green Revolution created an international public good largely funded by aid). With aid having such opposing effects and being one factor among many contributing to development, empirical estimates of aid effectiveness are not only problematic, but can have any outcome. What matters, is to find modalities that favour the positive and minimize the negative effects of aid.

However, finding the right aid modalities is complicated by the position developing countries take. As Collier (2006) explains, technical assistance is criticized as expensive if not wasteful. But it has proven helpful in support of reforms and post-conflict reconstruction. Project aid is considered un-co-ordinated and requiring far too much bureaucracy. Projects can add to public goods though, but their visibility should not be confused with accountability as donors and NGOs claim. Because of fungibility of resources, most donor-funded projects would have been undertaken anyhow. Programme aid and debt relief normally come with conditions that encroach on the recipient governments' own autonomy. And even proponents of aid see it as subject to diminishing returns, a point that most aid flows to African countries may well have reached. So it is useful to look first at recent aid performance, draw some lessons, and apply them to the case for more international support for agricultural intensification in Africa.

Aid performance

The last decade has seen a wealth of empirical work using aggregate data trying to establish whether aid is effective (for summaries see Collier, 2006; Goderis & Verbon, 2006). Whereas some studies find that aid is, on average, not effective, most studies now find that aid does improve growth. Aid effectiveness is claimed by some regardless of the domestic policy environment, but subject to diminishing returns; others emphasize its conditionality on good (economic) policies and governance. The latter position, which is by no means uncontroversial, is shared by the World Bank and a number of bilateral donors. Other findings point to a high effectiveness of aid after natural disasters, price shocks causing terms of trade losses, and during reconstruction efforts after violent conflicts and war.

Dalgaard *et al.* (2004) have stirred up a fierce debate with their finding that aid is effective, but less so in tropical, agriculture-based countries, of which there are many in Africa. The authors suggest that adverse geography and climate in the form of tropical land, diseases or being landlocked might play a role here. They also refer to the explanation of Acemoglu *et al.* (2001), who related geography to the nature of institutions: areas with high mortality rates for European settlers had few incentives to pay attention to lasting institutions. Dalgaard *et al.* (2004, p. 211) concede that it is hard to believe that aid would be less effective in the tropics. They hypothesized that tropical areas may have particular needs in terms of foreign assistance that have so far not been met. We think we have identified some of those needs in the foregoing.

Aid conditionality is another contentious issue. Although resisted, the right application of conditionality can be defended on rational and even moral grounds.

Altruistic, unconditional aid is likely to act as an implicit tax on own initiatives, as the disincentive effects of for instance food aid show (Barrett, 2002). In contrast to *ex ante* conditionality based on promises, *ex post* conditionality based on good governance or desired outcomes appears to be working well. During the last decade this approach has enhanced aid effectiveness through selectivity in the choice of countries (Dollar & Levine, 2006) and aid allocations that are more in line with the Millennium Development Goals (Baulch, 2006).

Selectivity requires a degree of political courage though, and creates a dilemma where poverty and poor governance go together. In such a situation, policy contagion can help: successful reforms, and performance in countries supported by aid may well inspire neighbours to rethink their development strategy (as in the case of Vietnam, and even India observing China's performance). Mosley *et al.* (2004) modified the verdict on *ex ante* conditionality by proposing another, 'third' way of new conditionality based on a policy dialogue that respects the recipient country's priorities and focuses aid on pro-poor public expenditures to enhance development. Their proposal would further improve aid effectiveness and at the same time be able to influence policies.

Africa and aid

Turning in more detail to Africa, there is no doubt that past aid flows during the cold war era have had a dismal record (Collier & Gunning, 1999, p.74; Sundberg & Gelb, 2006, p. 14). However, Collier (2006) warned for too much pessimism. Comparing the impact of aid flows with that of the unconditional natural resource rents, particularly oil, the impact of aid, thanks to its different modalities and conditionality, turns out to be far superior. Not only was "the growth rate of the non-oil part of African oil exporters ... identical to the rest of Africa", resource rents also undermined democracy and the rule of law by making patronage on a large scale financially possible (Collier, 2006, pp. 1482–1484), the so-called resource curse. Without aid, Africa may therefore well have fared worse.

At the micro level there is ample evidence that aid is working now. Recent evaluations of projects funded by the World Bank show returns for Africa at par with the rest of the world, with high scores of over 20% for transport and communications, and agriculture. Moreover, the quality of donor-supported agricultural lending has improved markedly during the past decade (Anon., 2007, chapter 11).

At the level of governance, changes are encouraging. African countries, though not all, have made substantial improvements, as measured by indicators of civil liberties, rule of law, policy and institutions (Collier, 2006; Dollar & Levine, 2006). A first beginning of a policy peer review has been made through the New Partnership for Africa's Development (NEPAD), and donors, though not all, are succeeding in making aid more poverty-effective by proper selection procedures. African economic performance is finally catching up, although the role of improved governance and external assistance needs more time and effort to have a lasting impact

Agriculture and development

Where does this leave the case for further assistance to agricultural intensification in

Africa? With estimated returns to agricultural R&D high and realized returns in agriculture and rural infrastructure more than satisfactory, there is little doubt that substantially more resources can be gainfully absorbed. For most of these activities, however, those who make the cost to develop them cannot be expected to fully appropriate the benefits. These services need therefore public funding, although they can be, and sometimes are, provided by the private sector under a proper regulatory framework.

However, long-term investments compete unfavourably with public spending that promises quick results or with input subsidies that are often captured by a small elite of large farmers. The until recently depressed prices on many agricultural world markets are not an encouraging signal either. Many governments, especially of smaller countries, count on the spillover of R&D by others (Anon., 2007, chapter 7). Given Africa's heterogeneous agriculture, the potential to capture spillovers are smaller than elsewhere, but due to the small country size in Africa, national agricultural research systems are fragmented, lack scale and are either too expensive or ineffective.

A stronger domestic commitment and budget priority for agriculture, better integrated markets, regional co-operation to capture scale economies in research, and strong links with international agricultural research centres therefore appear necessary conditions to justify more external assistance. There are encouraging signs that African governments are finally committed to increase their own efforts to focus on agriculture-led growth and poverty reduction under the Comprehensive Africa Agriculture Development Programme of NEPAD. Coupled with better training and institutional reforms, these initiatives will enable the strengthening of the capacity of African countries' agricultural administration, and a better balance between domestic and external funding. Despite the relatively low levels of donor support, in several countries that balance is currently too much biased towards external funding.

Donors could assist in this process, provided their priorities support it and they are willing to co-ordinate their own programmes better. But they too have to cope with the requisite of immediacy, visibility, appeal, and electoral reward, certainly in the eyes of the media. Long-term investments in agriculture (including markets, rural finance, research and extension) and infrastructure (irrigation, roads, transport, power, and telecommunications) compete with social programmes and emergency aid, and for some NGOs with the obvious visibility of schools, medical programmes or water wells. The situation for agricultural R&D is further complicated by the comparatively large amount of maintenance research on breeding for pests and diseases that is needed to retain current yield levels. One third to one half of agricultural R&D may be needed for this purpose, a little known fact to most people.

Since the turn of the millennium, however, the prospects for donor support look better. Both developing and developed countries have come to recognize more explicitly the importance of agriculture for development (the new Dutch Minister for Development Co-operation has included agriculture among his priorities, a hopeful sign after many years of neglect). Markets for high-value products and biofuels are rapidly expanding, and the OECD countries have started to reform their farm policies, albeit on a modest scale.

Within Africa, decentralization, farmer (including women) empowerment, and public–private partnerships are coming up, signalling better prospects for a market-

oriented, small farmer strategy. Challenging options are emerging: decentralized approaches to plant breeding and varietal selection involving farmers at an early stage can reduce development and dissemination of new and high-yielding varieties from 10–15 to 5–7 years. Commercially viable FM radio services, cell phones and solar-powered internet services nowadays convey price and market information that substantially lowers the transaction costs of poor farmers in dealing with traders. Private sector involvement, including NGOs, in extension, rural credit, technical and marketing advice has in many countries lifted the quality and timing of service delivery. The rapid development of value chains has opened up export opportunities for farmers who a decade ago were only serving local markets and hesitant to adopt high-yielding crop varieties. But all this should not distract from the need to justify and mobilize continued external assistance to co-fund public goods and expertise based on the classical arguments of evidence- and science-based policy, proper lobbying and leadership that is able to build political capital and shows results.

Concluding remarks

In a world that is developing fast, Africa's relative stagnation is a human tragedy that challenges the development profession. Economic theory explains how areas that feature common growth-retarding factors can diverge from and fail to catch up with the rest of the world. Although climate and geography, and their effect on local institutions are not in Africa's advantage, inappropriate policies and weak institutions, i.e., bad governance, appear to figure more prominently in the explanation of slow growth.

Media coverage emphasizing failures has not added to Africa's image, but many examples of successes documented by experts have gone unreported, creating confusion about the real state of affairs. So have poor statistics. Visible achievements at the micro level often do not show up at more aggregate levels, which complicates issues like food security, child malnutrition and urban poverty. Recent evidence of accelerated growth in most of Africa clearly contradicts the image of gloom, but still has to find its way outside the circle of development experts.

Analysing the developments of Africa's largest sector, agriculture, and comparing it with the successes of the Green Revolution in Asia, illustrates that the common factors explaining Africa's disappointing performance are not necessarily typical for Africa, although the intensity with which they constrain development appear to be stronger than elsewhere. These circumstances create serious poverty traps and cause initially higher costs to address the growth-retarding constraints. Analysis of the current state of affairs in agriculture shows that the adverse effects of nature can be handled, that efforts to develop and apply technology for intensification in a variety of farming systems are under way, but that sustained adoption by the mass of smallholder farmers has not sufficiently taken place.

It is probably here that the best lessons can be learned from the Asian Green Revolution: no successful distribution of technological innovations like high-yielding and more resistant varieties is possible without the complementary actions, both private and public, that make it attractive and justifiable to adopt new varieties and

practices. As these activity packages are likely to be location- and time-specific, that is not an easy task. How precisely to cover risk, make credit available, target subsidies, get fertilizers, find new marketing outlets, have better roads and provide more education and health facilities is analytically demanding, but impressive expertise has been built up and best practices (not to be confused with social engineering) are emerging.

Another lesson is the recognition that for agricultural intensification to succeed, the right mix of disciplines is needed, based on fruitful co-operation and mutual awareness of the contribution of natural and social sciences. Several CGIAR centres, often in combination with universities, international NGOs and philanthropic foundations have made a promising start with this type of work. It is illustrative that a recent initiative of the Rockefeller and Gates Foundations to help develop new varieties suited to African conditions has an almost 50/50 split of research funding for breeding and the entire distribution system.

The effective implementation of channelling the right amount of funds into agricultural R&D, selecting appropriate policies and public sector investment, and targeting external assistance is a tall order for good governance. But promising signs are emerging in several African countries, showing growing democratization, more transparent public sector management, decentralization, and farmer empowerment. Old ways die hard, certainly in politics, embedded as they are in vested interests, but a move away by a new generation of politicians from patronage and serving narrow interests is visible. External aid, ineffective in the past, has found a new architecture that is much better targeted towards poverty alleviation and supportive of efforts to improve governance.

Note

The present text is an extended version of the author's farewell address as professor of development economics at Wageningen University.

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