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PRODUCER FUNDING OF R&D IN AFRICA

An Underutilized Opportunity to Boost Commercial Agriculture

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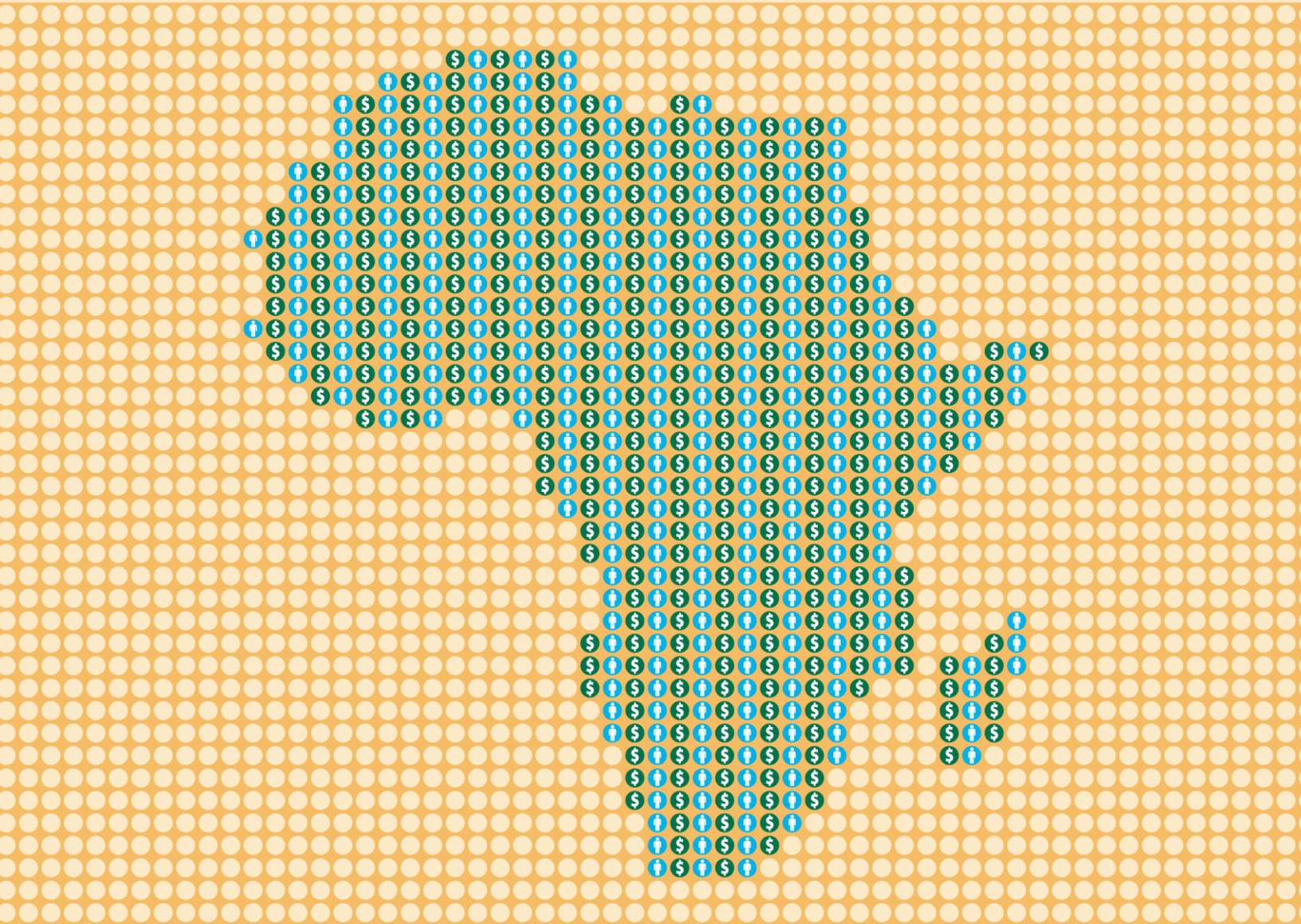
AGRICULTURAL R&D: INVESTING IN AFRICA'S FUTURE
Analyzing Trends, Challenges, and Opportunities



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Acronyms and Abbreviations

AgGDP	agricultural gross domestic product
CGIAR	Consultative Group on International Agricultural Research
CENICAFE	Colombian Coffee Research Center
CENIPALMA	Colombian Oilpalm Research Center
CENICANA	Colombian Sugarcane Research Center
CNRA	Centre national de recherche agricole [National Center for Agricultural Research] (Côte d'Ivoire)
FARA	Forum for Agricultural Research in Africa
FEDECAFE	National Coffee Federation (Colombia)
FIRCA	Professional Fund for Agricultural Research and Extension (Côte d'Ivoire)
FTE(s)	full-time equivalent(s)
IFPRI	International Food Policy Research Institute
INIA	Instituto Nacional de Investigación Agropecuaria [National Institute for Agricultural Research] (Uruguay)
KTDA	Kenya Tea Development Agency
R&D	research and development
TBK	Tea Board of Kenya
TRFK	Tea Research Foundation of Kenya

Abstract

Since 2000, global food and agricultural markets have expanded rapidly. Africa has missed opportunities to tap this export commodity boom, and at the same time has become more dependent on imports. With projected strong market prospects, both domestic and global, Africa will continue to lose competitiveness on both the export and import side unless it invests more, especially in research and development (R&D). A source of R&D funding that remains underexploited is collective action by farmers and related agribusinesses to fund research, usually through a small levy on the production of a particular commodity. This system is used extensively and with apparent effect in a number of countries with an export-oriented agriculture and for specific commodities in several African countries. Hence, there is a case for greater use of R&D levies and associated industry governance of R&D expenditures in Sub-Saharan Africa, in order to fill the looming gap in R&D funding.

The paper first presents a review of the declining competitiveness of commercial agriculture in Africa, notwithstanding its immense potential if Africa can regain competitiveness. The discussion then lays out the broad theoretical and practical issues associated with industry funding of R&D. The core of the paper provides an overview of current and potential use of levies in Africa, as well as four case studies from Africa and Latin America that represent a diversity of institutional structures for funding and carrying out research on commercial agriculture.

Evidence indicates that collective funding of R&D through levies is underutilized in Africa. Where it is employed, it works better than publicly financed research, although there is considerable potential for improvement. Importantly, strong producer and industry associations can ensure the success of such funding mechanisms.

1. INTRODUCTION

Since 2000, global food and agricultural markets have expanded rapidly. Africa has missed opportunities to tap this export commodity boom, and at the same time has become more dependent on imports itself. With projected strong market prospects, both domestic and global, Africa will continue to lose competitiveness on both the export and import side unless it invests more, especially in research and development (R&D). A good part of this investment must come from public sources. The private sector will also play a role, especially for commercial agriculture through technology embodied in inputs (Pray 2011). However, given recent trends, both public and private investment is likely to fall far below requirements (Beintema and Stads 2011).

A third source of funding that remains underexploited is collective action by farmers and related agribusinesses to fund research, usually through a small levy on the production of a particular commodity. This system is used extensively and with apparent effect in a number of countries with an export-oriented agriculture, such as Australia and Uruguay, and for specific commodities in many countries of the tropics, such as in Malaysia and Colombia. There is also experience of using commodity levies in Africa dating from colonial times, some of which have been successful. For reasons of feasibility and affordability, levy funding has the most potential for cash crops—a sector not supported by the Consultative Group on International Agricultural Research (CGIAR),which has played a critical role for R&D on food crops (Alene et al. 2011).

This paper aims to develop a case for greater use of R&D levies and associated industry governance of R&D expenditures in Sub-Saharan Africa. Such approaches can serve to both fill the looming gap in R&D funding as well as improve the overall accountability of research institutions to their major users.

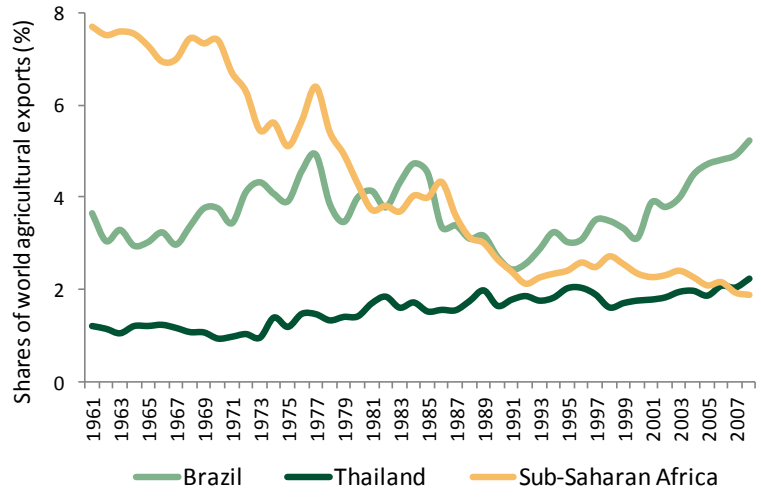
2. GLOBAL AND REGIONAL MARKETS: THE CHALLENGE AND OPPORTUNITYOF COMPETITIVENESS

The Loss of Competitiveness of African Agriculture

Over the past 15 years, world agricultural trade has approximately tripled in nominal value terms. Demand growth has been led by East Asia, especially China, and the Middle East, regions that face severe land or water constraints. A number of middle-income exporters have successfully tapped into these expanding markets. In terms of the increase in the value of net food and agricultural exports over the period 1993–2008, Brazil and Argentina were in1st and 2nd place, and three Southeast Asian nations—Indonesia, Thailand, and Malaysia—were in 4th, 5th,and 6th place (the United States was 3rd). African countries have ranked very poorly in capturing these expanding markets. Côte d'Ivoire, the best performer, was in 22nd place, followed by Kenya in 32nd, and Malawi and South Africa in 38th and 39th place, respectively.

While Africa contributes 12.1 percent of world population and 5.3 percent of agricultural GDP (AgGDP), its share of global agricultural exports fell to 2.0 percent in 2009 compared with 7.6 percent in the early 1960s. Much of this decline occurred during the pre-structural adjustment period, but it has continued to fall since 2000, at a time when global exports have risen steeply. The value of agricultural exports from Thailand, with less than 10 percent of the population of Sub-Saharan Africa, is now greater than that for the whole Sub-Saharan African region. Likewise, Brazilian exports are 250 percent of all African exports (Figure 1).

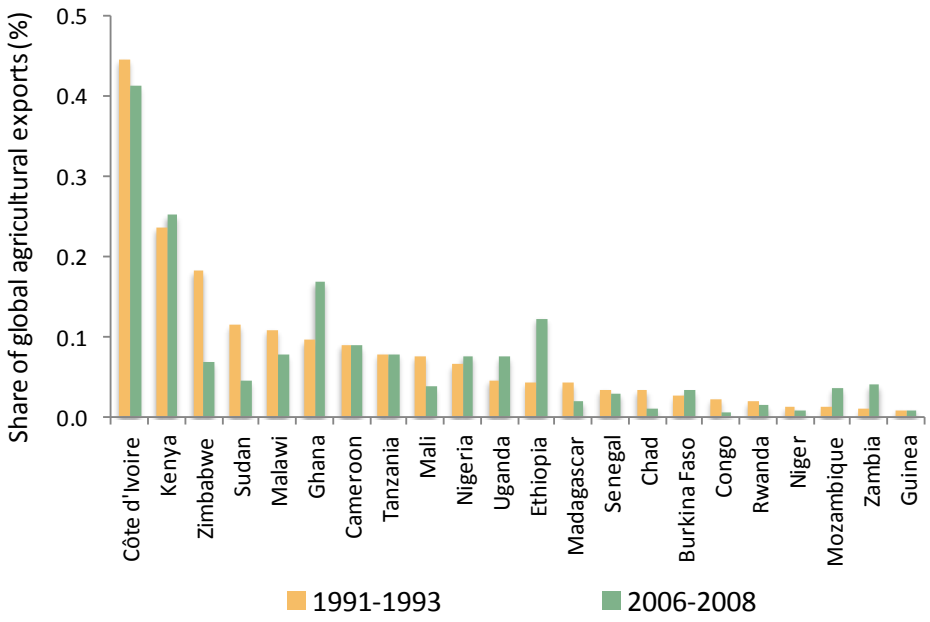
Figure 1. Shares of world agricultural exports, Africa versus Thailand and Brazil, 1961–2008



Source: Calculated by author from FAO (various years).

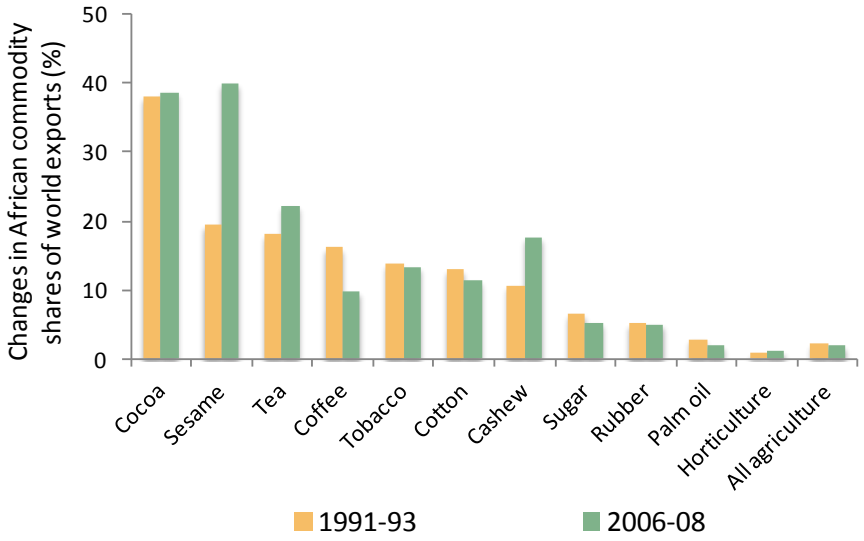
At the country level, successful African exporters in terms of market share have been Côte d'Ivoire, Kenya, and Zimbabwe, and except for Zimbabwe, these countries have maintained market share in recent decades (Figure 2). However, 15 of 24 countries with a population of over 10 million in Africa have lost market share. Ethiopia, Ghana, Uganda, Mozambique, and Zambia stand out as African success stories in terms of significantly increasing export market share since 1991, although the last two started from a very low base. Among its 10 most important exports in 2008, Africa has gained significant market share in tea, cashews, and sesame since the early 1990s and lost a major share of the coffee market (Figure 3). Other shares have not changed much, including horticulture—which, while growing rapidly, is still very small (less than 1 percent of world markets).

Figure 2.Global share of agricultural exports by country, early 1990s and late-2000s



Source: Calculated by author from FAO (various years).

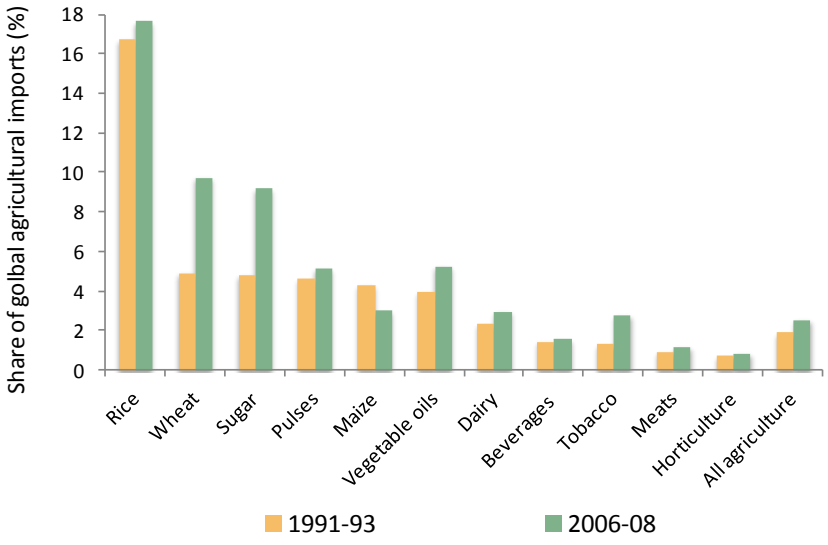
Figure 3. Changes in Africa commodity shares of world exports, top 10 agricultural exports, early 1990s and late-2000s



Source: Calculated by author from FAO (various years).

Further evidence of declining competitiveness is provided by import trends. Food import shares have been rising, so that Sub-Saharan Africa has converted from a significant net agricultural exporter in the 1970s, to a significant net agricultural importer in the 2000s. Eighteen of the 24 countries with a population above 10 million have increased their share of global imports. As expected, the two largest importers are oil producers, Nigeria and Angola. Since 1991, Africa's share of global imports increased for all commodity groups, except maize (Figure 4). African imports of rice are approaching 20 percent of global trade, and imports of wheat and sugar are close to a10-percent share. On the livestock side, milk and poultry imports have risen very rapidly to about US$2.7 billion in 2008.

Figure 4.Changes in African commodity shares of world imports, top 10 agricultural imports, early 1990s and late-2000s

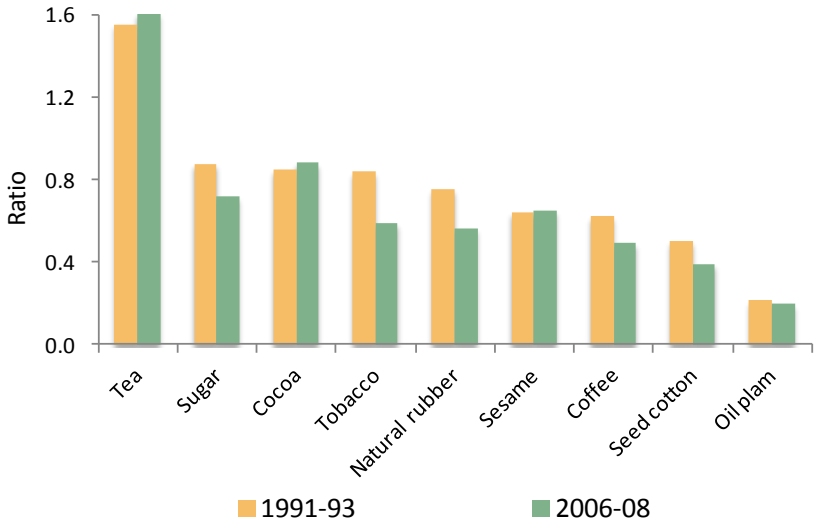


Source: Calculated by author from FAO (various years).

Low and Stagnant Productivity Underlies Poor Competitiveness

Declining competitiveness is in large part due to low and stagnant productivity (Figure 5).While Africa's growth performance has improved since 1995, this has mostly been achieved through expansion of area, in part driven by stronger commodity prices. For export crops, yields of tobacco, rubber, coffee, cotton, and oil palm are less than half the average for the rest of the developing world, and this gap has widened in nearly all cases. Tea is a major exception on both counts.

Figure 5. Ratio of yields of cash crops in Africa versus Latin America/Asia, early 1990s and late-2000s



Source: Calculated by author from FAO (various years).

Given that since structural adjustment African producers have captured a much higher share of world prices, a reasonable hypothesis is that poor yield performance is in large part due to low investment in R&D. In some crops this can be well documented. For example, research on oil palm, a crop that originated in Africa, has been led by Malaysia over the past three decades, through a strong industry-led effort to fund the Malaysian Oil Palm Board (with a budget of around US$30million for R&D in 2010). Much of this research spilled over to Indonesia, and exports of palm oil by these two countries now exceeds the value of *all* agricultural exports from Sub-Saharan Africa. In the case of cotton, a leading export for several African countries, Boughton and Poulton (2011) have documented the slowdown in release of cotton varieties in Sub-Saharan Africa from a total of about 45 in 1985–95, to about 19 in 1995–2005. Adoption of transgenic *Bt* cotton, for example, has only just taken off in Burkina Faso, the first country to adopt in West Africa—but six to eight years behind its global competitors. On the other hand, crops with a strong research presence in Africa have performed better, as the discussion of tea and cocoa below will show.

Strong Market Prospects Will Drive Agricultural Commercialization

It is not too late for Africa to reverse these trends. Rising demand for feed grains and feedstocks for biofuels, as well as fibers for industry, is driving global food and agricultural prices higher. Aside from the usual tropical crops like cocoa, coffee, cotton, tobacco, tea, groundnuts, cashew, rubber, and more recently horticulture—which tend to be grown in restricted areas featuring specialized agroclimatic characteristics—African countries with relatively good land and water resources and low population density, should be able to tap booming markets in rice, maize, soybeans, sugar, palm oil, and biofuel feedstocks, to emerge as major exporters on world markets following the example of recent successes in Latin America and Southeast Asia (World Bank 2009). Added to this, most African countries enjoy

special trade preferences with the European Union and United States, giving them an advantage over their competitors.

However, domestic and regional markets offer the most attractive opportunities for African commercial agriculture in the medium term. With the urban population in Africa projected to double by 2030, and with per capita income growth rates of 4 percent per year, urban food markets are set to quadruple in the next 20 years (World Bank 2011). Under a business as usual scenario, the International Food Policy Research Institute (IFPRI) projects that dependence on food imports will also grow with a doubling of cereal, dairy, and meat imports by 2025, providing a large potential market through competitive import substitution (World Bank 2007). The diversity of African agriculture and climatic conditions provides major opportunities for regional trade, which is only about 10 percent of Africa's total agricultural trade (Diao et al. 2007).

African Countries Have Several Comparative Advantages

On the supply side, there are at least four reasons why Africa should be able to tap improved market prospects.

- At a time when much of the world, especially in Asia, is facing acute land and water scarcity to further expand agricultural production, Africa has an abundance of both. Globally, nearly half of the about 450 million hectares (ha) of uncultivated land that is suited for crop agriculture expansion is in Africa—although often far from ports and roads (Deininger and Byerlee 2011). This is more than double the area currently cropped of 207 million ha. At the same time, total economically exploitable irrigation potential is estimated to be at least 39 million ha, four times the current level.
- The macroeconomic environment for business investments has dramatically improved. In 1980–84, governments plundered African agriculture with the average price of exports only about half of world equivalents; this fell to a 19-percent equivalent tax in 2000–04, still the highest of any region (Anderson and Masters 2009).
- Africa has significant locational advantages, real and potential. Much of Africa is physically close to big markets in the Middle East and Europe. While transport costs are high, this does not need to be so. Better road networks and transport corridors are opening new markets, such as exports from western Ethiopia via Port Sudan into the Gulf market.
- Private investor interest in Africa is unprecedented**.** Agriculture and associated industries are now one of the favored sectors for foreign direct investments, private equity investments, and sovereign wealth funds. Africa received about $1 billion in 2008, and reports of investment activity over the past two years indicate a sharp increase. While direct investment in farmland has often been to the detriment of local communities, it could provide significant benefits if managed well (Deininger and Byerlee 2011).

Together with strong markets, these four supply-side factors suggest that commercial agriculture could be a major source of growth in many countries of Sub-Saharan Africa, following the recent path of Brazil, Thailand, and other land-abundant countries over the past 20 years. The challenge is to invest more in R&D to ensure that African countries can compete in these markets.

3. THE WHY AND HOW OF LEVY FUNDING

Levies offer a way to fund R&D on commercial agriculture. In this paper, levies refer to collective action by producers and processors, nearly always backed by legislation, to impose a small tax on production in order to fund collective goods, such as R&D and market promotion, that are in turn made accountable to industry representatives. This type of funding arrangement has two major objectives. First, and most obviously, it aims to increase the total funding of R&D in a specific industry (Bingen and Brinkerhoff

2000), given the overwhelming evidence of underfunding of R&D nearly everywhere.[1] Second, if constructed as truly collective action by users rather than a dictate by government, it aims to empower users in setting the research agenda and making research organizations accountable to them (Klerkx and Leeuwis 2008).

While conceptually simple, there are a number of theoretical and practical issues in implementing a levy funding mechanism.

Theoretical Issues

It is well known that the private sector underinvests in most agricultural research, in large part due to its nonexclusive and nonrival nature. In a related paper for this conference, Pray (2011) notes some cases, such as hybrid seed, where profits from specialized private input firms that carry out R&D can be appropriated, although these are infrequent in the African context. A less stated reason for private underinvestment is that much research involves significant economies of size due to high fixed costs relative to market size (Byerlee and Traxler 2001). In agriculture, outside of a few cases, such as plantation crops and commercial horticulture, farms and other firms in the industry are generally too small to efficiently undertake R&D for their own use beyond very simple adaptive research for testing new technologies.

One way of overcoming both the nonexclusive and economies of size problems is for firms in the industry to collectively fund their own research. Take the simplest case of a one-stage industry where the production of a commodity is carried out by homogeneous firms (that is, farms), all using the same technology and facing a perfectly elastic demand so that all benefits of research are directly captured by firms in the industry. Firms in this situation could act collectively to fund their own industry-specific research with each firm paying an equal share of costs and receiving equal benefits, and each firm having equal vote in determining research priorities. If all research were industry specific (that is, no spillovers or spill-ins) and outcomes of research were known with certainty, they could collectively fund research until marginal returns fall to zero.

Even in this simplest case where all firms equally benefit, there would be strong incentives for free riders, unless the industry is able to make the cost of research mandatory for all firms in the industry. In a small industry of homogenous products and a few large firms, peer pressure and use of trade secrets might be sufficient to eliminate free riders. In other cases, a sufficient number of firms acting through the political process has to make the case for legislation to require all firms to pay the costs of research.

The real world quickly complicates the potential for this type of collective action. First, research is an inherently long-term and risky business, so risk-averse firms generally underfund research. Even risk-neutral firms would likely underfund very long-term research that will benefit the next generation, as well as more upstream research that provides benefits across industries. Industry participants would also have no incentive to fund research related to externalities of an industry, especially environmental goods, so that R&D in aggregate would remain underfunded from the point of view of the social good. Further, if each commodity organizes its own research, they may create inefficiencies by failing to realize synergies between products grown in the same production systems. Finally, an industry facing a less than perfect elasticity of demand may act to fund research only in proportion to the benefits received by producers, although theoretically it can be shown that under usual assumptions about research-induced supply shifts, the costs of a research levy are shared between producers and consumers in the same ratio as the benefits (Alston and Mullen 1992).

More importantly, agricultural industries are by nature heterogeneous and multistage, greatly complicating the distribution of benefits of R&D within the industry. These issues are explored in Alston in various dimensions (Alston 2002; Alston, Freebairn, and James 2004). In a multistage industry, under

[1] This is especially manifested in universally high rates of return to R&D.

plausible assumptions (competitive industry, parallel shift in the supply curve, similar factor proportions at each stage), the benefits of research are distributed according to R&D costs, so a multistage industry may not be a major problem (Alston 2002). In a heterogeneous industry with firms of different sizes, R&D costs can be shared according to a measure of size to achieve some level of equity. A common way to do this is to set a levy as a share of production value, but this introduces a potential distortion in price incentives, albeit a small one, and one that is eventually more than offset by a research-induced downward shift of the supply curve. In addition, agriculture is agroclimatically and structurally heterogeneous, and some farms will inevitably gain more, and some may even lose from technological change. These disparities are further accentuated if larger and more politically powerful members have disproportionate power in a collective process to set the research agenda. At the extreme, very large firms able to efficiently conduct their own R&D may have little incentive to join collective action on R&D.

Given all of these uncertainties and spillovers, an industry acting collectively is likely to underfund research, and this has been used as an argument for matching grants from general tax revenues. Theoretically, the optimum size of a matching grant can be determined under simplifying assumptions, but this is difficult to do in practice (Alston, Freebairn, and James 2004).

Practical Issues

Beyond theoretical issues, there are also a number of practical issues to using levies to fund research that have been identified in the literature (for example, Kangasniemi 2003; Brennan and Mullen 2003).The most obvious limitation is the feasibility and cost of collecting levies in smallholder agriculture. In general, levies are only cost effective for commercial crop and livestock products that pass through a small number of processing or marketing points. This is obvious for most export-oriented products, but many opportunities also exist within domestic markets, especially where production is largely commercial and geographically concentrated. Examples in Africa include irrigated rice, wheat, and sugarcane and, in many cases, some partially commercial products, such as groundnuts, poultry, and dairy.

Levies are obviously of limited value for a new industry with future potential, and will likely result in underfunding for a rapidly expanding industry (and vice versa), due to long-term payoffs to R&D. Levy funding may also be unstable due to variable prices and production. Although funding can be smoothed through reserves, it may still be difficult to manage very long-term research for tree crops with an inherently long-term cycle of prices.

There are also practical issues related to the objective of making R&D more accountable to industry in terms of priorities and delivery of results. Levies therefore require strong industry governance and accountability mechanisms, with appropriate means to aggregate demands from different segments of the industry and from different geographical regions. An additional complication is that the case for collective action goes beyond R&D to include other “industry public goods,” such as market promotion extension, and control of pests with externalities. There are clearly advantages from an efficiency viewpoint in having only one levy to cover these various activities; however, the allocation of the funds between research and other uses then becomes a further decision point. Long-term risky activities, such as R&D, are likely to be penalized in this process (as are also R&D expenditures in public budgets).

Finally, there are a variety of institutional design issues for undertaking the research generated by such funds. Funds may be managed by a dedicated funding body, such as the research and development corporations in Australia, which outsources research competitively or through other means to existing, largely public, research organizations. In other cases, a dedicated commodity research institute under the control of the industry is funded from the levy, although this may reduce economies of size and scope. A levy may also be applied across commodities, with a single governing body, that either outsources research (for example, Côte d’Ivoire) or funds a multicommodity research

institute (for example, Uruguay). This complicates governance, since allocation across subsectors is a further decision point. These practical issues are further examined in the case studies below.

Recent institutional innovations include a levy based not only on production, but also on production of a specific crop variety. This is being employed in Australia in what is called an "end-point royalty" that in most respects is akin to pure private research, since the fee is set by and paid to the developer of the variety. A twist on this approach has now been initiated in Africa to reward technology developers according to adoption levels, but with funds provided by donors rather than farmers.

4. POTENTIAL AND CURRENT USE OF LEVIES FOR FUNDING R&D IN AFRICA

The Potential for R&D Levies

In Africa, commercial agriculture—defined as farming that is largely oriented to the market—is dominated by smallholders. Major export crops, by definition, are commercially oriented. Since they pass through one or a very few ports, they are officially registered, and are also relatively easy to levy for funding for R&D and other activities in support of the industry. Obviously these opportunities are more important in countries with a strong export orientation, such as Côte d'Ivoire and Kenya. In addition, much commercial production is oriented to domestic markets, and in some cases the nature of production or processing could facilitate the collection of levies. Sugarcane, oil palm and some other oilseeds, and wheat are in this category, since most commercial production passes through a few fairly large-scale mills. In addition, crops extensively produced under irrigation, such as rice in some countries, are largely commercial and would be easy to levy. Some commercial livestock, such as dairy and poultry production, could also be levied.

A minimum threshold industry size is needed to introduce a levy, since the levy generated has to be large enough to cover the costs of collecting and managing it. I arbitrarily set the threshold industry size at $US100 million per country; a 1-percent levy on such an industry would generate at least $US1 million for R&D. This is roughly the budget of the very effective (although underfunded) Tea Research Foundation of Kenya (TRFK), discussed below.

Table 1 summarizes exports exceeding US$100 million for African countries with a population of over10 million (Mauritius has also been included, given the overwhelming dominance of sugarcane and the importance of levy funding). In addition, estimates of other commodities for domestic markets that could be potentially levied are added for a subset of countries, based on FAOSTAT values of commodity production (FAO various years).

In most countries, this screening process identifies several commodities that could be levied. Based on exports only, industries with over $100 million per country amount to $17 billion of production value, while domestic market-oriented industries with over $100 million are of roughly the same order of magnitude. Assuming that all large export commodities are levied, and about half of the large domestic market commodities are levied at 1 percent, the potential total levy would be about $250 million or about one-third of all current R&D spending (in 2005 PPP dollars).

The potential of levy funding could be greater if regional collective action that could fund R&D on commercial crops in small countries and producers were included. Indeed, prior to independence, several crops—including tea in East Africa, and oil palm, rubber, cocoa, and rice in West Africa—were regionally funded in the former French and British colonies. Regional collective action, as already employed for rice in Latin America, would be a logical extension of the current move toward formal regional collaboration in food crop research in Africa.

Table 1. Summary of research spending, commercial agriculture, and use of levies in Sub-Saharan Africa, 2008

Country	R&D intensity (% AgGDP)	Export crops of more than US$100 million	Additional commercial product of more than US$100 million	Existing levy	Estimate of levy for R&D PPP dollars million	Industry controlled research institute	Other industry funding
Angola		None	na				
Burkina Faso	0.43	Cotton	None				
Burundi	1.78	None	None				
Cameroon		Cocoa, banana, rubber, horticulture	Oil palm, sugar				
Chad		None	na				
Côte d'Ivoire	0.54	Cocoa, rubber, cashews, banana, coffee, oil palm	Rice	Cocoa, coffee, rubber, fruits, plus four others	5.6[a]		
DR Congo		None	na				
Ethiopia	0.27	Coffee, sesame, horticulture	Sugar				
Ghana	0.90	Cocoa, horticulture	None	Cocoa	32.7	Cocoa[d]	
Guinea	0.16	None	None				
Kenya	1.30	Tea, coffee, horticulture	Sugar, dairy, wheat	Coffee, tea, sugar[e]	6.1	Coffee, tea, sugar	
Madagascar	0.25	None	None			Horticulture	Industry members fund horticulture
Malawi		Tobacco	None	Tobacco, tea[c]	6.1		
Mali	0.64	Cotton	Rice				Ad hoc cotton funding to public research
Mauritius	3.92	Sugar	None	Sugar	9.4	Sugar	
Mozambique	0.38	Tobacco	None	Cotton			
Niger	0.25	None	None				
Nigeria	0.42	Cocoa	Rubber, groundnuts, oil palm, rice				
Rwanda	0.53	Tea	None				
Senegal	0.88	None	Groundnuts				
South Africa	2.02	Horticulture, citrus, sugar, wine, maize, oilseeds, wool, wheat	Soya, dairy, sugar	Sugar	18.6	Sugar	
Sudan	0.27	Sesame	Cotton, wheat, sugar, groundnuts				
Tanzania	1.24	Coffee, cotton, horticulture	Rice	Tea, coffee, tobacco, cotton, and others	7.4	Tea, coffee, tobacco	
Uganda[b]	0.50	Coffee	None	Coffee	4.7	Coffee	
Zambia	0.29	None	None		0.05		
Zimbabwe		Tobacco, cotton	Na	Tobacco, grains/ oilseeds	2.0	Tobacco, grains/ oilseeds	

Source: Compiled by author from ASTI country briefs, ASTI data, and FAO (various years).
Notes: NA indicates that data were not available.
a. Contributions by producer organizations through the Professional Fund for Agricultural Research and Extension (FIRCA).
b. Uganda collects levies on exports, but except for coffee these are not allocated to R&D.
c. Tea research is performed for Zimbabwe in addition to Malawi. Data are for 2001 only.
d. Cocoa research is under Cocobod, a state marketing board with some grower representation.
e. Does not include levy funding for sugar.

Current Use of Levies

Agricultural Science and Technology Indicators (ASTI) initiative data and reports provide an overview of current use of levies and other industry funding sources in Africa (also commonly known as cesses in former British colonies). Overall, my very rough estimate is that about PPP$93 million (about $45 million in 2005 dollars at official exchange rates) was provided by industry for research in Sub-Saharan Africa in

2008, most commonly for coffee, cocoa, tea, sugar, and tobacco (Table 1).This amounted to less than6 percent of total agricultural R&D spending. Only 9 of this set of 26 countries appear to use any levy, and where they do, only a couple of commodities are covered. Over half of industry funds were generated in two countries—Ghana for cocoa (PPP$33 million) and South Africa for sugar (PPP$19 million) (Nieuwoudt and Nieuwoudt 2004). Côte d'Ivoire, Kenya, Malawi, Mauritius, and Tanzania each generated PPP$5–10 million in levies.

Levies are mainly legislated, often at the request of the industry. In the case of Uganda, levies are imposed on exports, but except for coffee they are not allocated to research. In most other cases, the levies collected are not exclusive to research, and research institutes have to compete with other uses, such as extension and market promotion. In a few cases, the industry may make ad hoc contributions to funding. This is most evident for the Cocoa Research Institute of Ghana, which receives a yearly budget of about PPP$33 million from the earnings of the Cocoa Board of Ghana. This is the largest industry-funded research effort in Africa, although it is not strictly a levy. Other examples include the Mali cotton company's contribution to cotton research, but these are generally quite small.

The institutional arrangements under which the industry funds are allocated to R&D also vary considerably.

- Most common is a legally required levy that is allocated to an industry council or board with official status, which then allocates a portion of the funds to a dedicated nonprofit research institute affiliated with that board (for example, tea and sugar in most countries). The influence of producer organizations in these boards may be quite variable.
- A variant on this is to have a regional research institute funded by a levy on tea producers in the region. The only current example is the Tea Research Foundation of Central Africa, funded by a levy on tea production in Malawi and Zimbabwe and governed by representatives of both countries.
- A second mechanism is a legally required levy that is allocated to fund research on a commodity at a public research institute, with varying degrees of industry input into the research program. Cotton in Tanzania and Mozambique seem to be in this category. In both cases, there have been difficulties in setting up an institutional structure that provides the industry with a sufficient sense of ownership (Boughton and Poulton 2011).
- Côte d'Ivoire, discussed further below, is a special case, whereby a council of several producer organizations organizes the collection of the levy and then allocates it to the public research institutes.

ASTI data on 10 industry-funded research institutes in seven African countries is summarized in Table 2. Comparing crop-specific research expenditures relative to crop production values (assuming no research is conducted on these crops outside of these institutes) provides an estimate of crop-specific research intensity that can be compared with the research intensity for all public research in each country.[2] In eight cases, crop-specific research intensity supported by industry funding is higher than for overall research intensity. In some cases, research intensity is very high by global standards, although some are small industries (tea in Malawi and Tanzania), or the industry is declining (coffee in Kenya and sugar in Mauritius). In two cases, tea in Kenya (a large industry) and tobacco in Tanzania (a relatively small industry), crop-specific research intensity is lower than the national average.

[2] The estimates are not strictly comparable, since crop-specific research intensity is relative to production value, whereas overall research intensity is relative to value-added. However, the difference is likely to be small, and in any event would not change the conclusions because crop research intensity is likely underestimated.

Table 2. Overview of industry funding of crop specific research institutes in Africa, 2008

Country	Commodity	R&D expenditure	Levy	Industry value	Specific crop R&D intensity[a]	Public R&D intensity
			Million 2005 PPP dollars			
Ghana	Cocoa	33.25	32.67	757	4.4	0.9
Kenya	Tea	3.10	1.70	369	0.8	1.3
Kenya	Coffee	5.78	4.41	45	12.8	1.3
Malawi/ Zimbabwe	Tea	2.42	1.38	65	3.7	0.7[b]
Mauritius	Sugar	9.89	9.44	149	6.6	3.9
South Africa	Sugar	18.59	na	673	2.8	2.0
Tanzania	Coffee	3.43	0.37	46	7.4	0.5
Tanzania	Tobacco	0.06	na	81	0.1	0.5
Tanzania	Tea	4.10	na	37	11.1	0.5
Uganda	Coffee	4.75	1.51[d]	228	2.1	1.2

Source: Compiled by author from ASTI data; industry value data are FAOSTAT estimated values of production in purchasing power parity (PPP) dollars 2004–06.
Notes: Research intensity is relative to agricultural GDP.
a. Percent of industry value for specific crops and agricultural GDP for all public R&D. Public R&D estimates include levied crop research for Ghana, Tanzania, and Uganda.
b.2001 data.
c. 2007 data.
d.Uncertain estimate.

How effective is levy-funded research? At an aggregate level it is difficult to assess effectiveness, but nonprofit spending as identified in the ASTI database is a good proxy for levy-funded research in some countries. In every case, spending per full-time equivalent (FTE) scientist is significantly higher for nonprofit research than for publicly funded research, although this is in part due to the inclusion of costs of managing on-station plantations in the budget data of nonprofits (Figure 7). By contrast, trends in research spending are less conclusive. In Mauritius and Kenya, spending in the nonprofit research institutes has declined in the past decade, while spending in government institutes has increased. In South Africa and Tanzania, spending in nonprofits has increased, and at a faster rate than in government institutes. Further insights on effectiveness are provided by case studies of funding in specific industries and countries in the following section.

5. CASE STUDIES OF INDUSTRY FUNDING

Four cases of levy funding were chosen for further analysis—two in Latin America and two in Africa. The cases are not intended to be representative and were selected based on a number of factors:

- success in terms of improving research effectiveness;
- diversity of institutional arrangements, from single-commodity research institutes to multicommodity institutes, and outsourcing of the research; and
- availability of information and direct contacts with the institution.

In the Latin American cases, I made visits to the institutes or associations, talked to relevant officials, and reviewed annual reports and other documentation. In the African cases, local experts prepared the case studies (Nzuma 2011; Doumbia 2011). The reviews focused on three issues—the institutional setup, the levels of and trends in funding, and evidence of the effectiveness of the research funded and the role of producer associations in enhancing effectiveness. The last issue is necessarily quite subjective, since in all but one case, there has been little impact evaluation. In the case of INIA Uruguay, a 20-year impact evaluation has just been completed (IICA 2011).

National Institute for Agricultural Research, Uruguay

The National Institute for Agricultural Research (Instituto Nacional de Investigación Agropecuaria or INIA) of Uruguay represents a model of farmer financing at the national level. INIA was established in 1989 as a autonomous public agency, under private and state co-management. It is a not-for-profit organization that conducts research, manages scientific knowledge, and links with technology transfer bodies. INIA is funded through a levy of 0.4 percent on traded agricultural products matched by law with an equivalent contribution from the Government of Uruguay. In this sense, INIA is similar to research and development corporations in Australia, the major difference being that INIA performs most of the research itself. By law, 10 percent of the funding is allocated to research performed externally, mainly at the national university. Overall, INIA accounts for about 60 percent of public spending on agricultural research in Uruguay (Stads, Cotro, and Allegri2008).

The levy is collected on all agricultural produce with the exception of fruits and vegetables produced for the local market. It is collected at major processing or marketing points in combination with a general tax on agricultural products. It is estimated that at least 90 percent of the value of agricultural production is covered by the levy. Overall the levy generated about $33 million in funds in 2008 (including the matching government contribution), a sizable amount for a small country of 3.5 million people.

INIA has a board of four members with two appointed by producer organizations and two, including the chair, appointed by the government. As such it responds to both the farming population and government policy. For example, in recent years it has established research programs on (small-scale) family farming and sustainable agriculture in response to government policy directives. The Institute employs some 134 scientific staff located on five major research stations across the country. By most measures, INIA is well resourced relative to its counterparts in neighboring countries (Table 3). Real expenditures have grown 2.3 times since its establishment, and Uruguay has the highest research intensity in the region. Salaries are generally competitive and account for about 55 percent of the budget, leaving considerable flexibility to cover operating costs. Some 77 percent of scientists have postgraduate degrees, and funding per scientist has increased in real terms by 60 percent since 1990.

Table 3. Comparative indicators of research spending and human resources, Uruguay and its neighbors

Indicator	Uruguay	Argentina	Brazil	Chile
R&D spending as a share of AgGDP, 2006 (%)	1.99	1.27	1.68	1.22
INIA budget as share of AgGDP, 2006 (%)	1.19	na	0.96	na
Percapita R&D, 2006 (2000PPP dollars)	15.61	7.61	6.81	6.45
Annual growth of government R&D spending, 1990–2006 (%)	3.65	2.61	–0.74	1.92
INIA operating budget as share of total budget, 2006 (%)	52	20	na	40
Spending per full-time equivalent researcher, 2006 (2000PPP dollars)	206	130	241	152
Share of INIA scientists with a postgraduate degree (%)	77	13	99	60
Share of INIA scientists with PhD degree (%)	32	na	77	na

Source: ASTI database and country briefs.
Note: INIA indicates Uruguay's National Institute for Agricultural Research.

As a multicommodity research institute, INIA has to respond to demands from a range of sectors within the context of a small open economy. INIA's board allocates funds across programs, including commodity-based programs and others, such as natural resources management and family farming. Simple congruency analysis suggests that there has been under-spending on annual rainfed crops and plantation forestry relative to rice, dairy, and especially fruits and vegetables (IICA 2011). However, given the importance of private sector spill-ins for rainfed summer crops (maize and soya) and forestry, and the large number of fruit and vegetable species and their importance to small-scale farmers, such

difference may be expected. But it does mean that some who pay the levy may receive little benefit, while fruit and vegetable farmers who do not pay, still benefit.

INIA has a strong institutional structure to capture the demands of producers and other actors along the value chain. Each regional station has a regional advisory council, as well as technical working groups for each commodity or research program to provide input and feedback into research priorities, technology design, and technology transfer. In addition, INIA has facilitated specialized associations for integrated management of horticulture, as well as for fine wool merinos. INIA also actively participates in 14 commodity-based roundtables at the national level and in an innovation consortium for dairy.

A recent evaluation of INIA supports its overall effectiveness as a national leader in agricultural research. Uruguayan agriculture has enjoyed a growth of total factor productivity of about 2 percent annually, and over the past 20 years, it has gained export market share in 8 of its 10 top commodities. The evaluation estimated a benefit–cost ratio for investment in public research of 16:1 to 20:1, and also found generally positive social and environmental impacts as well. However, impacts have been patchy with positive evidence for dairy, rice-pastures rotation, and wheat and barley. Impacts have been negligible for extensive livestock grazing, Uruguay's largest sector (IICA 2011).

The evaluation also identified weaknesses in socioeconomic research and technology transfer. Without a formal extension system, INIA needs to explore multiple impact pathways. Management issues identified that require attention included replacement of aging staff, better priority setting, monitoring and evaluation, maintaining scientific quality through peer-reviewed publications, and knowledge management (IICA 2011).

The "CENIs" of Colombia

Colombia has a long tradition of strong producer and industry associations, beginning with the founding of the National Coffee Federation (FEDECAFE) in 1927 (Gomez 2011; Bentley and Baker 2000). These associations have developed a series of collective actions around R&D, technology transfer, quality control, market promotion, and sectorial policies and strategies, supported by "parafiscal" taxes on that product. These taxes are legislated and levied by the government on behalf of the association, and the associations are in turn contracted to manage the revenues generated in benefit of the industry. National associations exists for at least 13 products with accompanying legislation on levies for coffee, sugar, oil palm, rice, cereals, cotton, cocoa, and fruit (Stads and Romano 2008). Together these account for about 30 percent of the total spending and scientific staff for agricultural research in Colombia (Stads and Romano 2008).

Each of the associations funds research on its product. However, the amount of the levy and the institutional arrangements for research vary considerably by industry. The large sectors have their own dedicated research institutes, such as Colombian Coffee Research Center(CENICAFE), Colombian Oilpalm Research Center(CENIPALMA), and the Colombian Sugarcane Research Center (CENICANA). The case studies considered here are for two major cash crops, coffee and oil palm. These crops both originated in Africa, but Africa has been losing global market share, while Colombia has gained third place in coffee and fourth in palm oil production. Coffee, Colombia's most important and best-known agricultural export, is produced in the mid-altitude areas by over a half a million smallholders with an average of 1.5 ha (Table 4). Coffee research is undertaken as an integral part of FEDECAFE. It is the oldest such institute, established in 1938, and now commands a considerable infrastructure, consisting of a state-of-art headquarters and eight research substations, together with a scientific staff of 92. CENICAFE is funded by a volume-based levy on exports of US$0.06 per pound, only 14 percent of which is used for R&D. Domestic coffee sales, which account for about 10 percent of the market, are not subject to the levy.

Table 4. Summary of industry levy and R&D spending, coffee and oil palm, Colombia, 2010

Indicator	Unit	Coffee	Oil palm
Total value of production	US$ million	2,316	738
Value of exports	US$ million	2,200	114
Area	Thousand hectares	914	404
Number of producers	Thousands	550	na
Average farm size	Hectares	1.5	na
Total levy	US$ million	64.0	10.5
Budget of the research institute	US$ million	11.0	9.2
Share of R&D budget from the association	%	86	87
Share of levy allocated to R&D	%	14	78
Research spending as a share of industry value	%	0.47	1.24
Number of scientists	Number	92	88
Salaries as percent budget	%	na	42
Cost per scientist	US$ thousand	120	105

Source: Compiled by author from CENICAFE (2010), CENIPALMA (2010) and interviews with center officials.

Oil palm is a relatively new industry that has increased rapidly from 1990 to meet rising domestic demand for vegetable oils and more recently for biodiesel, as well as strong export demand. It is mostly produced by large-scale plantations, although there is now a growing cadre of small-scale farmers, promoted through special government incentives.

Research is undertaken by CENIPALMA, established in 1990, which has its own legal status as a nonprofit organization, but operates under the overall umbrella of FEDEPALMA, the association of producers and processors of oil palm. CENIPALMA has a scientific staff of 88 and is still building its research infrastructure. It is funded by a levy on palm oil products of 1.5 percent of value at the mill gate (an increase from 1 percent in 1997 at the request of the industry). Nearly two-thirds of the levy is used for R&D.

In both cases, the levy is obligatory under law, and compliance is virtually 100 percent, largely paid through the internet. The decision on the allocation of the collected funds to various uses, including R&D, is taken by the respective association board. Both research institutes also raise funds from other sources, including their own earnings, as well as research grants from domestic and international sources. However, the levies account for about 80 percent of their funding.

Overall, funding for CENICAFE has been falling in real terms since the coffee levy is volume based, and has not benefited from recent increases in coffee prices, while harvests have been below average. In contrast, funding for oil palm research, which is value-based, has been increasing strongly because the industry has grown, the price of palm oil has increased, and the levy was adjusted from 1.0 to 1.5 percent in 2008.

In part due to the lower share of levy funds allocated to research, the intensity of research (R&D spending as share of production value) is much lower for coffee than for oil palm. Indeed, the intensity of research on coffee is a bit lower than the average for all agriculture in Colombia. In both CENICAFE and CENIPALMA, overall spending per researcher and levels of operating costs do not seem to be significantly different from the main publicly funded research institute, CORPOICA (Stads and Romano 2008).Both institutes have a strong culture of producer and industry participation in defining research strategies and setting priorities (Ton and Jansen 2007; Estrada, Holmann, and Posada 2003). They respond to demand from both producers and processors through a hierarchy of committees from municipal and departmental levels for coffee, and zonal and national levels for oil palm. Coffee also has a large extension program of over 1,000 extension agents managed by FEDECAFE, which feeds back to priority setting. Both institutes are recognized for their science quality, receiving scientific accreditation from the national science council, and a number of scientific prizes. CENIPALMA has its own scientific

advisory council with all but one member from abroad. Although there are few documented impact studies, both research institutes are recognized for their impacts on industry productivity. Practically all commercial varieties are provided by these centers, and CENICAFE has developed rust-resistant coffee varieties. The centers have strong programs in crop management, especially the management of pests. CENICAFE, too, has a strong environmental program on conserving biodiversity. CENIPALMA has estimated an overall benefit–cost ratio to investments in its research during 1990–2006 of 3.4 (CENIPALMA 2011).

Even so, the centers face significant challenges in keeping abreast of rapidly changing pests, science, and markets. Both centers appear to be under-resourced in terms of PhD-qualified scientists in relation to major competitors, such as Brazil (coffee) and Malaysia (oil palm). Coffee research is also underfunded relative to other commodities and the growing demands on the institute to respond to social and environmental challenges relating to the industry. Oil palm, although better funded in relation to industry size, holds major challenges in terms of reversing a recent decline in yields (partly pest related) and lower yields and higher production costs in relation to competitors (FEDEPALMA 2010).

The Professional Fund for Agricultural Research and Extension (FIRCA), Côte d'Ivoire

FIRCA was established in 2003 as an interprofessional agency operating under private company law to fund research, extension, and capacity building.[3] It is essentially a federation of 14 industry associations (currently), including producers and processors. The associations are represented in FIRCA's General Assembly according to the importance of the product and the funds contributed. The associations have a majority vote (73 percent) in both the General Assembly and in FIRCA's Executive Board, which is appointed by the Assembly. Most of the remaining seats are distributed among agro-industry and academics. Only 5 percent of the seats are allocated to government officials.

Funds are provided through levies on exports (bananas) or processed products (palm oil), or in one case on imports (rice), per agreement of the member organizations. A total of about US$15 million in levies was collected in 2008, amounting to 0.26 percent of the value of agricultural production, and 0.34 percent of the value of exports in that year. However, four commodities, cocoa, coffee, rubber, and oil palm, provided 92 percent of the funding. This means that for many of the associations, levies only provided a few thousand dollars. This in part relates to the nature of the commodity and the difficulty of collecting the levy—for example for poultry and swine for domestic markets. The levies are all volume based and fixed by the industry association. The actual levy as a share of production value varies substantially, from 0.60 percent for cocoa/coffee, to 1.6 percent for rubber, and 3.1 percent for cotton. But some exports, such as cashews—the second largest export—are not well covered. FIRCA also receives about 10 percent of its funding from the state.

At least 75 percent of the funds levied are allocated to needs of the respective subsector, with the remainder going to administration and noncommercial sectors, especially food crops. Industry associations determine the projects to be funded for that subsector. However, research tends to receive a small share of the allocation, depending on the industry. Over the period 2004–08, FIRCA allocated only 18 percent of its budget to research; 59 percent was allocated to extension and most of the rest to administration. The relatively modest amount of the levy, and the low share allocated to research, means that research intensity is often low. In the case of cocoa, for example—by far the largest and most important sector—it was only about 0.20 percent in 2008, compared with 4.4 percent in Ghana.[4]

FIRCA contracts most research to the National Center for Agricultural Research (Centre National de Recherche Agricole, or CNRA). Originally, the government was to provide 40 percent of CRNA's funding, but in practice this has been much lower and was only 15 percent in 2008. Presumably, government funding was intended to cover research gaps, especially for noncommercial food crops.

[3] This section is based on Doumbia (2011) and FIRCA's annual reports, available at <http://www.firca.ci>.

[4] The figures for Cote d'Ivoire include coffee, which is about 10 percent of the value of cocoa.

FIRCA has attempted to fill this gap through a solidarity fund; however, in 2008 the fund only amounted to 10 percent of FIRCA's allocation, although food crops made up about half of the value of production.

FIRCA is an innovative example of funding commercial research in Africa. It has strong buy in from producers and other industry stakeholders, and works well in sectors with strong organizations, such as rubber. Industry associations are clearly in the driver's seat in setting the research and extension agenda. However, research investment in key sectors is still low as a share of production value—extremely so for the largest sector, cocoa. The associations have tended to prefer short-term gains from extension over research. The lack of public budget for research only accentuates an acute funding shortfall for food crops. Administrative costs, at 18 percent of the total budget, also seem high.[5]

Tea Research Foundation of Kenya (TRFK)

Kenya is the world's largest exporter of tea, and tea is Kenya's largest export—amounting to over US$1 billion annually or 26 percent of agricultural export earnings.[6] Originally, tea was mostly produced on large estates, many in the hands of multinational companies. Over time, with support from government and donors, smallholders have increased their share to now account for 62 percent of national tea production. There are an estimated 630,000 smallholders with an average of 0.25 ha, and 63 tea-processing factories owned by smallholders and managed on a fee basis by the Kenya Tea Development Agency (KTDA), a private company owned by smallholder tea producers. KTDA also provides inputs and advisory services to smallholders. Significantly, the yield gap between smallholders and estates has fallen from 68 percent in 1980 to only 18 percent today (Mitchell 2011).

The Tea Board of Kenya (TBK) is the apex body of the tea industry established to regulate and promote the industry and to fund research. TBK has an elected board of 16 members, 10 of which are producers, so it is well balanced in terms of industry representation. TBK is funded by a volume-based levy of K0.46 cents per kg of exports, split 50:50 with TRFK. There is an additional agricultural produce levy of 1 percent of value to fund local infrastructure, as well as numerous other taxes (see Nzuma 2011).

TRFK was established as a parastatal in 1980 incorporated under the Companies Act to conduct tea research in Kenya. TRFK has a Board of 13 members representing various tea organizations, although the majority including the chair and CEO are appointed by the government. Smallholder interests on the Board are represented by KTDA. TRFK is a small organization with only 13 scientific staff and 124 support staff. TRFK receives over 80 percent of its funding from the levy, and the remainder from other sources, including self-generated income. The levy funding as a share of output value has been low and declining—now only about 0.1 percent of the production value, which is half what it was in 2000. Some tea research is conducted by large companies, but combined research intensity on tea is still likely to be well below research intensity estimates for public research in Kenya of 1.3 percent (Flaherty et al. 2010). In addition, TRFK's expenditures have fallen by more than half in real terms since 2000.

TRFK works closely with the industry in setting its research program and disseminating results. A Research Advisory Council approves the research program. However, smallholders largely participate in governance through KTDA. This has generated criticism that TRFK does not adequately respond to the needs of its clients, and the composition of the Board is now under review. TRFK is generally regarded as being an effective research organization. Salaries are competitive, and scientists have access to a reasonable operating budget, equivalent to the budget for salaries. However, the capital budget has been very small, at less than 2 percent of the 2010 budget. Budget constraints have, for example, prevented TRFK from constructing a tea processing unit for research.

[5] A general rule of thumb is that a research funding agency that does not undertake research should be able to administer the funds with less than 5 percent of the total research expenditures.

[6] See Nzuma (2011) for more details.

As already discussed, tea is generally regarded as a success story in terms of yields and competitiveness. TRFK products, such as improved clones, agronomic practices, and innovative processing methods, have been widely adopted especially by smallholders. Kangasniemi (2003) characterized tea research in Kenya as effective but underfunded, and that applies even more today. The very low funding to tea research has been recognized as a problem, and changes in legislation in 2010 will replace the volume-based levy with an ad valorem levy not to exceed 2 percent; 40 percent of the levy will be allocated to TRFK. When implemented this would increase the tea research budget by eight times over current levels, but intensity of tea research would still be below Kenya's average research intensity. The legislation also calls for a review of the governance structure of TRFK to allow more direct influence by producers.

Discussion of the Four Cases

What do the cases collectively tell us about the two objectives of implementing produce levies for R&D—increased funding and more accountability?

On the first objective, while the levies have increased funding to R&D overall, the contribution has mostly been modest. INIA in Uruguay is the major exception, where there is a levy dedicated to R&D, and where the government, by law, is matching industry contributions. In other cases, a surprising finding is that there is little evidence that R&D on commodities that are levied is better funded than R&D on other commodities. This is because the levy is often small, and because there is serious competition from multiple uses of the levy, nearly all of which can demonstrate more immediate benefits than can R&D. In fact, it could be argued that some important levied commodities receive less funding than what might have been provided through normal government budgets. Coffee in Colombia and tea in Kenya are examples where research intensity is below the average research intensity for the whole country, and has been falling in the past decade. Cocoa in Côte d'Ivoire is also poorly funded relative to other commodities, partly because the levy on cocoa cross subsidizes R&D on other commodities. These findings are especially critical given that spill-ins for cash crops are likely to be much smaller than for food crops, where the CGIAR has an explicit mandate and a strong regional presence.

Part of the problem is that most levies are volume based, and adjustment of the levy rate has been slow. Over a decade of rising commodity prices, the value of the levy as a share of the value of production has sharply declined. One could, however, argue that volume-based levies provide more stable funding, especially if commodity prices trend downward (as was the case to 2000) or unless production risk and price risk are negatively correlated (for example, a producer with a large market share). Overall, funding instability did not seem to be a major problem in managing R&D. Still in two cases, oil palm in Colombia and tea in Kenya, the government at the request of industry has increased the levy to more competitive levels and for tea has moved to a value-based levy, indicating that low funding can be overcome by industry pressure.

On the second objective of improving the demand orientation and accountability of research, the conclusions are universally positive. All of the cases have developed governance mechanisms to ensure that producers and processors have a strong say in research priorities. This is manifested at top levels in the governance of the research fund or institute, as well as at lower levels through regional advisory groups. There is little evidence that some large and more politically powerful producers have distorted priorities in their favor. Of course, good governance goes with strong producer and industry organizations, and this is a weakness in many African countries. Even within a country, research governance works better for some commodities than for others. An often-cited case is Kenya, where tea research works much better than coffee research, even though both have similar funding and institutional structures, but where coffee producer associations have become politicized (Kangesniemi 2003; Mitchell 2011).

Where the research is carried out by a research institute under the control of the producer association or industry board, the research institutes seem to be well managed and productive, relative

to public research organizations. They generally have more flexibility in allocating funds between salaries and operating costs, and salaries are competitive at least with the public sector. And while detailed impact evaluations are not generally available, all can point to significant successes in adoption of their research products.

Finally, while governance is easiest for a single commodity, the cases of FIRCA and INIA indicate that levies can work well in a multicommodity system. FIRCA has strong producer associations responsible for approving projects for each commodity, and INIA has commodity working groups for each research station where a commodity is important. In both cases, there was a tendency for levies on more valuable commodities to cross subsidize research on smaller commodities, but in fact, this represented a transfer from richer groups to poorer groups.

6. CONCLUSION

This review points to three major conclusions.

First, Africa has immense potential in commercial agricultural production but has missed out significantly in the commodity boom of the early 2000s. Low productivity due to low investment in R&D is one of the main reasons. This can be reversed. Indeed if it is not, imports are likely to rise rapidly to meet a rapidly expanding domestic market due to growing population, incomes, and urbanization.

Second, collective action to levy commercially oriented industries, both for exports and domestic markets, can potentially provide more funding for research. The review of 10 industry-funded research institutes indicates relatively high research intensities in most cases. However, this outcome is not guaranteed. Levies need to be set high enough, and where possible be dedicated to R&D. Matching funds from government can provide a powerful incentive to an industry to impose a reasonable levy on itself. Matching funds can also be justified by externalities associated with research that go beyond the specific industry. Finally, matching funds that are legislated guarantee a place in the national budget. Despite these advantages, there is still no example of matching funds in Africa, although Côte d'Ivoire tried.

Third, levy-funded research can deliver more efficient and demand-oriented research but works best where strong producer and/or industry associations ensure an important or even controlling interest in the governance of the funds collected. This is probably the largest impediment to rapid scaling up of levy systems in Sub-Saharan Africa. There are some short-term opportunities, such as cotton in Francophone West Africa, but elsewhere the development of strong producer organizations is by nature a long-term process. A second best is a reformed parastatal with increasing producer influence, such as provided to cocoa research in Ghana.

The bottom line is that greater use of industry funding offers much promise to enhance the funding of R&D in Africa and the effectiveness of the R&D carried out with that funding. Combined with an improved policy and business environment, increased R&D on commercial crops could allow Africa to regain competitiveness and tap a major opportunity for growth. The Forum for Agricultural Research in Africa (FARA) in partnership with other regional and international bodies could take a lead in encouraging stronger industry associations and improved awareness of the role of investing in research. Even so, industry funding through levies needs to be combined with other options for promoting R&D on commercial crops, including public funding, enhanced regional collaboration, liberalized seed markets to encourage spill-ins, and technology transfer through foreign direct investment.

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The Agricultural Science and Technology Indicators (ASTI) initiative compiles, analyzes, and publishes data on levels and trends in agricultural R&D investments, capacities, and institutional arrangements in developing countries. ASTI is managed by the International Food Policy Research Institute (IFPRI) and involves collaborative alliances with many national and regional R&D agencies.

Jointly convened by ASTI/IFPRI and the Forum for Agricultural Research in Africa (FARA), the conference, "Agricultural R&D—Investing in Africa's Future: Analyzing Trends, Challenges, and Opportunities," brought together experts and stakeholders from the region to contribute their expertise for the purpose of distilling new insights and creating synergies to expand the current knowledge base. The themes under focus were (1) why African governments under invest in agricultural R&D; (2) how human resource capacity in agricultural R&D can be developed and sustained; (3) how institutional structures can be aligned and rationalized to support agricultural R&D; and (4) how the effectiveness of agricultural R&D systems can be measured and improved.

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