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SUCCESSES IN AFRICAN AGRICULTURE: RESULTS OF AN EXPERT SURVEY

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ABSTRACT

Using primary data from a survey of expert opinion, this paper identifies key successes emerging in African agriculture. Among these, major commodity-specific successes identified include breakthroughs in maize breeding across Africa, sustained gains in cassava breeding and successful combat of its disease and pests, control of the rinderpest livestock disease, booming horticultural and flower exports in East and Southern Africa and increased cotton production and exports in West Africa. Using a dynamic analytical framework, the paper attempts to identify key ingredients that appear necessary for building on these individual cases and expanding them into broad-based agricultural growth.

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SUCCESSES IN AFRICAN AGRICULTURE: RESULTS OF AN EXPERT SURVEY

Eleni Z. Gabre-Madhin[1] and Steven Haggblade[2]

1. IMPERATIVES AND OBJECTIVES

Agricultural growth will prove essential for improving the welfare of the vast majority of Africa's poor. Roughly 80% of the continent's poor live in rural areas, and even those who do not will depend heavily on increasing agricultural productivity to lift them out of poverty (Sahn et al., 1997; World Bank, 2000). As producers, 70% of all Africans -- and nearly 90% of their poor -- work primarily in agriculture (World Bank, 2000). As consumers, all of Africa's poor -- both urban and rural – count heavily on the efficiency of the continent's farmers, since farm productivity and production costs prove fundamental determinants of the prices of basic foodstuffs which account for 60% to 70% of total consumption expenditure by low-income groups (Sahn et al, 1997). Consequently, significant reductions in poverty will hinge in large part on the collective ability of African farmers, governments, and agricultural specialists to stimulate and sustain broad-based agricultural growth.

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Agricultural production across the continent has changed considerably since the beginning of domesticated agriculture in Africa, seven thousand years ago. Today, African farm households plant over half of all cropped area in imported plant species, principally maize, cassava, groundnuts, bananas, cocoa, potatoes, sweet potatoes, Asian rice, tea and imported varieties of cotton. These imported species currently account for over two-thirds of the value of Africa's gross agricultural output (Gabre-Madhin and Haggblade, 2001). Even more striking, the continent's 600 million head of livestock and 700 million head of poultry descend almost exclusively from imported species, with the lone exception of the guinea fowl (Diamond, 1998). Despite a virtual absence of indigenous domesticable livestock species and with a limited range of indigenous plants, African farmers have built up diverse agricultural systems based largely on imported plant and animal species, as well as indigenous plant species, such as *teff*. Much of this transformation has taken place in spite of the formidable constraints imposed by endemic trypanosomiasis, which has largely prevented livestock rearing, animal traction and mixed cropping in the tropical zones in addition to other diseases, including mosquito-borne diseases, as well as the adverse effects of climate and geography (Bloom and Sachs, 1998; Masters and McMillan, 2001).

In spite of these considerable historical achievements by African farmers, acute pessimism pervades much of the current dialogue on African agriculture. Comparisons of aggregate production performance across continents over the past forty years reveal deterioration in agricultural performance in Africa alone (FAOSTAT). Similarly, recent studies of world poverty single out Africa as the region of the world in which numbers of

people malnourished and living in poverty have risen most rapidly in recent decades (FAO, 1996; World Bank, 2001). These trends, coupled with political instability and a thicket of wars across the continent, have inspired the Economist magazine to question whether Africa was "The Hopeless Continent."[3]

Despite the bleak picture painted by the aggregate trends, individual case studies provide signals of promise. In agriculture, micro-evidence from village studies documents a series of impressive achievements, what a recent review has called a collection of "small and not so small booms in production of food crops for the national and sub-national markets" (Wiggins, 2000). Nutritional data from individual children suggest that Africa may be better off than South Asia, contradicting what the more pessimistic production-derived food availability figures imply (Svedberg, 1999; Osmani, 2000). Trends in the incidence of chronic child malnutrition suggest steady but gradual improvements over the past two decades (de Onis et al., 2000). Impact studies of agricultural research in Africa regularly demonstrate robust results, with median rates of return over 35% (Evanson, forthcoming; Masters et al., 1998; Oehmke and Crawford, 1993). This paper adds to the growing awareness that there have been successes on the ground, at given points in time and in space. Having polled a broad range of experts on African agriculture, the paper analyzes the results of that survey, with the objective of stimulating thinking about promising avenues for achieving similar success in the future.

[3] *The Economist,* May 15, 2000.

Nonetheless, there is an important divergence between those who report instances of success and the reality perceived by many that Africa is lagging behind in economic performance. While agricultural specialists engaged on the ground are often upbeat, donors and the public at large remains defeatist. Even those who do cite successes, such as those reviewed in this paper, often focus on commodity successes rather than successes at the country level. One respondent suggests a plausible explanation for this apparent divergence by noting that, "the real trick does not seem to be the isolated success stories but a pattern of building on these in order to generate other commodity success stories and a general pattern of sustained growth and development at a country level." Resolution of these diverging perceptions remains of central importance for African policy makers given the critical role that agricultural growth will have to play in any program of broad-based poverty reduction in Africa. This paper aims to address the following issues. Can one build on the individual successes? What underlies these successes and what lessons can be learned for spreading success?

The paper starts by describing the data collection in Section 2. In Section 3, we review the criteria used to define success, followed by an overview of the nominated successes in Section 4. In Section 5, we apply a dynamic framework to analyze the relationship between actors, interventions, and the environment in which change occurs. In the final section, we return to the central question of how to build on isolated successes to generate momentum for aggregate success.

2. THE DATA

Our survey of expert opinion targeted a selected list of African and Africanist agricultural specialists. Based on their experience, we asked each to identify the instances they considered most important in advancing the state of African agriculture. To encourage the respondents to think broadly, we deliberately left the criteria for success, as well as time and geographic scope, unconfined. For each success story nominated, the survey form asked respondents to provide both their selection criteria as well as the factors they considered crucial in determining the success of each particular case.

To identify a target population of experts, we drew on several key resources. First, we combined the IFPRI Africa mailing list with the IFPRI 2020 Network list of collaborators to produce a consolidated roster of African and Africanist stakeholders with active ongoing interest in agriculture and food policy in Africa. We supplemented these with lists available in directories published by the Special Program for African Agricultural Research (SPAAR), Association for Strengthening Agricultural Research in East and Central Africa (ASARECA), as well as a series of donor and NGO clearinghouses and directories of groups active in African agriculture. In total, these efforts yielded a roster of 1,116 total targeted respondents. We polled them using the quickest technology available for each. As a result, 38% received their questionnaire by email, 7% by hand delivery at the July 2000 ASARECA conference in Antananarivo, and the remaining 55% by mail.

This three-pronged data collection effort elicited a total of 118 responses, for an overall response rate of 10.6%. Of the 118 total respondents, roughly two-thirds are African, with a majority of these coming from East Africa, while over 70% of all respondents live and work in Africa. While this response rate is fairly consistent with mail surveys responses, the use of mail survey may introduce respondent bias. First, mail surveys are particularly sensitive to the type of paper used, the appearance of the questionnaire, and the content of the cover letter. Second, because respondents are required to expend extra effort in returning responses, including postage and envelopes, it is likely that those who respond are those with a positive message to convey. It is equally plausible that others, with an equally positive message, were less inclined to make the required effort to respond. It is also possible that those who respond are persons of a particular type, people who generally exhibit behavior of good citizenry for the common good. Thus, respondent self-selection bias must be weighed as well as other biases related to other characteristics of those who did respond. The predominance of respondents from East Africa and from technical agricultural research institutes invites concern about possible locational, functional, and disciplinary biases in the respondent pool (Table 1). For this reason, the ensuing analysis will test formally for these biases, and where they exist, will disaggregate results by region, discipline or function, as appropriate.

Table 1 -- Respondent* Characteristics (in percent)

A. Location			B. Institutional Affiliation	
	Nationality	Work Location		
Africa				
East	43	51	African national agricultural research organization	24
West	10	7	International agricultural research center	18
Southern	6	9	University or research institute	17
Central	5	4	Implementor (NGOs,project staff, private sector)	16
total	64	71	Donor	15
			African government	10
North America	15	20		100
Europe	15	7		
Asia	4	2		
Australia	2	0		
	100	100		

C. Function		D. Training	
technical research	32	agricultural economics	36
implementation/extension	24	plant sciences	35
policy research	22	animal sciences	9
policy maker	10	agricultural engineering	5
donor	9	management	3
information management	3	forestry and natural resource management	3
	100	general agriculture	2
		other sciences (nutrition, agrometeorology)	4
		other social sciences (sociology, political science)	3
			100

* The total sample includes 118 respondents.

3. CRITERIA FOR DEFINING SUCCESS

What implicit criteria define "success" in African agriculture? Our respondents, like much of the literature, overwhelmingly focus on production growth. Roughly 40% of the cases cited involve significant increases in agricultural output, while another 20% cite corollary efficiency concerns about increased farmer incomes and foreign exchange earnings (Table 2). Given the public prominence accorded to gloomy aggregate production trends, it is not surprising that professional preoccupation with reversing this falling per capita production pervades the agricultural community.

Table 2 -- Respondents' Criteria for Success

Criteria	Respondent Category*				
	Total	Technical research	Social or policy research	Implementor	Govt
Efficiency					
Farmer gains (production, income)	56%				
Government (foreign exchange, taxes)	7%				
subtotal	63%	70%	59%	54%	70%
Equity (helps small farmers, food security, vulnerable groups)	20%	15%	21%	23%	21%
Sustainability					
Farm-level (improves soil fertility, environmental sustainability)	13%				
Agricultural system (train people, improve markets and other institutions)	5%				
subtotal	18%	15%	21%	23%	10%
Total criteria cited	100%	100%	100%	100%	100%

* Differences between groups are not statistically significant.

Source: IFPRI Expert Survey.

Equity concerns feature in a further 20% of the success nominations. Respondents express these concerns principally in terms of helping small farmers, women and other vulnerable groups, or improving food security. In the present environment where poverty alleviation has, as in the 1970's, become a central focus of donor efforts; where the IMF and World Bank have transformed structural adjustment programs into poverty reduction programs and morphed policy framework papers into poverty reduction strategy papers these equity concerns will likely increase.

Sustainability of production gains likewise elicited considerable attention from our respondents, garnering 18% of the rationales they cited. This concern mirrors recent increases in research attention to soil fertility and sustainability of evolving African agricultural systems (Sanchez et al. 1997; Pretty, 2000; Cleaver and Schreiber, 1994). In

the presence of increasing population density, where shifting cultivation becomes more difficult and fallows periods available for soil reconstitution become shorter, maintenance of soil fertility will increasingly become a key pillar in building sustainable systems for future agricultural growth.

THREE DIMENSIONS OF SUCCESSFUL OUTCOMES

Success in agriculture is defined as a measurable improvement in net welfare, with broad-based impact and achieved in an environmentally sustainable manner. Net welfare improvement includes, but is not limited to, income growth along with increased assets, improved nutrition, reduced variability in consumption, and a greater sense of well-being. Success is defined as a *net* improvement in welfare, implying that there are more gainers from the positive change than there are losers. Finally, the net improvement in welfare must be economically viable over time, implying that the economic benefits of the positive change outweigh the social costs associated with bringing it about.

The second dimension of success is that positive change be distributed broadly. That is, a successful outcome is realized if the gains in welfare are equitable. Successful outcomes are those which reduce the poverty of a broad group of people rather than large increases for a very few beneficiaries, resulting in greater income disparity. The third dimension of success is that positive gains are not achieved at the expense of long-term resource availability, such as short-term gains through soil mining. These three dimensions form a critical triangle of success: growth, equity, and sustainability (Figure 1).

Defined in this way, success becomes a highly dynamic, highly demanding, ever-evolving process. It requires a sustained sequence of incremental advances in order to retain successful upward momentum (Figure 2). Success requires progression down a viable long-term pathway, rather than a one-time leap forward. Success requires staying ahead of the game. It demands continuous positive change, movement along a dynamic pathway of success.

Figure 1—Dimensions of Success

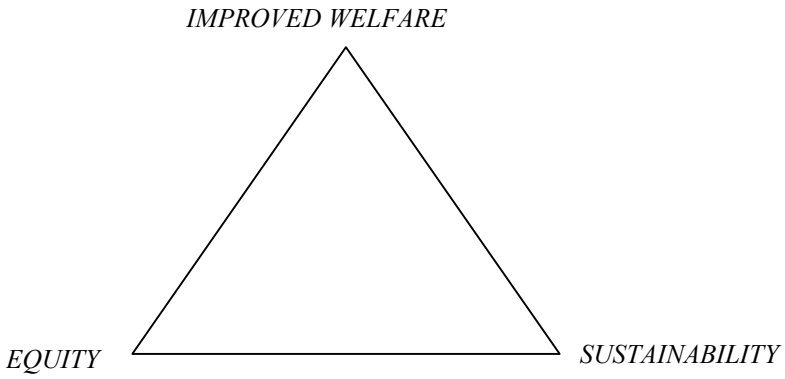
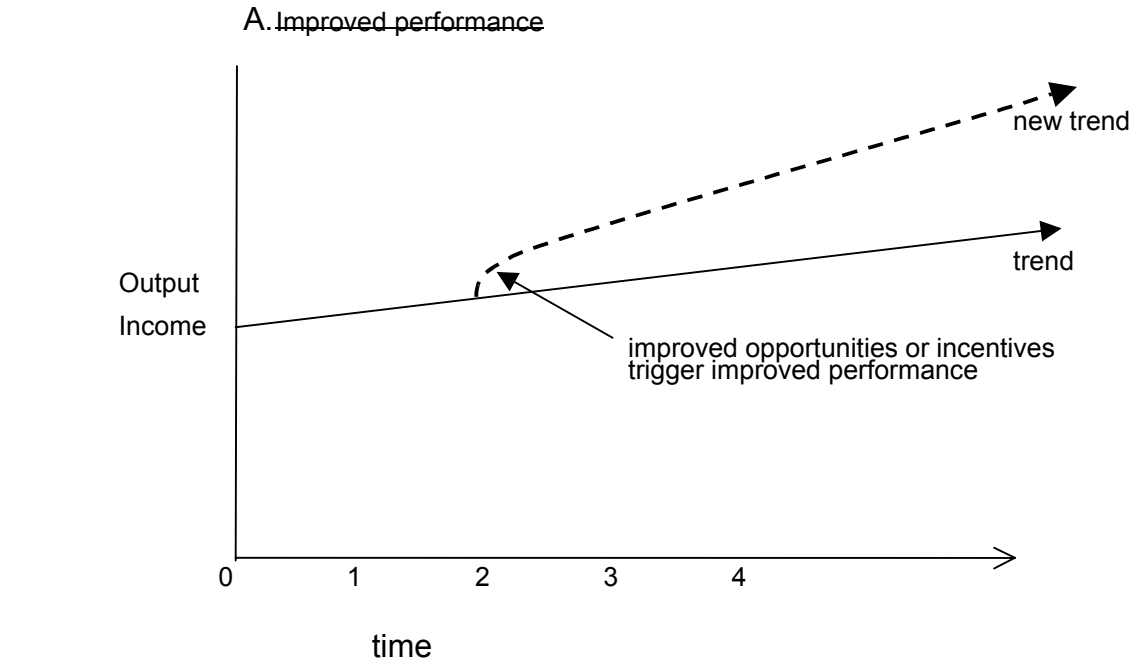


Figure 2—Definition of "Success" in African Agriculture



4. SUCCESSES IN AFRICAN AGRICULTURE

AN OVERVIEW OF SUCCESS NOMINATIONS

Because many respondents identified multiple successes in African agriculture, our sample generated a total of 253 individual success nominations (Table 3). The majority of responses, 62%, identified successes linked to specific commodities, while 21% featured successes involving activities such as soil fertility enhancement or policy reforms, and a further 16% focused on successful institution building efforts. Country-specific aggregate successes inspired little enthusiasm, attracting only about 1% of all nominations. While most successes proved region- our country-specific, a significant minority of about 30% applied Africa-wide.

The full detail and range of nominations provided by our respondents is summarized elsewhere (Gabre-Madhin and Haggblade, 2001). The following selection, though far from exhaustive, attempts to capture some of the rich detail furnished by our respondents, by providing thumbnail sketches for an illustrative cross-section of commodities, activities, regions and time periods.

Table 3. Agricultural Successes Identified

Category	Successes Identified		
	Total	Africa-wide	Region-specific
Commodity-specific			
maize	10.3%	11.1%	10.0%
cassava	6.7%	15.3%	3.3%
horticulture	6.6%	1.4%	8.6%
livestock	6.2%	9.7%	4.8%
cotton	4.5%	1.4%	5.7%
coffee	4.3%	5.6%	3.8%
dairy	3.4%	0.0%	4.8%
rice	3.3%	5.6%	2.4%
cocoa	2.5%	2.8%	2.4%
banana	2.5%	1.4%	2.9%
beans	1.8%	1.4%	1.9%
other	9.5%	6.9%	10.5%
subtotal	***61.6%***	***62.5%***	***61.2%***
Activity-specific			
soil fertility enhancement*	7.1%	5.6%	7.7%
policy reform			
agricultural markets	2.0%	0.0%	2.7%
macro policy	1.6%	0.0%	2.2%
irrigation development	2.4%	1.4%	2.7%
specific technology development**	1.6%	1.4%	1.6%
other	6.7%	6.9%	6.6%
subtotal	***21.2%***	***15.3%***	***23.5%***
Institution-building			
agricultural research	5.5%	12.5%	2.7%
farmer organizations	3.1%	1.4%	3.8%
market institutions	2.4%	1.4%	2.7%
human capacity building***	1.6%	5.6%	0.0%
other institutions	3.5%	1.4%	4.4%
subtotal	***16.1%***	***22.2%***	***13.7%***
Countries			
Ethiopia, 1990's	0.4%		0.5%
Ghana, 1990's	0.4%		0.5%
Ivory Coast, 1960's and 1970's	0.4%		0.5%
subtotal	***1.2%***		***1.6%***
Total			
Share	***100.0%***	***100.0%***	***100.0%***
Number of nominations	***253***	***71***	***182***

* Includes improved fallows, crop rotations, conservation farming.
** Biotechnology applications, vaccines.
*** Finance, management, business.

Source: IFPRI Expert Survey.

COMMODITY-DRIVEN SUCCESSES

Maize Breeding

The development and diffusion of modern, high-yielding varieties of maize have transformed this imported cereal from a minor crop in the early 1900's into the continent's major source of caloric consumption of staples today.[4] National agricultural research systems in Zimbabwe (then Southern Rhodesia) and Kenya launched the first major maize breeding programs in Africa to support large commercial farmers seeking to supply export markets as well as growing populations of urban and mine workers (Miracle, 1966). The first commercial sales of hybrid maize in Rhodesia occurred in 1948, making it the second country in the world to do so. Both Rhodesia and Kenya achieved major breakthroughs with hybrid maize during the 1960's (Gerhart, 1975; Eicher, 1995). Maize breeding spread throughout the continent with strong support from international centers such as CIMMYT and IITA from the 1970's onward (Byerlee, 1994; Manyong et al., 2000a). Though output expansion has proven spotty, across regions and over time, farmers across Sub-Saharan Africa currently plant over one-third of maize area in improved varieties (Byerlee and Eicher, 1997; Jayne et al., 1993). In East and Southern Africa, farmers plant about 50% of maize area in improved hybrids where they

[4] Maize and cassava are the two most important foodcrops in Sub-Saharan Africa (including the Republic of South Africa). In 1999, they supplied 373 and 265 calories per person per day, respectively (FAOSTAT).

achieved yield gains of about 40% over local varieties (Byerlee, 1994). In West and Central Africa, over nine million farmers grow improved open-pollenating varieties on about 20% of total maize area, enjoying output gains of 15%-45% over local varieties and boost production by 2.5 million tons annually (Byerlee, 1994; Manyong et al., 2000a).

It is important, nonetheless, to nuance this success with the recognition that at least part of the expansion of this crop was due to the very large and unsustainable subsidies that left maize uncompetitive when subsidies and other protection were removed in the 1980s and 1990s.

Combating mosaic virus and pests in cassava

Cassava's first serious threat in Africa emerged in the 1920's and 1930's when outbreaks of the cassava mosaic virus spread rapidly across the continent (Jones, 1959). Since then, repeated invasions and mutations by diseases and pests have spurred agricultural research institutions to growing commitments to cassava breeding and extension that have resulted in a widespread transformation dubbed "Africa's best-kept secret" (Nweke et al., 2002).

New threats emerged in the early 1970s, following a devastating pair of pest infestations, the cassava mealy bug and the cassava green mite. which caused crop losses of 80% and threatened the principal food source of over 200 million Africans by the 1980s (Herren and Neuenschwander, 1991). Using a predator wasp, international research centers, African NARs and donors launched a mass rearing and distribution

program that led to the biological control of the mealy bug threat by 1988. With a conservative estimate of the value of production saved at over $2.2 billion and a program cost of $15 million, this resulted in a benefit-cost ratio of 149 (Norgaard, 1988).

Sustained breeding efforts by NARs across Africa, backstopped by steady inflow of improved material from IITA, have resulted in a continuous diffusion of improved cassava varieties over the past three decades (Manyong et al., 2000; Nweke et al., 2002). Over this period, yields have increased by 50% on average, and improved varieties have raised per capita output by 10% continent-wide, benefiting 14 million farmers (Manyong et al., 2000b). Time and again, this ongoing research capacity has proven crucial in confronting new threats, most recently in turning back the devastating 1993 mosaic virus epidemic in Uganda with eight years of furious, collaborative effort (Otim-Nape *et al*., 2000; Legg *et al*., 1999; University of Greenwich, 2000).

A key food security crop for the poor, cassava's low labor requirements make it a favorite response to declining maize subsidies and growing labor shortages in Malawi, Zambia and other countries with high prevalence of HIV AIDS.

Expansion of horticultural and flower exports

From the early 1970's onward, private traders have steadily expanded high-value exports of fruits and vegetables from Kenya by exploiting growing demand in Europe, improved technologies and marketing systems for fresh vegetable distribution there, and substantial increases in air-freight space from Nairobi to Europe. To ensure consistent quality and timely supply, many exporters developed contract-farming arrangements with

smallholders, who supply about 75% of all vegetables and 60% of all fruits (Jaffee and Gordon, 1993; Noor, 1996). By the mid-1990's, over 500,000 Kenyan farmers and distributors earned income from this horticultural export trade (Kimenye, 1995; Swanberg, 1995). One of the country's fastest growing foreign exchange earners, horticultural exports have grown by a factor of 10 over the past 30 years, increasing from $13 million in 1970 to $155 million in 1999 (FAOSTAT). Meanwhile, other countries such Uganda, Zimbabwe and Zambia have all emerged, in recent years, as growing participants export markets for fresh vegetables and cut flowers. In Zambia, over the past 15 years exports of horticultural products have grown from $2 million to $24 million per year, while flower exports have truly blossomed, growing from $0.3 million to $43 million per year (Export Board of Zambia, 1999).

Control of the devastating rinderpest disease for livestock

Since its accidental introduction from Asia to tropical Africa, rinderpest has remained the continent's most deadly threat to livestock and to many wild animals as well. The initial rinderpest epidemic of 1890 killed an estimated 95% of Africa's cattle (Reader, 1997; Mack, 1970) and has continually diverted veterinary resources from other animal health and improvement activities. To address this widespread threat, the Organization of African Unity established an Inter-African Bureau on Animal Resources (IBAR) to coordinate an all-out international effort to control rinderpest. Assembled beginning in 1986, this alliance involved national governments, their veterinary services, international centers and donors as a coalition of 35 countries launched the Pan Africa

Rinderpest Campaign (PARC). Their concerted efforts resulted in the development of a tissue culture attenuated vaccine for the control and eradication of rinderpest (Plowright and Ferris, 1962; Provost, 1982). Following development of the vaccine, government and private veterinary services across the continent distributed the vaccine (Scott, 1985; Wamwayi et al, 1992). Recent assessments evaluate income gains on the order of $50 million for livestock producers in 10 of the 35 countries evaluated. The production gains have generated $1.80 in net income for every dollar invested in the vaccination program (Tambi et al., 1999).

Rapid growth of cotton production and exports in West Africa

Since independence in the 1960's, West African cotton production and exports have both grown rapidly, at a compound annual rate of about 6.5% per year over the past forty years. The most robust growth has occurred in the four West African countries of Mali, Benin, Burkina Faso and Ivory Coast which, together, produce 70% of total cotton production in francophone Africa (Béroud, 1999). A fully integrated model of government and semi-government institutional support for research, input supply, production, processing and marketing has underpinned this sustained growth. Since independence, the model has taken various forms in different francophone countries. With this support, cotton yields quadrupled between 1960 to 1999 as the use of fertilizer increased to over 75% in the major producing countries and use of animal traction equipment rose from near zero to 50% in Burkina Faso and Ivory Coast and to 90% in Mali and Cameroon (Follin and Deat, 1999). Following the devaluation of the CFA franc

in 1994, production in francophone Africa has nearly doubled, growing from 500,000 to 980,000 tons (Béroud, 1999). Over the past forty years, francophone Africa's share in world exports has grown from near zero to 16%, making them the world's third largest cotton exporting block after the USA and former USSR (Bocchino,1999).

Like the case of maize, this success needs to be qualified by the large volume of subsidies that underlies cotton production and the financial difficulties that have emerged in the 1990s with the overall push for liberalization.

Adaptive on-farm breeding of bananas in the central highlands

A historical success story suggested by our respondents' highlights the importance of farmer ingenuity, tenacity, organizational and inventive capacity in adapting this imported crop to local conditions. For over 800 years, farmers in the Great Lakes Region experimented intensively with bananas, attracted by the new crop's lower labor requirements, high calorie yields per hectare and favorable effects on soil erosion. Through assiduous selection of cultivars, farmers bred a wide range of varieties suitable for human consumption. Led by inventive, local mainly women farmers, these efforts launched an extraordinary agricultural and demographic revolution in the Central African Highlands beginning about 1300 A.D and laid the foundation for the subsequent political rise of the Buganda kingdom (Reader, 1997; Schoenbrun, 1993). By the mid-twentieth century, Ugandan farmers cultivated 60 different cultivars, the largest pool of genetic diversity anywhere in the world (de Langhe et al., 1996; Reader, 1997). Because most edible bananas are seedless, they must be reproduced by vegetative propagation, severely

limiting the prospects for genetic evolution. Given this constraint, most experts marvel at the rapidity with which African farmers achieved such genetic diversity (Simmonds, 1959; McMaster, 1962). In doing so, they developed an important food security crop that currently accounts for over one-fourth of caloric consumption in the region (FAOSTAT).

Substantial and widespread income gains from dairying in Kenya

Dairy production in Kenya has grown rapidly in recent decades resulting in per capita production double the levels found anywhere else on the continent (Mbogoh and Ochuonya, 1992; Staal et al, 1997). Growth began slowly in the 1950's and 1960's, spurred by rapidly growing cash incomes in rural areas wich stimulated steadily rising demand for milk. Following the adoption of the Swynnerton Plan for encouraging smallholder production in agriculture, the Kenyan government and donors financed a series of promotional projects supplying veterinary and artificial insemination services, extension support for intensive zero-grazing production package, and support for cooperative development (Conelly, 1998; Leonard, 1991). Subsequent decontrol of milk pricing in 1992 spurred a surge in production and greatly improved milk availability in retail outlets (Jaffee, 1995; Mbogoh and Ochuonya, 1992; Stall et al, 1997). Smallholders have captured a steadily rising share of that growing market so that, today, some 600,000 small farmers operating 1 to 3 dairy cows produce 80% of Kenya's milk (Impact Assessment Group, 2000). Despite recent trends that reveal, however, that the earlier success may be waning with stagnating production growth since the mid-1990s, nearly 70% of Kenyan smallholders produced milk in 2000 and it had become their

fastest growing income source. Among the small farmers who produce milk, annual gross earnings average a substantial $455 per year from milk alone, with average net earnings estimated at $370 (Tschirley, 2001).

Increased rice production in Mali

Policy reform in rice milling and marketing has radically altered opportunities and incentives for Mali's rice producers over the past decade and a half. Beginning in 1987, the Malian government initiated a gradual set of reforms. These included price deregulation together with the dismantling of the monopolies on paddy assembly, milling and rice marketing held by the Office du Niger (ON) and Office des Produits Alimentaires du Mali (OPAM). As a result, small private dehuller mills, operating at one-fourth milling cost of the cost of the large state mills, began to appear in the Malian delta region. And these private millers and retailers began to offer higher prices for preferred varieties and for more carefully processed grains. The subsequent 50% devaluation of the CFA franc, in January1994, further boosted producer incentives. Import prices doubled overnight pulling up domestic rice prices sharply in their wake. Producers responded rapidly to these new options and incentives and Malian rice production has more than tripled since 1985, growing by 9% annually over past 20 years (Diarra et al., 2001).

ACTIVITY-LED SUCCESSES

Soil Fertility Enhancement

Improved techniques for soil fertility enhancement received the most prominent mention among the activity-specific success stories. These techniques include work with improved fallows, often in association with nitrogen-fixing trees, crop rotations incorporating legumes and supplemented, in some locations, with application of locally available rock phosphate (Sanchez, 1999). In West Africa, nominations focused on alley cropping and crop rotations including legumes, while several from Southern Africa centered on related dryland soil and water management techniques commonly grouped under the label of conservation farming (Reij et al, 1996; Pretty and Hine, 2001; Buresh and Cooper, 1999; Rao et al., 1998; Vissoh et al., 1998). Surprisingly, soil and water conservation techniques practiced in West Africa, such as "zai", bunds and ridges, or confinement feeding of cattle to improve livestock productivity and supply of manure, were not mentioned.

Policy reforms

Respondents widely credited the devaluation of the CFA franc in West Africa in 1994 with stimulating the export of livestock, cotton and horticultural products from the region. A series of food policy reforms in East and Southern Africa likewise prompted frequent mention as vehicles for stimulating competition in milling and food marketing

(Jayne et al., 1995). By reducing input subsidies, similar reforms in West Africa during the late 1980's substantially improved the profitability and prevalence of green manure applications and alley cropping there (Adesina and Coulibaly, 1998).

Public infrastructure investments

Number of respondents highlighted the important impact of irrigation investments across the continent, ranging from large-scale gravity-fed perimeters like the Gezira Scheme in Sudan to current small-scale treadle-pump irrigation efforts in Niger.

INSTITUTIONAL SUCCESSES

NARs

Institution-building successes identified by our respondents focused on the substantial investments by donors and African governments during the 1960's and 1970's in building up African national agricultural research organizations (NARs). Though current fiscal distress compromises the operation of these institutions and makes them increasingly reliant on external funding, the productivity of these public investments has proven remarkably robust, with a median rate of return of 35% (Eicher, 1999; Evanson, forthcoming; Pardey et al., 1995).

Farmer organizations

Farmer organizations, spontaneous and induced, have likewise attracted interest as vehicles for providing an array of collective services including common property

management, technology development and testing, design, financing and management of rural infrastructure, and marketing of key production inputs or farm outputs (CIRAD, 1995; Smale and Ruttan, 1997; Merrill-Sands and Collion, 1994; Veit et al, 1995; Bingen, 1998). Commenting on a recent visit to one West African country, a respondent reported, "I was awed by what I saw. The farmer groups there are a powerful force today."

Market institutions

Interest in market institutions reflects the findings of recent work on market behavior in Africa which underlines the important role of institutions in promoting trust, protecting property rights, reducing transaction costs, and enabling exchange critical to market efficiency (Fafchamps and Minten, 1999; Gabre-Madhin, 2001). Market information systems, notably in Mali and neighboring Sahelian countries, are among the successes. Other successful market institutions are the case of warehouse receipt systems in Ghana, the dismantling of parastatal institutions engaged in market procurement and distribution, as well as the subsequent introduction of commodity market exchanges in some countries (Kherallah et al., 2002). Our respondents, like many agricultural specialists, recognize that the further development of key agricultural support institutions will prove critical to the expansion of production possibilities and to improved agricultural performance with a given set of technology and endowments.

COUNTRY-LEVEL SUCCESSES

In spite of the wide range of individual commodity and activity-specific successes, very few respondents pointed to successes in country-wide aggregate agricultural growth. The 1% who did cited Ivory Coast's agriculturally powered post-independence period, the so-called "Ivorian miracle" of the 1960's and 1970's, as well as more recent surges in Ethiopia and Ghana during the second half of the 1990's.

REGIONAL AND DISCIPLINARY BIASES

Not surprisingly, respondents generally report about what they know best. Both nationality and work location influence the location of the successes identified. Consequently, all respondents born or working in a particular region cite more successes in that region than would an average outsider (Gabre-Madhin and Haggblade, 2001, Table 5). Yet East Africans and the professionals resident there, who account for 40% and 50% of our sample, respectively, turn out to be the least insular and most likely to cite successes from outside their region. About 40% of their nominations centered on general, Africa-wide successes, the highest share of any group and a level double that of other regional respondents. Perhaps because of the prevalance of international organization based there, the majority of nominations coming out of East Africa identified either general Africa-wide successes or those specific regions other than their own. Ultimately, slightly less than one-third (32%) of the successes cited occurred in East Africa even though over half (51%) of our respondents work in the East Africa region.

Disciplinary and functional biases did emerge. Not surprisingly, respondents proved most well-versed about activities within their own professional purview (Table 4). Technical agricultural scientists cite institution-building successes in agricultural research more frequently than do other respondents. Social scientists cite policy reforms and institutional development among farmer organizations and market institutions more frequently than other respondents. Project implementers, extension staff, NGO personnel and other operational staff are least likely to cite commodity-specific successes and more likely than average to designate specific activities such as soil fertility enhancement, irrigation development and the building up of agricultural research institutions.

5. AN ANALYTICAL FRAMEWORK FOR THE DYNAMICS OF CHANGE

The starting point for analyzing outcomes in agriculture is the individual farm household unit. Outcomes in African agriculture depend fundamentally on choices made by farmers in allocating labor and land, in selecting crop mixes, in the inputs they apply and in the technology they select. From results achieved by individual farm households, outcomes can be scaled up to community level, the agricultural sector, and the aggregate national level. Thus, our framework for analyzing success in agriculture begins from the perspective of the farm household or producer unit (Figure 3).

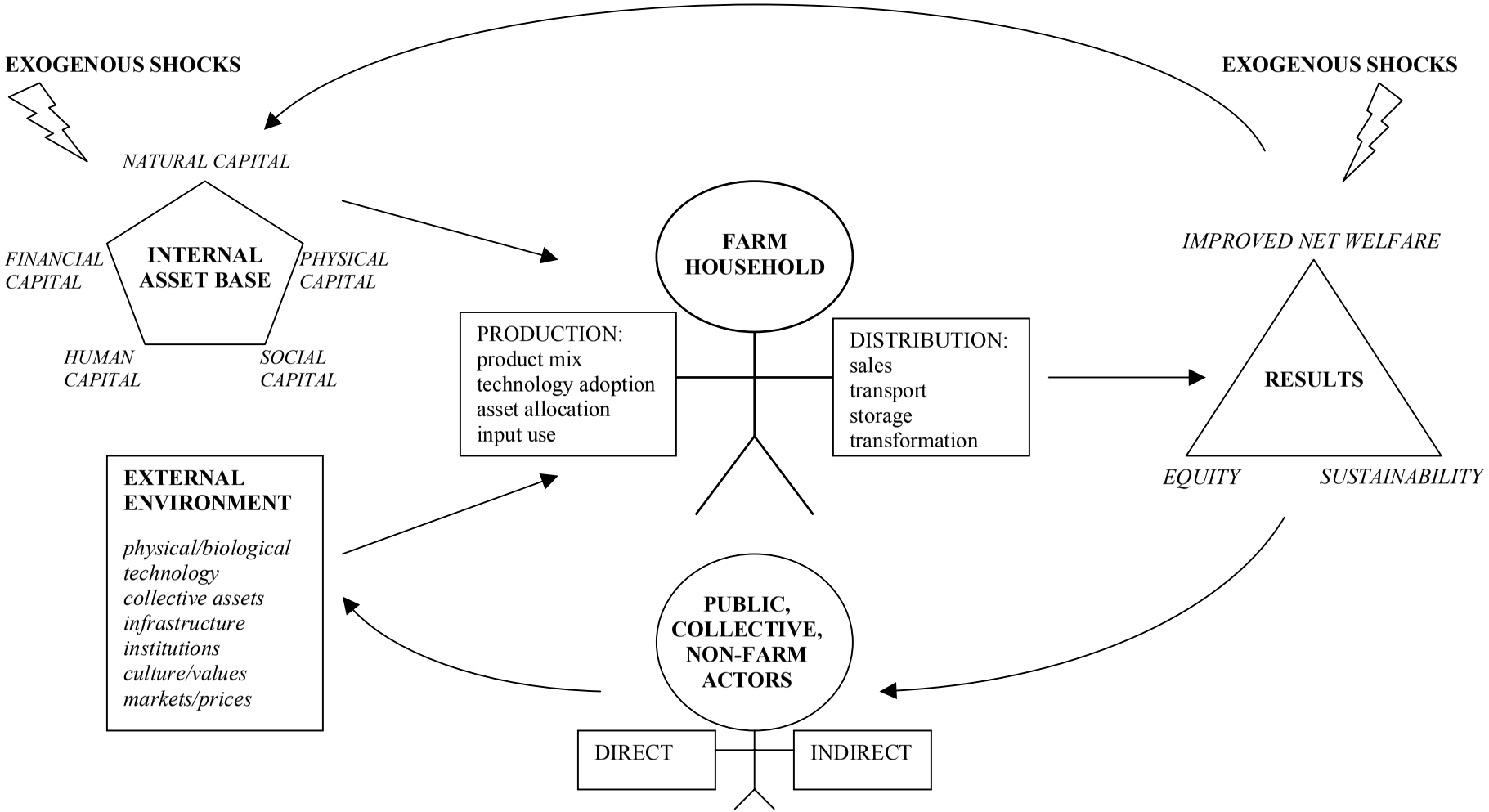
Table 4 -- Exploring Possible Disciplinary Biases in Successes Identified

Successes Identified	Respondent Categories* Technical researchers	Social Scientists	Implementors	Government /donors	Total
Commodity-specific					
food crops	34%	31%	27%	29%	31%
cash crops	19%	20%	15%	21%	19%
livestock/dairy	***18%***	11%	8%	6%	11%
subtotal	70%	63%	51%	56%	61%
Activity-specific					
soil fertility enhancement	4%	6%	***17%***	2%	7%
irrigation development	1%	0%	3%	***6%***	2%
market/policy reform	0%	***11%***	0%	4%	4%
other	9%	2%	8%	***15%***	8%
subtotal	15%	19%	29%	27%	22%
Institution-building					
agricultural research	***11%***	2%	***7%***	2%	6%
farmer organizations	0%	***6%***	0%	***8%***	3%
market institutions	1%	***5%***	2%	2%	2%
other institutions	3%	6%	8%	4%	5%
subtotal	15%	19%	17%	15%	16%
Countries	0%	0%	3%	2%	1%
Total	100%	100%	100%	100%	100%
N	74	64	59	52	249

Bold italics indicate above-average representation.
Underlining indicates below average representation.
* Differences across respondent categories are significant at the 1% level.

Source: IFPRI Expert Survey.

Figure 3—Analytical Framework for Dynamics of Change



A dynamic analytical framework for analyzing success in agriculture is based on four main building blocks: (i) the decision-making environment facing farm households; (ii) the behavior of key actors (farm households as well as public, collective, and non-farm private actors; (iii) outcomes of actions taken by actors; and (iv) exogenous shocks that influence either the decision-making environment or outcomes. The framework borrows from many related and not so related literatures, including the co-evolution paradigm developed in the anthropological and archeological literature studying the emergence and long-term evolution of agriculture,[5] a related body of empirical work in the biological and social sciences on crop evolution,[6] nutrient monitoring,[7] induced innovations,[8] endogenous growth,[9] new institutional economics,[10] development pathways,[11] sustainable agriculture,[12] and sustainable livelihoods.[13] Its inherently dynamic nature is related to that of the co-evolution literature, which underlines the continuously evolving interactions that propel agricultural systems along highly dynamic and often unstable time paths. Outcomes alter the market environment, natural resources conditions, as well as the biological responses of pests and diseases, which together in turn transform the decision-making environment and influence farmer decisions in the next period.

[5] see Rindos 1980, 1984; Price and Gebauer, 1995.
[6] see Harlan, 1992,1995; Diamond, 1998; Evans, 1993; Smith, 1995.
[7] see Stoorvogel and Smaling, 1990; Fresco, 1986; Stoval, 1996; van den Bosch et al., 1998.
[8] see Boserup, 1965; Hayami and Ruttan, 1975; Binswanger, 2000; Scherer et al., 1996; Wood et al., 1998.
[9] see Romer, 1990.
[10] see Nabli and Nugent, 1989; Binswanger and Rosenweig, 1986; Hayami and Otsuka, 1993.
[11] see Pender et al., 1999.
[12] see Pretty and Hine, 2001; Pretty, 1995.
[13] see Carney et al, 1999; DFID, 1997.

Second, like the sustainable livelihoods framework and the emerging literature on sustainable agriculture, the farm household is taken as the starting point for analysis of this dynamic system and the outcomes are viewed from the perspective of the household. Like these literatures, the internal asset base of the household is given explicit emphasis. The framework also borrows from the development pathways framework in distinguishing what is internal or endogenous to the household from the external environment or behavior that is exogenous to the household.

Third, in recognition of the rising awareness of the key role of institutions highlighted in the New Institutional Economics literature, the framework explicitly distinguishes institutions as a component of the external environment facing households. Institutions can be both market and non-market, formal and informal, emerging endogenously by private actors or externally driven by the public sector. Fourth, the framework borrows from endogenous growth theory in focusing on the importance of human capital in the asset base of farm household, specifically focusing on the accumulation of knowledge and its potential spillover effects. Finally, the framework uses an expanded definition of successful outcomes, avoiding the narrow focus on production and on income. Thus, in keeping with the broader focus of the sustainable livelihoods and development pathways frameworks, the definition of success includes concepts of well being and reduced vulnerability. Moreover, the framework goes beyond these frameworks by including net welfare in terms of equity and economic viability, as well as environmental sustainability.

DECISION-MAKING ENVIRONMENT

External to the household.

A number of factors influence the external decision-making environment in which households operate. One factor is the physical and biological environment, such as natural resource conditions, pest and disease mutations, genetic diversity, among others. Another major factor influencing household decision-making is the set of available technologies. Other factors that comprise the external environment faced by households are the set of collective assets, which are defined as assets owned collectively by producers or other private actors, the extent of infrastructure and institutions that facilitate market exchange, culture and values, and the presence of market and price incentives.

Internal to the household

As in the case of the sustainable livelihoods, sustainable agriculture, and the nutrient monitoring literatures, household behavior is conditioned by its internal asset base. Assets take many forms. Natural capital includes land, soil nutrients, water, biodiversity, forests, among others. Physical capital includes housing, equipment, transport, roads, electricity, communications, etc. Financial capital includes cash and other liquid assets, credit and other inflows such as gifts. Human capital includes education, skills, knowledge, health, and nutrition. Social capital includes networks, trust, reputation, and reciprocity. The tracking of assets is central to efforts at tracking

both ecological sustainability as well the evolving equity of asset distribution and incomes over time.

ACTORS

An important distinction made in this framework is between internal actors and external actors. As an internal actor, farm households are individual economic units who individually benefit from change. Internal actors face several types of external actors. One type of external actor is the collective or group of individuals, collectively engaged in traditional communities or formally in organizations, who collectively benefit from change. Collective actors can be associations, cooperatives, companies, among others. Thus, collective actors are composed of mutually interdependent individuals who act collectively and jointly benefit from change.

Other external actors are the state, local government, donors, the international community, firms, non-governmental organizations, and civil society. Public actors play a particular role in bringing about public goods that would not ordinarily be produced by either private or collective actors and are motivated by broader concerns of sustainability, distribution, and aggregate growth.

The interaction between the external environment and the internal asset base that is facing households generates responses by the household as well as by other key actors in the system. Behavioral responses by farm households are decisions concerning production, marketing, and consumption. Thus, these decisions are related to input use, asset allocation, investment, technology selection and on-farm experimentation, asset

allocation, and decisions on cropping mixes and product generation. In addition, households make decisions regarding commercialization as well as consumption.

Collective actors are defined as private actors jointly in order to fulfill mutually compatible objectives. These objectives concern natural resource management as well as input or output marketing, among others. In addition to non-producing households who act as consumers, another set of key actors are firms whose actions may involve processing and other services, marketing, and technology development. Finally, the public sector is a key actor whose actions involve establishing policies and programs, investments, as well as research and development.

KEY INTERVENTIONS TRIGGERING CHANGE

To propel agricultural systems up onto a higher growth path, interventions either increase farmers' internal asset base or alter the incentives from their external environment. According to survey results, both appear to matter, nearly equally (Table 5).

Expanding Production Assets

Overall, the sample of respondents according 43% key interventions to those related to increasing farmers' assets. Cited interventions included (improved soil fertility, irrigation facilities, farm equipment, and land rights, as well as improved access to extension, seeds, fertilizer and pesticide, and credit. Among these assets-based interventions, respondents gave highest importance to agricultural extension, which was between 8 and 18 percent of interventions. Extension is a means of increasing human capital and these results corroborate the recent emphasis in the endogenous growth

literature on the importance of learning and human capital as the engine of growth. Interestingly, public sector respondents viewed this as considerably less important than access to improved seeds. It is somewhat surprising that access to credit was not given higher importance, with only 3% of responses. This may be explained by the extent of subsidies that may have been in place in specific instances that masked the need for producer credit.

Improving Incentives from External Environment

The second trigger for inducing change involves changes in the environment that is external to the farm household, such as in the domain of technology, infrastructure, institutions, markets, values, etc. We re-classified the interventions cited by respondents into two main categories: technology-related and market-related. As could perhaps be predicted, respondents gave highest importance to technology development, which was 34% of all the interventions cited. Technical researchers attached considerably more importance to technology than other respondents. At the same time, all respondents considered productivity-enhancing technology to be the most important, with little variation among them. Technology for disease resistance followed in importance.

Table 5—Key Interventions Triggering Agricultural Change*

Interventions	Technical researchers	Social Scientists	Practitioners	Government/ donors	All
	(%)	(%)	(%)	(%)	(%)
A. Increasing Farmer Assets					
Soil fertility	6	3	7	3	5
Irrigation	1	2	8	6	4
Farm and processing equipment	0	1	7	4	3
Land rights	2	1	0	0	1
Draft power	0	0	2	2	1
Extension	13	15	18	8	14
Seeds	7	8	5	17	9
Fertilizer and pesticides	7	0	2	1	2
Credit	3	3	6	3	4
Sub-total	*39*	*33*	*55*	*44*	*43*
B. Changing Incentives from the External Environment					
Technology development					
Higher productivity	30	27	22	19	25
Disease resistance	15	0	2	7	5
New species introduction	2	0	2	0	1
Other	3	0	5	8	3
Sub-total	*50*	*27*	*31*	*34*	*34*
Markets					
Macro and trade policy reform	0	9	0	3	4
Agricultural sector reform	9	9	2	4	7
Private marketing	2	7	4	6	5
Public marketing agencies	0	7	5	6	5
Growing markets	1	5	4	2	3
Sub-total	*12*	*37*	*15*	*21*	*24*
Total interventions identified					
%	22	39	20	19	100
Number**	111	202	103	98	51

* Differences among respondent categories are significant at 1% level
** Totals exceed the total number of cases because many respondents cited multiple interventions.

Source: IFPRI Expert Survey.

With the exception of social scientists, respondents considered changes in market incentives to represent between 12 and 21 % of interventions. Social scientists gave the role of markets considerably more prominence, with a 37% share. With tradable commodities such as cotton, horticulture, and maize, active market promotion and assurance of price incentives has played a major role in stimulating increased output. Many respondents noted the importance of the CFA devaluation in stimulating cotton exports in the 1990s. Vertically integrated export marketing proved crucial in the rise of private horticultural exports from Kenya and cotton from French West Africa. Processing in smallholder dairies and maize markets prove essential in sustaining incentives for local producers.

THE ROLE OF ACTORS

Farmers

Individual farmers have played a central role in stimulating improvements in African agriculture. In 14% of the case studies nominated, farmers and farmer groups proved to be key initiators of system change (Table 6). The introduction and dissemination of both cassava and maize was a purely private affair. Similarly with bananas, plant breeders marvel that farmers in Uganda and surrounding countries have bred so selectively that, after roughly a century of on-farm selection, the Central Highlands of Africa house the largest genetic diversity of bananas in the world (Reader, 1997). As one respondent noted, the expansion of banana production, "has depended

solely on selective breeding by farmers. It now covers the entire Great Lakes region and is the number one food security staple in the region."

Table 6 -- Key Actors Initiating Change in Agriculture

	Respondent Categories*				
Actors	Technical researchers	Social Scientists	Implementors	Government /donors	Total
Public sector					
African					
national agricultural research systems	***28%***	13%	***22%***	***21%***	20%
government	23%	***28%***	12%	15%	21%
parastatals	1%	3%	5%	6%	3%
International					
donors	8%	17%	12%	17%	14%
international agricultural research cent	18%	8%	5%	12%	11%
subtotal	78%	68%	55%	71%	69%
Private sector					
agribusiness	6%	10%	12%	15%	11%
farmers	9%	8%	12%	3%	8%
farmer groups	3%	9%	8%	3%	6%
NGOs and projects	4%	5%	13%	8%	7%
subtotal	22%	32%	***45%***	29%	31%
Total actors					
percent	100%	100%	100%	100%	100%
number	78	116	60	66	320

* Differences among respondent categories are significant at the 5% level.
** Because many respondents credited multiple actors in the cases they cited, the totals here exceed the total number of cases identified.

Source: IFPRI Expert Survey.

Private agribusiness

Respondents identified private firms as key instruments of change in 11% of the cases cited, with this figure rising to 15% among African government and donor respondents (Table 6). Seed supply industries have proven crucial to the maintenance of high-yielding hybrid maize varieties throughout East and Southern Africa. Private exporters have sustained horticulture exports of flowers, vegetables and tropical fruits from East Africa to Europe and the Middle East through export marketing and often

through input supply to farmers. Common to many of these systems are what the agricultural marketing literature calls "system nodes," where large commercial firms provide key inputs or market outputs that sustain production by thousands of small producers (Boomgard et al., 1992; Delgado, 1999). In doing so, these commercial firms can and do play a crucial enabling role necessary for the advance of smallholder agricultural production.

Non-governmental organizations.

Though less frequently cited than the other private sector actors, with 7% of overall citations, non-governmental private agencies have many times played important strategic roles. In the ICRAF experiments with controlled fallows, NGOs have proven valuable partners in testing and disseminating new soil management techniques. Likewise with the spread of conservation farming techniques in Southern Africa, NGOs have played a key role in technology extension and work with farmer groups. Churches, clinics and NGO's proved valuable partners in the diffusion of improved varieties of winged beans in Rwanda as did a small army of non-government organizations helping to distribute disease-resistant cassava cuttings to combat the virulent recent outbreak of cassava mosaic virus in Uganda (Sperling et al., 1995***;*** Otim-Nape et al, 2000).

Government

Though private actors have made invaluable contributions to agricultural growth in Africa, many necessary interventions remain public goods. Underlining the importance of this public role in African agriculture, our respondents identified the public

sector -- which includes national and international research centers, governments, parastatal agencies, and donors -- as key initiators of change in over two-thirds of the instances cited (Table 6). Agricultural research in open pollinating crops, agricultural extension, and the provision of roads and communications infrastructure represent key investments that the private sector will not initiate or for which private incentives alone will lead to under-investment (Alston et al., 1998).

Government policy makers, agricultural ministries and extension services received 21% of all citations for initiating favorable change, making them the most commonly cited actors overall. Social scientists cited government most frequently, not surprising given their focus on the importance of government policies in stimulating agricultural change.

At the same time, in other cases, the absence or withdrawal of the government can prove to be a favorable catalyst of change. Several respondents working in East Africa echoed the sentiment of one who stated flatly that, in promoting horticultural production and export, "What most people say is that the industry flourishes because there was never government involvement." However, this statement must be nuanced in that, while perhaps the government was not directly involved in procurement and distribution, it nonetheless still maintained conditions such as facilitated access to air and road transport, as well as to credit, that resulted in an enabling environment. The key, as in most of economics, is finding the right balance between public and private roles (Johnson, 1995).

National and international research centers

The role of national research centers in stimulating change in African agriculture received the second highest share of citations overall (20%). In fact, they received the highest share from all groups except social scientists, whose focus on policy issues led them to emphasize the importance of government policy actions (Table 6).

International agricultural research centers received high marks for their interaction with national research systems, for supplying germplasm and technical assistance, and in rallying donor support around key priorities, most emphatically in the recent outburst of cassava mosaic virus and pest infestations. They have made long-term contributions to the improvement of hybrid and open pollenating maize lines, in the recent development of interspecific varieties of rice and in promoting promising new techniques of soil fertility enhancement via controlled fallows and limited applications of mineral fertilizers (Jones, 1999; Manyong et al. 2000a, 2000b; Byerlee, 1994; Nweke et al., 2002; Sanchez et al., 1997; WARDA, 2001). Respondents also noted important contributions in tissue culture improvements in bananas, improved dairy breeds and management, in the development and distribution of improved livestock vaccines, and improved varieties of groundnuts, millet, sweet potatoes, cowpeas and climbing beans (David et al., 2000; CGIAR, 2001; Inaizumi et al., 1999). Overall, the share of citations received by international agricultural research centers comes to 11% of the total, with that figure rising to 18% in the case of technical researchers who work most closely with the international centers.

Donors

Respondents identify donors as key agents of change 14% of the time, though among social scientists, African governments and donors themselves that share rises slightly. The entirety of the international agricultural research system as well as one-third of African NAR budgets are now donor-financed.[14] So, currently, donors play a crucial role in sustaining international agricultural research and technology transfer. Several respondents noted the long time lags involved in agricultural research – 11 years in one FAO project, 17 years in Malawi's maize breeding, 28 years for Zimbabwean maize and applauded the long-term donor funding horizons necessary to support viable research results. Others point to specific donor pushes to assist with programs such as livestock vaccination, the urgent battle against the cassava mealybug, and the promotion of horticultural exports and dairy production.

[14] That figure rises to one-half if we exclude the largely state-financed systems of Nigeria and the Republic of South Africa (Pardey et al., 1995).

6. CONCLUSIONS AND LESSONS FOR BUILDING ON SUCCESS

We now return to the set of questions that we raised in the introduction. Can sporadic and isolated instances of success be replicated and sustained to achieve broad-based, aggregate successful growth in Africa's agriculture? What can be learned from closer investigation of these isolated successes? The results of our analysis point to several insights for the dynamics of successful change. First, private actors—farmers and trading firms—are central to the process of change. Second, changes in the internal asset base of private actors and in the external environment are equally important. From the multiplicity of responses, one can conclude that neither type of intervention is sufficient in isolation. Thus, farmers cannot benefit from improved market opportunities if they do not have the means to access knowledge about improved practices, or seeds, or other inputs. Conversely, farmers cannot benefit from greater resources for production without injections of technology and outlets for their surplus. Third, the role of the public sector, as well as that of civil society and collective actors, in influencing the changes in both internal and external environments is critically important. Fourth, science-based technology, particularly productivity-enhancing, is a key driver of Africa's agricultural growth. Certainly the success stories reviewed here overwhelmingly point to improved technology as the lynchpin of increased farm production and incomes. For this reason, recent declines in the funding for agricultural research – by both African governments and donors – threaten to stall agricultural advance. Finally, these success stories highlight the highly dynamic environment within which farmers, traders and agricultural

policy makers operate. Rapidly mutating diseases, ever-adapting pests, climatic shocks, changing world market conditions and policy environments all contribute to continuously evolving pulsations, surges and shocks to Africa's agricultural systems.

The above lessons highlight the relationships among triggers of success. A better understanding of the underlying drivers of change, as perceived by those who have observed closely these success stories, provides a useful opportunity to apply these lessons to new thinking of replicating, expanding, and sustaining success in African agriculture. These insights suggest that, where there is participation and individual motivation, where incentives are aligned with improved means to respond to incentives, and where technology plays a pivotal role, success may follow.

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