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Payoffs to Investments in Agricultural Technology in Sub-Saharan Africa

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BACKGROUND: Over the past fifteen years, USAID and other donors have made considerable investments in African technology development and transfer (TDT) activities, primarily for research and extension. Yet obligations for TDT under the Development Fund for Africa (DFA) declined steadily from $55 million in 1986 to $35 million in 1991, reflecting a decrease in the proportion of the DFA allocated to agricultural TDT from 34 percent of the allocation to all agricultural activities in 1986 to 14 percent in 1991.

This dramatic decrease in USAID funding for TDT stemmed in part from perceptions that TDT has had little impact. These perceptions were based on gloomy aggregate statistics, such as stagnant per capita food production in Africa, which resulted from high population growth rates, war, drought, and other factors in addition to TDT. The perceptions were also based on examples of real problems that agricultural research and extension organizations faced.

To inform TDT investment decisions, USAID commissioned a set of studies to measure the people-level impacts of TDT in sub-Saharan Africa, as well as the accomplishments of TDT in achieving national-level impacts. Results from these and other relevant impact assessments were reported at the Symposium on the Impact of Technology in Sub-Saharan Africa held on Oct. 14-16, 1992, in Washington, D.C.

A primary purpose of the symposium was to present evidence that would either confirm or contradict the perception that the accomplishments of TDT were insufficient to justify continued funding. A secondary objective was to consider the adequacy of available methods of impact assessment. The objective of the current report is to summarize and interpret the symposium results.

THE IMPACTS OF INVESTMENTS IN AGRICULTURAL TDT

The Rate of Return (ROR) Method of Impact Assessment: TDT is a process characterized by four sequential stages: creation of the institutional capacity to develop improved techniques of production, expansion of the technology frontier, transfer of technology to users, and sustainable changes in long-term productivity.

The rate of return (ROR) is the most commonly used measure of the economic profitability of TDT investments. This measure summarizes the benefits, costs and time frame of the activity. Investments with positive RORs give benefits that more than cover costs. Investments with RORs that exceed the return to alternative investments or the cost of obtaining funds are considered economically profitable. The benefits included in the appraisal of TDT investments are usually people-level benefits such as changes in income or other measures of household welfare.

There are several other accomplishments of TDT that are not often counted as benefits, due to difficulties in quantifying the impact. These accomplishments include improvements in the status of women within the household, improvements in the environment and the sustainability of agricultural production, improvements in the human and institutional capacity for research, and improvements in equity (income distribution). The ROR

TABLE 1. EX POST ROR STUDIES OF AFRICAN AGRICULTURAL TDT.

AUTHOR(S)	YEAR	COUNTRY	COMMODITY	TIME PERIOD	ROR in %
Abidogun	1982	Nigeria	Cocoa	-	42
Makau	1984	Kenya	Wheat	1924-74	33
Evenson	1987	Africa (Regional)	Maize & Staple Crops	1962-80	30-40
Karanja	1990	Kenya	Maize	1955-1988	40-60
Mazzucato[b]	1991	Kenya	Maize	[a]	58-60
Mazzucato and Ly[b]	1992	Niger	Cowpea, Millet & Sorghum	1975-1991	< 0
Schwartz, Sterns & Oehmke	1992	Senegal	Cowpea	1981-1986	31-92
Sterns & Bernsten[b]	1992	Cameroon	Cowpea	1979-1992	3
Howard et al.[b]	1992	Zambia	Maize	1978-1991	< 0, 90-103[c]
Laker-Ojok[b]	1992	Uganda	Sunflower, Cowpea, Soybean	1986-1991	< 0
Boughton,	1992	Mali	Maize	1969-1991	135
Henry de Frahan[b]				1962-1991	54

[a] Parameters estimated for 1955-1988; ROR for research undertaken in 1978. [b] USAID-commissioned studies
[c] Including and excluding real costs of maize program subsidies, respectively.

studies presented in the symposium do not account directly for these other benefits, although evidence of progress in these areas was reported in some studies.

***ROR Assessment Results**:* Table 1 shows results for a set of *ex post* studies, i.e., those analyzing TDT benefits achieved to date. In general, the RORs are not only positive but also high enough to indicate economic profitability. These findings are striking. They provide a direct contrast to the negative views of African agricultural research impacts that have permeated recent discussions. In the current set of studies, only Niger and Uganda show *ex post* RORs that are negative. The remainder of the studies find positive returns, ranging from 3 percent for cowpea in Cameroon to 135 percent for maize in Mali. Examined as a group, the estimated RORs support the proposition that African agricultural research has had people-level impacts large enough to justify the level of investment that led to the impacts.

Alternative interpretations of the consistently high estimated RORs were examined during symposium presentations and discussions. For example, if ROR studies focus primarily on success stories, the reported results are biased upward. The countries and commodities in the USAID-sponsored studies were chosen to avoid any such bias. Cases of likely TDT successes (e.g., Kenyan maize) were examined, as well as cases where conventional wisdom said that little impact had been achieved (e.g., Niger). The countries included in the MSU study constitute a stratified random sample, although the crops were chosen based on their importance to the food system and/or the priorities of the AID missions, national agricultural research systems, and Ministries of Agriculture. Regional evidence (Evenson, 1987) relating measures of productivity to measures of all research funding, including successes and failures, also shows large positive RORs. Thus, biased selection is not a likely explanation of the ROR results.

Table 2. Components of TDT by Study.

STUDY	RESEARCH COSTS	EXTENSION COSTS	OTHER COSTS	OTHER OUTPUTS
Kenya	YES	NO	NO	NO
Niger	YES	YES	YES[a]	YES[b]
Senegal	YES	YES	YES[a,c]	YES[d]
Cameroon	YES	YES	NO	YES[d]
Zambia	YES	YES	YES[e]	YES[b]
Mali	YES	YES	YES[a]	NO

[a] Costs of providing farm-level inputs. [b] Institution building. [c] Costs of degree training. [d] Sensitivity analysis included food security benefits. [e] Farm input costs plus real costs of maize program subsidies.

The ROR studies were undertaken from the per spective of national research systems. The reported RORs therefore represent the returns to investment in national research programs, taking as given the contribution of the international agricultural research centers (IARCs).

A Comparison of Methodologies Used: While each of the MSU ROR studies used the same conceptual background in assessing benefits and costs, the investigator's decisions about data collection, the scope of the study, and other critical variables varied somewhat from country to country. These issues and their effect on the estimated RORs are discussed in the next section.

First, for young TDT systems such as those in Africa, many projects have continuing impacts. Impact assessments are sensitive to the starting and ending points chosen by the evaluator.

A young research program may just be starting to have impacts, with the bulk of the impacts to come in the future. An assessment of impacts only through the present therefore will not capture any benefits of future use of improved crop or livestock varieties or management practices. Ignoring likely future benefits may lead to an unprofitable or negative ROR, as in the Niger and Uganda cases. Similarly, if the starting point of the analysis is extended backwards in time, perhaps because the project being evaluated is the second phase of an earlier activity, additional costs would probably be included, reducing the estimated ROR, as in the Mali case.

Second, in most cases, it is difficult or impossible to identify the impact of a given component of TDT, such as research or extension. Table 2 summarizes the components of TDT that are considered by each of the AID-commissioned studies.

A third complication is that some benefits are difficult to quantify. For example, benefits of institution building and improvements in seasonal food security are discussed but not estimated monetarily in most of the studies (Table 2, last column). Another benefit often not quantified is any reduction in consumer prices resulting from increased production or marketing efficiency. Such benefits to consumers are particularly important for the poorest farmers, who are often net purchasers of food. Hence lower prices are likely to improve equity, and to increase the estimated ROR (when consumer benefits are included).

Factors Influencing Impact: An important part of the impact assessment story is the analysis of factors that had a positive or negative effect on the impact of TDT. Insights from this analysis help suggest how future TDT programs could be better designed or implemented. Five major factors emerged from the studies presented, and from comments by symposium participants.

Policies affecting the supply and price of agricultural inputs, and the market for and the price of agricultural outputs, clearly have an effect on impact of improved technology. A dramatic example is Zambia, where government policy stimulated a degree of improved maize adoption that appears to have been economically unprofitable as well as budgetarily unsustainable. In Sudan, the adoption of improved sorghum suffered a set-back when government pricing policy changed.

Input supplies (including seed and credit) and output markets play a key role in supporting or restraining adoption of productivity-increasing agricultural technology. Lack of effective improved seed multiplication and distribution was a critical constraint in Uganda and Niger, as was lack of fertilizer in Zambia. Limited markets for output were constraints in Mali and Uganda. By contrast, wide use of improved maize hybrids in Zambia was encouraged by relatively effective input and output markets.

Many of the TDT programs evaluated in the impact studies were implemented in zones with difficult agroclimatic conditions. The Niger and Cameroon TDT programs faced a challenge in trying to develop improved cereal and cowpea technology for areas with low and variable rainfall. Droughts also reduced impact in Niger. Diversity of agroclimatic conditions within the zone targeted by research also presents problems because of the drop in performance of an improved technology outside the area for which it was designed. The Zambia maize study showed, for example, that improved hybrids or varieties were adopted by two-thirds of farmers in the best maize zone, but by only one-third of farmers in the less favorable (low-rainfall) zone. Also, farmers in the best maize zone planted three-quarters of their land in improved maize, compared to one-quarter in the low-rainfall zone.

Research organizations, and other institutions needed for effective TDT, depend on a stable political environment. The Uganda study illustrates the cost of restoring the institutional framework destroyed by civil unrest.

Appropriate priorities, scientific leadership, favorable incentives, and adequate human and financial resources are needed if research systems are to be effective in generating improved technology. Several country studies (e.g., Zambia, Kenya, Cameroon) showed that a combination of well-funded programs by national and international research centers and donor agencies did result in the release of improved technology that was adopted by farmers. Maintaining productive research system performance with tighter budgets and reduced donor involvement requires more rigorous priority-setting (maintaining adequate funding for fewer research programs) and changes in the incentive structure (salary, merit-based researcher evaluation procedures) within national agricultural research systems.

CONCLUSION: Given the importance of raising productivity in agriculture as a step towards agricultural transformation, continued investment in agricultural TDT is merited. The evidence of impact achieved from previous investments, and the evidence of beneficial changes in the macroeconomic policy environment in many countries, provide the basis for expecting that future investments will pay off. The evaluation results indicate that USAID may wish to maintain or gradually increase the amount of funding allocated to agricultural technology development and transfer in sub-Saharan Africa.

References: Evenson, Robert E. 1987. "The International Agricultural Research Centers: Their Impact on Spending for National Agricultural Research and Extension." CGIAR Study Paper #22.

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