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ASSESSING THE IMPACT OF COWPEA RESEARCH AND EXTENSION IN NORTHERN CAMEROON: LESSONS LEARNED

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I. INTRODUCTION

Problem Statement

Since the early 1960s, developing countries, assisted by foreign donors, have invested resources to strengthen their agricultural research systems. Agricultural economists have supported this strategy, arguing that technological innovations in agricultural production drive the development of the agricultural sector, which in turn contributes to the development of the general economy (Mellor, 1966; Eicher and Staatz, 1984). While several studies report a high rate of return to agricultural research in Asia and Latin America, there is no clear consensus that these investments have netted positive returns in Sub-Saharan Africa (Oehmke, et al., 1991).

This suggests that additional research is needed to address two critical issues. First, in today's world of limited resources and tight budgets, there is a need to determine if past investments in technology-generating agricultural research in Sub-Saharan Africa have generated sufficient returns to justify continued investments. Second, there exists a need to examine national experiences in implementing agricultural research in order to identify factors that explain the variability in the impact of these investments.

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Objectives

Cameroon, like many other countries, has sought to increase agricultural productivity through research and extension of locally developed and/or screened technologies. The general objective of this paper is to assess the impact of cowpea research and extension in northern Cameroon, and to describe factors that contributed to the observed impact. The specific objectives are to:

a. Estimate the economic rate of return to cowpea research and extension in northern Cameroon, using a cost/benefit approach;

b. Review the institutional factors, linkages, and characteristics associated with the research-extension system, determining how each interacted to complement and/or impede the performance of the cowpea subsector;

c. Discuss lessons learned from this study, focusing particularly on the choice of criteria for setting research agendas and on constraints in assessing impact.

Cowpea's Niche in Northern Cameroon

Cowpea, a traditional food crop in northern Cameroon, accounts for an estimated 5% of total food crop area harvested. Although a relatively minor food crop in terms of hectares harvested, several studies (Ta'Ama, 1983; Wolfson, 1989; Kitch, 1990) have found that cowpea makes an important contribution to household food security in northern Cameroon. First, because the crop matures early, households are able to harvest fresh cowpea leaves and green pods during the "hungry season" (late June through August) when grain reserves from the previous year's harvest are depleted, and farmers have not yet harvested this year's crops. Second, cowpea is an important source of protein, especially for the rural poor. Singh and Rachie estimate that cowpea contains 23 to 30% protein, with variations in content due to varietal differences and environmental factors (1985). Third, as a drought tolerant crop that matures in 60 to 80 days on as little as 300 mm of rainfall, cowpea reduces farmers exposure to production risk. Finally, cowpea hay (leaves and stems) is a major source of forage for animals which limited resource farmers both feed to their livestock and sell in local markets.

Cowpea Research-Extension System in Northern Cameroon

Cowpea research is conducted under the auspices of *l'Institut de Recherche Agronomique* (IRA)--the national agricultural research system. Since 1979, cowpea research and extension has been supported by three donor projects--the Semi-Arid Food Grain Research and Development Project's Joint Project No. 31 (SAFGRAD JP 31), the Bean/Cowpea Collaborative Research Support Project (CRSP), and USAID's National Cereals Research and Extension (NCRE) project. The cotton parastatal--*le Société de Développement du Coton* (SODECOTON)--was the primary entity responsible for extending research results. In addition, USAID's North Cameroon Seed Multiplication (NCSM) Project and the World Bank's Center-North Project (PCN) played indirect roles in developing and extending cowpea technologies.

Technologies Extended

In northern Cameroon, cowpea research initially focused on screening cultivars for high grain yields. Sources of plant material for screening included both local and exotic varieties. In general, exotic varieties were grown as part of a series of regional multi-location variety trials organized by the International Institute of Tropical Agriculture (IITA), the Bean/Cowpea CRSP and/or SAFGRAD.

The first technology package developed by IRA included the new cowpea variety TVX3236 OG1. This indeterminant, medium cycle (75 to 80 days to maturity) variety was selected from IITA regional screening trials for its high yield potential, grain color, and insect (thrips) tolerance. The extension recommendation was that farmers monocrop the variety on a quarter-hectare plot and, when possible, treat the standing crop with insecticide.

Although TVX3236 was first extended to farmers in 1980 through SAFGRAD's on-farm testing program, SODECOTON did not begin to extend the variety widely until 1984. Widespread extension was facilitated by the North Cameroon Seed Multiplication Project, which produced and sold approximately 20 tons of TVX3236 from 1984 to 1986. SODECOTON continued to recommend and extend the "TVX package" through the 1987 growing season. In addition, IRA introduced Ife Brown (a local Nigerian cultivar) and VYA (a local Cameroonian cultivar from the Moutourwa area) in 1985 and 1986-1987, respectively. These two varieties were identified for extension by SAFGRAD/CRSP screening trials.

During this period (1980-1986), researchers and extension workers documented significant (sometimes total) storage losses due to bruchid infestations. As a result SODECOTON modified its extension recommendation. Foremost, SODECOTON advised farmers to reduce their cowpea area from a quarter to an eighth of an hectare. SODECOTON's contention was that until storage constraints could be met, cowpea should be grown primarily as a garden/compound food crop for the hungry season, not as a commercial grain crop.

In 1987, IRA released two new sister lines[2] with several advantages over TVX3236 including comparable yield, larger grain size, significantly less shattering of seed pods, and more importantly, greater tolerance to bruchids. These two varieties, BR1 and BR2 (IITA cultivars IT81D-985 and IT81D-994 respectively), are sufficiently tolerant to bruchids to allow farmers to store cowpea for an additional month before bruchid damage becomes significant. In 1987, in recognition of the importance of post-harvest losses, the research agenda shifted to give greater priority to developing improved grain storage technologies and to establishing a breeding program directed partly at achieving storage pest (bruchid) tolerance. Since 1987, researchers

[2]These varieties were developed through IITA's cooperative multilocational trials program.

have continued to recommend that farmers monocrop quarter-hectare plots of BR1 and BR2 and apply two to three insecticide sprayings.

II. RATE OF RETURN ANALYSIS

Research and Extension Costs

Total cowpea research and extension costs are the sum of investments made by five participating institutions. Cost streams were compiled for the three donor projects and two host country institutions which financed the cowpea research-extension system responsible for developing and extending the original technology package[3]. Research specific to the development of these technologies began in 1979, was moved to on-farm testing as a technology package in 1981 (for TVX 3236, in 1984 for BR1 and BR2) and was extended to farmers in 1984 (for TVX3236, in 1987 for BR1 and BR2). Thus, only costs incurred during this nine-year period are included in the cost stream (Table 1).

For each contributing project, the cowpea share of research and extension investments was calculated as follows. For SAFGRAD JP 31, costs include the 25% of project resources that were targeted towards cowpea research. For the Bean/Cowpea CRSP, all expenditures (as reported by the CRSP Management Office at Michigan State University) supported the development of the technologies extended and are included in the cost stream. Since NCRE Project's financial contribution was limited to a two-year buy-in to support on-farm research as SAFGRAD JP 31 was being phased out, only these NCRE costs are included. IRA's contribution to the cost of developing the new technologies--including the salaries of host country research staff and unskilled labor, and some operating expenses (eg., fuel, electricity, water, office materials, per diem, temporary hires)--are also included in the cost stream. Finally,

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[3] The package extended to farmers consisted of a recommendation for monocropped, improved varieties with chemical applications (seed treatments and insecticide sprayings).

to include SODECOTON's contribution to cowpea research and extension involved several estimations. As part of its general activities, SODECOTON maintains a large extension network. The adoption of the cowpea package and its subsequent impact is, in part, dependent on SODECOTON's extension and distribution system. Hence, the share of these costs attributable to cowpea extension was included in the analysis.

Table 1. Estimated Total Costs (nominal $US) for Cowpea Research and Extension Programs, Far North Province, Cameroon, 1979 to 1987.

Year	SAF-GRAD J.P. 31	CRSP	NCRE	IRA	SODE-COTON	Total Annual Costs
1979	19,901	0	0	10,771	0	30,700
1980	17,325	0	0	11,001	0	28,300
1981	15,187	0	0	13,278	15,317	43,800
1982	15,657	131,565	0	33,478	14,769	195,500
1983	16,505	278,689	0	41,847	11,035	348,100
1984	34,916	332,003	0	58,585	11,147	436,700
1985	38,302	298,535	0	55,103	15,239	407,200
1986	32,638	272,893	4,890	26,462	15,043	351,900
1987	26,974	186,452	9,780	84,954	15,688	323,800

Research and Extension Benefits

Three time series of data are needed to estimate the benefits of a technology: (1) the market value of annual production since 1984, the first year that the technology was extended; (2) the market value of annual production, assuming that the technology had never been developed and extended; and, (3) annual on-farm costs of adopting the technology.

To estimate the cowpea benefit stream data were needed for: (1) yields under three different sets of farming practices (total adoption of the cowpea package, adoption of the package minus insecticide use, and traditional practices[4]); (2) adoption rates of the new technologies (including adoption ceilings and the lifespan of the technology); (3) total area harvested; and, (4) annual input and output prices.

Yields are estimated from SAFGRAD/CRSP/NCRE on-station and on-farm trial data, from yields reported by farmers in surveys, and from SODECOTON reports. Adoption rates are estimated from adoption survey results reported by the CRSP and the IRA-Maroua Testing Liaison Unit (TLU) and extrapolated into the future, using a logistic function. Prices are estimated from price time series reported by Cameroon's Ministry of Agriculture, NCRE/IRA, and SODECOTON.

Gross benefits are determined by summing the gains and reductions in production minus the increases in input costs. For this analysis, gains, reductions, and on-farm input costs are reported in $US (Table 2).

The improved package extended to farmers represented a completely new cropping system. Traditionally, cowpea is intercropped with sorghum and grown as much for its leaves as for its grain. The improved packaged represented a significant increase in grain yields, but required a reduction in the production of other commodities, specifically sorghum grain and stover and cowpea leaves. With adoption, sorghum production on cowpea acreage is reduced to zero since farmers monocrop improved varieties. Also with adoption, the level of cowpea leaf production for food becomes de facto zero since farmers will not eat the leaves of cowpea treated with insecticide and forage production for feed is reduced since improved varieties produce less forage.

[4]Cowpea yields are needed under each farming practice for grain, leaves for food, and forage for feed. With traditional practices, yield data are also needed for intercropped sorghum (grain and stover).

Table 2. Estimated Gross Benefits ('000 $US) from the Cowpea Package Extended, Far North Province, Cameroon, 1984 to 1998.

Year	Gain In Value of Cowpea Grain Production	Reduced Value of Cowpea Leaf Production	Reduced Value of Cowpea Forage Production	Reduced Value of Sorghum Grain Production	Reduced Value of Sorghum Stover Production	Total Annual On-farm Input Cost	Gross Benefits from Improved Package
1984	5	-1	-0	-2	-0	0	2
1985	20	-3	-0	-7	-0	1	8
1986	53	-7	-1	-20	-1	3	21
1987	110	-15	-1	-42	-1	7	43
1988	449	-63	-6	-171	-5	30	174
1989	499	-70	-6	-189	-5	33	195
1990	1318	-185	-17	-498	-14	87	517
1991	1888	-265	-24	-710	-20	125	744
1992	2030	-285	-26	-761	-21	134	803
1993	2246	-315	-28	-839	-23	148	892
1994	2430	-340	-31	-906	-25	160	967
1995	2437	-341	-31	-908	-25	161	970
1996	2444	-342	-31	-911	-25	161	973
1997	2444	-342	-31	-911	-25	161	973
1998	2444	-342	-31	-911	-25	161	973

The IRR and Sensitivity Analysis

The internal rate of return (IRR) is a measure of "profitability" of an investment. An IRR of zero indicates a return sufficient to cover the initial investment, but no more. The IRR must be equal to or greater than the target rate of return (the opportunity cost of capital) in order for the investment to be considered "profitable". For this study, the base run IRR is 15%, calculated from the cost and benefit streams reported in Tables 1 and 2. The net cost/benefit flow is reported in the appendix (Table A.1).

Although the base run is the best-judgment estimate of the returns to cowpea research and extension in northern Cameroon, sensitivity analysis is conducted to test the robustness of that estimate. Further, given that some data used in the analysis are estimates based on informed assumptions and not actual empirical findings, sensitivity analysis is useful to indicate how each assumption affects the results.

Over sixty additional estimates of the IRR to cowpea research and extension have been calculated, modifying the values of one or more of the model parameters/variables for each of the sixty-plus runs. From this analysis, eight parameters/variables were identified as having a significant influence on the estimated rate of return. In general, when key variables were modified by plus or minus 25%, the IRR varied by less than plus or minus 30%, implying an IRR in the range of 10 to 20%. There were two exceptions to this general range, resulting in IRRs that were beyond these values. When cowpea market price and cowpea grain yield for the package extended to farmers were increased by 25%, the IRR became 22.2 and 24.8%, respectively. When decreased by 25%, the IRR became 3.5% and negative, respectively. Although the estimate of the yield of the cowpea package extended to farmers greatly affects the returns to research, key informants within the research-extension system have a high degree of confidence in the expected yield of the technology. Hence, varying its value by 25% is probably excessive, and the resulting negative rate of return is unlikely unless key inputs (eg., insecticides) become unavailable. With respect to cowpea price, trends indicate that the base run prices may be underestimated. Improved storage technologies, developed since 1987, should allow farmers and grain merchants to delay sales to capture higher market prices reflected in the extreme seasonality of food crop markets in northern Cameroon. Hence, the low rate of return associated with a 25% reduction in cowpea prices is unlikely.

Insights on How Institutions Can Affect the IRR

Institutions that affected the productivity of cowpea research include donor projects (eg., CRSP, SAFGRAD), Cameroon's system of research within the Ministry of Agriculture (eg., IRA), input suppliers (eg., NCSM, SODECOTON), output markets, and the government's policies towards food crop marketing (de facto laissez-faire). The evaluation of these institutions can help identify factors that contributed to the "success" of the technology extended. For this study, three insights are particularly clear.

1. *Linkages, via donor projects, among actors involved in the research-extension system contribute to the technology development process.*

In a sense, all the "pieces of the puzzle" were present in northern Cameroon: on-station varietal and agronomy research, companion and complementary research by collaborating US teams, an on-farm pre-extension testing program, a capacity for seed multiplication, and an effective extension system. In 1982, the World Bank's PCN provided the impetus that brought together each of these "pieces". Two actions by the PCN fostered the development of ties between each of the actors. First, the PCN aimed to improve IRA's management practices, creating information flows and collaboration among each of IRA-Maroua's commodity-based research units. Second, PCN contracted SODECOTON to carry out food crop extension through its extensive cotton extension network. These conditions led to considerable cooperation among the system's various actors. SODECOTON, with its input distribution system and nearly 1,000 extension workers, provided a conduit for both the extension of technologies and feedback from the farm to researchers. In turn, researchers knew that as they developed appropriate technologies, there was a system ready to diffuse these technologies widely. Even after the PCN was phased out in 1987, SODECOTON and IRA continued to collaborate on food crop research and extension, indicating that once mutually beneficial linkages are established, their self-maintenance is possible.

2. *Linkages, via donor projects, between national agricultural research systems (NARS) and international agriculture research centers (IARCs) contribute to the technology development process.*

In northern Cameroon, both the Bean/Cowpea CRSP and SAFGRAD J.P. 31 collaborated in multilocational varietal screening trials that were organized at the international level by either IITA, SAFGRAD, or the CRSP. Most of the varieties that were extended to farmers as part of the "improved" technology package were actually exotic varieties identified as appropriate for the area during these international varietal screening trials. IARCs, by collecting (from NARS), maintaining and distributing germplasm, act as an important catalyst to the agricultural development process. Donor/collaborative projects that have the capacity to access the resources of IARCs and international networks provide a critical link between the IARCs and NARS.

3. *A passive (non-interventionist) agricultural policy by the government may limit the returns to research.*

The Cameroonian government has played a very limited role in the agricultural sector of northern Cameroon's economy. For example, the Cameroonian government does not fix food crop prices, nor does it effectively control food storage and distribution during times of food stock fluctuations. The government extension system's limited physical and human resources constrain its ability to supply "improved" technologies to local farmers. As a result, the one large-scale "private" sector agricultural entity in the region, SODECOTON, established its own extension and input distribution network rather than depend on the governments's system.

The returns to research appear to be lower due to these policies, particularly due to its limited role in agricultural extension and input distribution. While farmers connected to

SODECOTON's system are much more likely to adopt technologies developed by the research system, cotton farmers represent perhaps as few as 40% of all farmers in northern Cameroon. Hence, the adoption of technologies is dependent, in part, on which and how many farmers are served by the extension and input distribution systems. Had these systems served a wider range of clientele in northern Cameroon, the adoption of cowpea technologies would have likely been higher. However, it is uncertain whether the benefits from attaining a higher adoption rate could compensated for the additional costs of establishing an extension system which serves a broader constituency.

III. LESSONS LEARNED

Setting the Research Agenda

Several characteristics defined the cowpea research-extension system in northern Cameroon. The system focused on a minor crop--cowpea, on average, is grown on less than 25,000 ha per year. Instead of developing a major breeding program, IRA focused on varietal screening to "develop" improved varieties. The system was also supported by considerable feedback from farmers, both through on-farm research and by a large extension network. Finally, the system demonstrated a capacity to incorporate feedback from farmers and extension agents, permitting some redirection of research efforts (ie. addressing storage losses).

Research programs often focus research on the principal food crop(s) within a region. Looking for the largest potential impact, researchers and donors target major crops. This study indicates that acceptable returns (returns that are equal to or greater than the opportunity cost of capital) are possible even with a minor food crop. In addition, most beneficiaries of this research were limited resource farmers living in an environment prone to high production risk.

Given that this is a case study, little can be said about the general appropriateness of funding screening programs versus breeding programs within research projects. Yet, the study's findings indicate that a relatively small research program, depending solely on screening to develop technologies, can have positive returns. The research was supported by an integrated national research-extension system and by donor projects that had the capacity to link with IARCs and regional centers. Hence, the findings highlight the important complementarity between NARS, donor and collaborative projects, and IARCs, and the contribution of international spill-overs to increasing the returns to research projects.

The research-extension system of northern Cameroon institutionalized several information flows between farmers and researchers. Examples include on-farm testing of promising varieties, an annual planning meeting between researchers, extension agents, development agencies and farmers, and regular contact between village level SODECOTON extension agents and researchers. These flows proved to be an effective means of identifying farmer constraints and for setting the research agenda. As a consequence of this interaction, the cowpea research agenda shifted from a primary focus on producing high grain yields to addressing post-harvest storage constraints, which are singularly the largest constraint to higher adoption of the already extended improved varieties.

Data Constraints in Assessing Impact

Impact assessment models assume that adequate data are available. Impact assessment literature seldom discusses data constraints, which is a critical shortfalling since available data often determine the assessment methodology employed.

In northern Cameroon, data on the research and extension system are available from two sources: project documents and interviews of "key informants". Annual reports and research summaries constituted the bulk of available documents, but these often failed to provide sufficient detail for the needs of the analysis. To supplement the document review, key informants within the research-extension system and the cowpea subsector were interviewed.

Several issues concerning the data base became evident during the study. Three issues of primary concern were: data availability, data reliability, and the potential cost and benefits of maintaining an adequate data base.

1. Data Availability: In northern Cameroon, the research-extension system historically had not collected and organized data specifically for rate of return analysis. Specific data needs often could not be met since the data simply had never been collected, necessitating the use of proxies and estimates based on the opinions of key informants. Also, data that had been collected were typically not in a form which could be readily transferred into cost/benefit streams.

2. Data Reliability: Although information gathered during interviews with key informants is critical to this study, the analysis relies heavily on secondary data. The integrity of the study's results then depends, in part, on the reliability of this secondary data. It is difficult to assess the historic quality of the data collection methodologies for such key data as area in production, adoption rates, and market prices. Hence, the study must use sensitivity analysis to test the robustness of its conclusions.

3. Data costs and benefits: If impact assessment is to be institutionalized within Sub-Saharan NARS, then financial resources must be committed to generate appropriate data to support these analyses. This study confirms that administrators, plant breeders, and agronomists are not well versed in the methods and scope of data collection necessary for economic analysis. Assessing the economic returns of projects and/or research-extension systems is highly dependent on data which historically have not been collected or given a high priority in the research agenda.

REFERENCES

Eicher, Carl K. and John M. Staatz. 1984. "Agricultural Development Ideas in Historical Perspective" in Agricultural Development in the Third World, ed. by Eicher and Staatz. John Hopkins University Press, Baltimore, MD.

Kitch, Laurie. 1990. *Preliminary Results of a Survey of Cowpea Farmers.* IRA-Maroua Legume Program, Cameroon.

Mellor, J.W. 1966. The Economics of Agricultural Development. Cornell University Press, Ithaca, NY.

Oehmke, James F., L. Daniels, J. Howard, M. Maredia, R. Bernsten. 1992. *The Impact of Agricultural Research: A Review of the Ex-Post Assessment Literature with Implications for Africa.* Department of Agricultural Economics Staff Paper No. 92-38, Michigan State University, East Lansing, MI.

Singh, S. R. and K. O. Rachie. Cowpea Research, Production and Utilization. John Wiley and Sons, New York, 1985.

Sterns, James A. 1992 (pending). *Assessing the Returns to Research: The Case of Cowpea and Sorghum in Northern Cameroon.* Master Thesis, Michigan State University.

Ta'Ama, Moffi. 1984. *Provisional Report on Cowpea Baseline Data Survey in Northern Cameroon.* IRA-Maroua, Cameroon.

Wolfson, Jane L. 1990. *Analysis of Cowpea Production and Storage Methodologies Used By Small Farmers in Northern Cameroon.* Bean/Cowpea CRSP Project Report, Department of Entomology, Purdue University, West Lafayette, IN.

APPENDIX

Table A.1. Estimated Cost-Benefit Flows (in '000 $US) for the Cowpea Technology Extended, Far North Province, Cameroon, 1979 to 1998

Year	Gross Benefits from Package Extended	Gross Costs of Research & Extension	Net Cost/benefit flow
1979	0	-31	-31
1980	0	-28	-28
1981	0	-44	-44
1982	0	-195	-195
1983	0	-348	-348
1984	2	-437	-434
1985	8	-407	-399
1986	21	-352	-331
1987	43	-324	-281
1988	174	0	174
1989	195	0	195
1990	517	0	517
1991	744	0	744
1992	803	0	803
1993	892	0	892
1994	967	0	967
1995	970	0	970
1996	973	0	973
1997	973	0	973
1998	973	0	973