



An Economic Assessment of **Sorghum Improvement in Mali**

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The main report is available [here](#)

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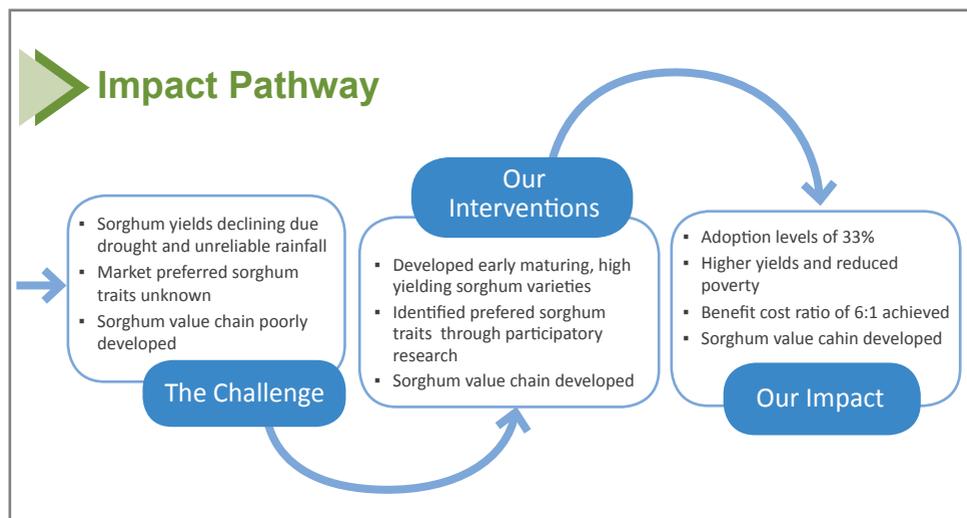
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► Key Fact

The sorghum improvement program in Mali led by ICRISAT in collaboration with the Institut d'économie rurale, (IER) Mali has increased sorghum productivity and reduced poverty levels in Mali. The investment in the sorghum improvement program has generated social benefits which are 6 times the cost of the program.

► Summary

Sorghum yields in Mali have been declining over time due to unreliable rainfall patterns and drought. In the late 1970s, ICRISAT started working with IER to develop and promote sorghum varieties with desirable traits of - short duration, drought tolerance, short plant height, emergence in high temperature, and higher grain yields. Higher sorghum yields were achieved and the sorghum value chain was developed.



► Who Helped Us (Funding)

The sorghum improvement program received funding from United States Agency for International Development (USAID), United Nations Development Program (UNDP), and Agricultural Research for Development (CIRAD) and lately from a consortium of donors.

► Return on Investment

The internal rate of return is estimated at **36% per year with a benefit–cost ratio of 6:1**, which indicates that each dollar invested in the pilot project to develop improved sorghum varieties and hybrids generates an **average of US\$6 in terms of net benefits**.

Impact Summary

Introduction

Sorghum yields in Mali have been declining over time due to drought and unreliable rainfall patterns. Since 1970s, ICRISAT worked with the Rural Economy Institute, Mali, to develop and promote sorghum varieties with desirable traits - short duration, drought tolerance, short plant height, emergence in high temperature, and higher grain yields. Examples of the improved sorghum varieties include Fadda, Jakumbe, Sewa, Soumba and Wassa. Along with this research program, ICRISAT also developed and strengthened the sorghum value chain to link producers to markets. These efforts have produced numerous new sorghum varieties with desirable traits that have been adopted by smallholder farmers in Mali.

In 2013 a farm household survey was conducted in Mali and complemented with secondary data sources. The study analyzed household adoption of improved sorghum varieties, area planted and seed sources. In addition the study analyzed the profitability of sorghum improvement program and social returns to investment.

Data

This study used data from farm household survey, key informant interviews and secondary data sources. A total of 2430 farm households were surveyed across 58 villages located in the Cercles of Kati, Dioila, and Koutiala, which constitute three of nine Cercles that compose the sorghum belt of Mali where IER and ICRISAT conducted its pilot-testing activities from 2009 to 2013. Data was collected in 2013 during the main growing season by experienced enumerators and village agents under the supervision of ICRISAT and IER. The household survey collected information on household characterization, crop production, sorghum varieties

grown from 2009 to 2013 including seed sources and area planted. Sorghum prices were collected from Observatoire du Marché Agricole and through key informant interviews. Sorghum area and production data were provided by the Cellule de Planification Statistique du Secteur du Développement Rural.

Impact

Survey data revealed that more than half of the farmers who planted hybrids reported that the area allocated to this variety type increased over the 5-year period (Table 1). In comparison, about 30% of farmers reported that areas planted to local varieties increased while 50% of farmers reported that areas remained constant. Just over one-third (35%) of farmers increased the area they planted to improved sorghum varieties over the period.

Considering the period spanning 1997-2013, and assuming the parameter values given below Table 2, we estimate a net present value of US\$16 million from investing in sorghum improvement in Mali. The internal rate of return is estimated at 36% per year with a benefit–cost ratio of 6:1. The benefit–cost ratio of 6:1 indicates that each dollar invested in the pilot project to develop improved sorghum varieties and hybrids generates an average of 6 dollars in terms of net benefits. This contribution to growth in agricultural productivity was sufficient to lift an estimated 20,000 Malians above the \$1-a-day poverty line, given assumptions shown below in Table 2. The total number of persons leaving poverty during the period 2004 to 2024 (the benefit period) is estimated to be 536,887, representing 5% of the poor population of Mali in 2014. Table 2 also presents results of a sensitivity analysis to

Table 1. Changes in area planted (ha) to sorghum variety types by farmers, 2009-2012.

	Increase	Decrease	Constant	Total
Local	688	463	1,175	2,326
(%)	29.58	19.91	50.52	100
Improved variety	277	175	336	788
(%)	35.15	22.21	42.64	100
Hybrid	60	14	38	112
(%)	53.57	12.5	33.93	100
Total	1,025	652	1,549	3,226
(%)	31.77	20.21	48.02	100

Source: Smale et al. 2014; n=3500 plots

Table 2. Returns to investment in improved sorghum varieties and hybrids in Mali, 1997-2024.

Scenarios	Net Present Value (million US\$)	Rate of Return	B-C Ratio	Poverty Reduction ('000) per year of benefit
Baseline	16	36	6	20
Scenario relative to baseline parameters				
Increase in average yield advantage from baseline of 10%	161	59	63	200
Production cost per ton increased to 10%	4	11	2	6
Sorghum price increase of \$50 per ton	19	27	8	24
Discount rate increase from 5% to 10%	7	NC	4	NC
Discount rate increased from 10% to 25%	1	NC	1	NC

explore how findings change with variation in key parameter values. Thus, we varied other parameters in our sensitivity analysis. Alternative scenarios included, relative to baseline parameters: (1) yield gains increase by 10%; (2) production cost per ton further reduced by 10%; (3) sorghum price increase of \$50/ton; (4) discount rate increased from 5% to 10%; (5) discount rate increased from 5% to 25%.

An increase in the yield advantage, such as those predicted for newly released hybrids, has a dramatic impact on all summary measures of financial returns, other assumptions held constant. Net present value, benefit-cost ratios and poverty reduction rates increase by multiples of ten, and the internal rate of return more than doubles.

Parameters: Productivity change due to investment were, 30% (hybrid), 20% (improved) and 21% area-weighted average; 5% change in sorghum production cost per ton harvested; 30% maximum adoption level, 8 years until start of adoption, 19 years until maximum adoption, 0.5 price elasticity of supply, -0.4 price elasticity of demand, 5% discount rate, US\$3.5 million total investment, Time path of benefits is 2005-6 to 2024-25, and time path of cost is 1997-98 to 2011-12.

Higher production costs, however, would dramatically reduce net present value, internal rate of return, benefit-cost ratios, and poverty impacts. Thus, cost effects associated with greater yield advantages would partially offset the overall benefits of productivity growth. Rising sorghum prices, such as those that have occurred since the global food price crisis, would also augment benefit streams. Overall price effects are relatively minor given that sorghum is a staple and both demand and supply are relatively inelastic. Higher discount rates to reflect risk and the financial perspectives of private as compared to public investments, have no effect on the internal rate of return or poverty reduction, but have sizeable effects on the net present value and benefit-cost ratios. Clearly, the base model estimates based on the initial assumptions and targets of the pilot project are well within the range of possible benefits implied by alternative assumptions. The sensitivity analysis thus lends credence to the stability of benefits and returns under the baseline scenario.

The adoption of improved sorghum varieties have been high - around 33%. The rate of return to investment in sorghum and market development generated an internal rate of return of 36% per year. Our results suggest that investment in the sorghum improvement program is associated with social benefits 6 times the cost of the program. The results have important policy implications. These demonstrate that sorghum is a profitable enterprise in Mali and has associated social benefits. The development and promotion of improved sorghum need to be strengthened and up-scaled in Mali and other developing countries.





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ICRISAT works in agricultural research for development across the drylands of Africa and Asia, making farming profitable for smallholder farmers while reducing malnutrition and environmental degradation.

We work across the entire value chain from developing new varieties to agri-business and linking farmers to markets.

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