

Mali Food Security Policy Research Program

Use and Adoption of Sorghum Improved Varieties and Hybrids in Mali: Economic Impact

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A challenge

Adoption rates for improved varieties of sorghum remain low in Mali—ranging from 13 to 33% depending on the estimation method used—despite the central role of this crop and significant long-term investments in its development. Explanations include, but are not limited to:

- a) the difficulties both plant breeders and farmers confront in attaining sufficiently high yield advantages given Mali's harsh and heterogeneous growing environment;
- b) challenges in providing hybrid seeds because of the weak involvement of private suppliers in the supply chain;
- c) absence of a formal market channel that would be appropriate for improved sorghum seed. Currently, sorghum growers in Mali depend very much on harvests from their one families or fellow farmers to obtain the seed they need for planting.

Since 2000, the Malian research program has shifted from the formal plant breeding system (FPB-S) to a more participatory approach based on field trials and a decentralized supply of seeds by farmers' associations (PPB-F). The release of the first generation of sorghum hybrid seeds, mainly Guinea- race, developed in Mali using the participatory approach, has the potential to contribute to increasing their adoption rates.

So far, analysis of data collected from participatory field trials shows a large yield increase associated with the Guinea-race sorghum hybrids grown under diverse conditions on farms—notably, either with or without fertilizer (Rattunde et al. 2013).

Key Conclusions

- Adoption rates for improved varieties of sorghum remain low in Mali
- Sorghum hybrids developed largely from local Guinea-race germplasm with participatory methods have the potential to increase adoption
- The impact of adopting sorghum hybrids on farm yields is significant, positively affecting household dietary diversity and contributing to a greater share of harvested amounts sold by farmers
- Research on sorghum hybrids is a good investment when combined with seed supply at local level

Two studies were conducted to assess the potential impact of new sorghum hybrid seeds in Mali (Kergna et al. 2016, Smale et al. 2016). In the study by Smale et al. (2016), we explore the factors behind the adoption of improved varieties of sorghum by differentiating between the new hybrid seeds and the improved varieties. Then, we gauge the impact of the adoption of each type of sorghum on the well-being of farmers in family farm enterprises.

A census of sorghum varieties in 2430 farming families in 58 villages of the Sudan Savanna provided us with a baseline adoption rate and detailed information on varieties. Here, we utilize primary data collected from 628 farm family enterprises among the 2430 farmers.

In the study by Kergna et al. (2016), we assess the potential economic impact of the first Guinea-race sorghum hybrids produced and released using the new



research and development paradigm (PPB-F) and comparing it to what would have been achieved through the earlier approach (FPB-S). Our methodology incorporates risk in the analysis and explore which factors influence variations in economic returns, lending insights for policy.



L'hybride de sorgho "Pablo" dans une parcelle près de Dioila.

Farm-level impact

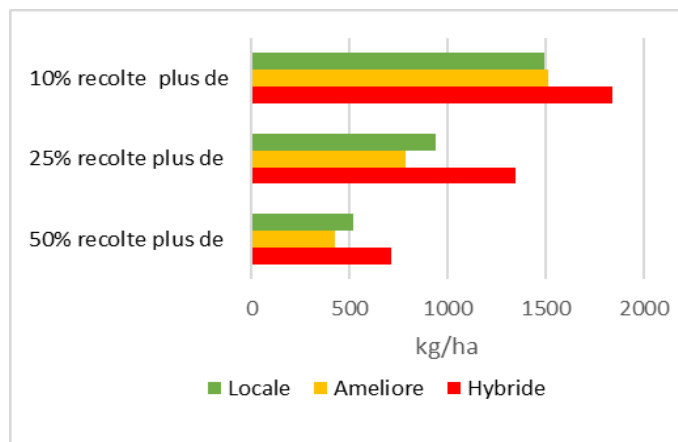
Characteristics of the plot manager (woman or man, young or head) affect the adoption of improved seed. Adoption rates are higher on large plots managed by the head of the household and also on plots managed by the wives and the sons. This is primarily explained by the new direction taken by the program which recognizes the role of women in sorghum production.

In general, the adoption of improved seed is strongly related with the total value of the EAF's assets and the availability of abundant family labor rather than with the presence of a weekly market fair or registered cooperative membership. Historically, in fact, these did not constitute the distribution channels through which improved sorghum seed was supplied to farmers (Haggblade et al. 2015).

The impact of hybrid use on yields is significant, positively affecting household dietary diversity and contributing to a greater share of harvested amounts sold by farmers.

The yield difference between individual plots and collective plots is significant. We assume that families dedicate most of their assets, equipment, and labor to the larger household plots to meet their food needs. Also, data show that most plots managed by women are intercropped and that demand in male labor is higher on large household plots. At the same time, female labor is needed to meet the other basic needs of the family.

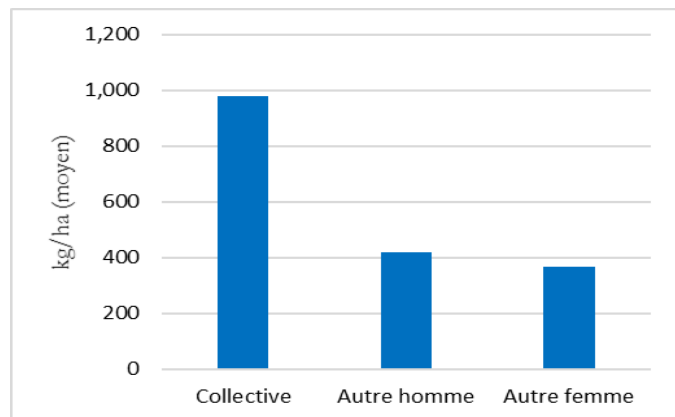
Figure 1: Sorghum yields attained by the plot manager



Average kg/ha: Hybrids: 995; Improved: 875; Local 783

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Figure 2: Average sorghum yields attained by the plot manager



Research and development paradigms

Based on our data, areas planted to sorghum have slightly increased from 2009 to 2013, more rapidly for improved varieties than for local varieties and even more rapidly for hybrids. In our 2013 study region, all improved varieties and hybrids covered 24.3% of sorghum area, of which hybrids represented 2.3%.

**Table 1: Simulation results (50,000 iterations)
under the PPB-F and FPB-S scenarios**

	PPB-F		FPB-S	
	IRR	NPV	IRR	NPV
Maximum	410%	201	126%	187
Minimum	0%	-53	0%	-15
Mode	50%	14	26%	5
Mean	65%	25	26%	15

IRR= Internal Rate of Return. NPV= Net Present Value in million USD.

Research on sorghum hybrids is a good investment when combined with seed distribution at local level. Considering the Internal Rate of Return (IRR) and the Net Present Value (NPV), our simulation results show that the economic potential of sorghum hybrids, developed through the PPB-F approach, is clearly superior to that of improved varieties developed through the FPB-S approach.

The mode of the density of simulated values for the IRR with the formal and state-based approach is roughly half of that of the participatory and more decentralized approach (26% compared to 50%). Nearly 90% of the values lie between 11% and 42% as compared to 14% and 154%, respectively. The average NPV is 15 million USD compared to 25 million USD for the two paradigms in the study region. The participatory approach (PPB-F) is superior with higher yields, a shorter adoption lag and more reasonable costs for the national research program as these costs are shared by the farmers and their associations.

Since the cost streams in both scenarios include the recurring expenses of the national program and the benefits scale in the pilot project includes only the regions of Koulikoro and Sikasso, these findings are conservative.

Sensitivity analysis underscores the importance of cost advantages associated with new sorghum hybrids, which are related to yield advantages and input costs. Complementary investments to support soil and water management can help sustain these advantages. The sensitivity of results to the price elasticity of supply suggests that linking seed supply to incentives for commercializing sorghum products would also support diffusion.

Policy implications

Preliminary results from the two studies clearly show that the adoption of well-adapted sorghum hybrids can contribute to significant yield gains, and thus higher production levels, also generating a surplus that can be commercialized by smallholders.

To encourage wide-scale adoption of promising new hybrid seeds, policies should focus on better promoting them. In this regard, policies should, first, improve access to these varieties and, second, raise their adoption rates. In the 2007-2015 period, the amount of seed produced by small and medium-sized companies in Mali, including sorghum, increased to 426 MT (AGRA, 2016). Despite the liberalization of breeder and foundation seed production, the quantity of seed available to farmers remains low.

The following measures should be considered:

1. *Extend the reach of the seeds value chain to villages:*
 - a) Increase the capacity of both public and private services (including small and medium-sized companies and farmers' associations) in charge of seed production and multiplication;
 - b) Provide incentives for the production of seeds by private seed companies;
 - c) Promote and facilitate production of breeder and foundation (first generation) seeds.
2. *Create demand and improve farmers' knowledge of the value of seeds:*
 - a) establish a more efficient distribution and extension system through a better involvement of seeds companies, agrodealers and farmers' associations;
 - b) maintain the participatory approach by involving both male and female producers in plant breeding and production of sorghum hybrids;
 - c) extend the seeds and fertilizers' distribution base to all farmers by including in the programs (for instance: subsidy and others) collective and individual plots;
 - d) recognize the role of women by factoring in their needs when estimating improved seeds and complementary inputs.

However, the yield surpluses attained from the Guinea-race hybrid seed in several environments are not, in and of themselves, sufficient to ensure that the encouraging

results of the pilot project will reach the scale needed for actual, widespread productivity gains. For the diffusion of hybrids to be efficient, public and private stakeholders must continue to invest in innovative methods to develop the sorghum seed system and build its capacity to supply quality and affordable seeds.

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