

# The Agricultural and Economic Advantage of Biopesticides

## Increasing Rice Yields and Smallholder Farmer Equity in Mali

**RICE IS A STAPLE FOOD** and cereal crop for more than half of the population in sub-Saharan Africa, particularly in Mali, where agriculture drives the national economy.<sup>1</sup> Mali is one of the top rice producers in Africa—the commodity generates 5% of the country’s national GDP.<sup>2</sup> Unfortunately, the country is also particularly vulnerable to agricultural pests and disease, which limits rice yields to below the global average, threatening smallholder farmers’ livelihoods as well as food and economic security.<sup>3</sup> Using naturally occurring bacteria—known as endophytic bacteria—as a biopesticide during rice production can help create greater resistance to pests, control plant diseases, and improve rice growth and yield.

Initial research has demonstrated that this bacteria could successfully control the spread of rice gall midge (a small fly), increasing rice yield by 240% compared to non-treated (fly-infested) fields.<sup>4</sup> Projections suggest that, over the course of three years, biopesticides made with these beneficial bacteria could improve rice yield by as much as 20% across West Africa.<sup>5</sup> Initial trials—as well as media coverage—have generated significant interest and demand for biopesticides. Overall, increased availability and use of this resource could enhance the productivity, economic prosperity, and food security of small farm households in Mali, which are often headed by women.

Dissemination of this research and improved access to this biopesticide have the potential to strengthen Mali’s

agricultural sector—both through economic empowerment and efforts to improve gender equity. Policymakers in Mali’s Department of Agriculture have the power to broaden the reach of biopesticides to those who need it most—local smallholder farmers and extension workers—by incentivizing the production and use of biopesticides nationwide.

### RICE PRODUCTION IS A KEY REVENUE GENERATOR FOR MALI

Sub-Saharan Africa has experienced a significant supply-demand gap in rice, which has cost the region billions of dollars in potential rice imports.<sup>6</sup> Rice is the dominant commercial food crop in Mali, generating nearly USD 83.3 million in national revenue and nearly USD 5 million in state revenue.<sup>7</sup> Malian rice production is competitive and can be profitable, benefiting from higher global prices and an increase in the demand for local rice, if the country is able to increase supply to meet demand.<sup>8</sup>

Average rice productivity in Mali is below the world average (3.38 t/ha vs 4.40 t/ha).<sup>9</sup> These low rice yields are attributed mainly to diseases and pests. Mali can increase rice production by implementing cost-effective disease and pest protectants on crops. In Mali, women are the primary growers of rice as a staple crop to assure food security at the household level.



### SOCIAL IMPACT

**In Mali, the rice farming industry is generally dominated by women. As rice is the main source of income for these households, the yield is critical to food security at the household level. Training women farmers on the production and use of biopesticides will build their capacity to generate household income. Women’s competence in utilizing this technology will contribute to gender equity advancements in Mali.**

Increasing rice adaptability and productivity using low-cost and sustainable methods to control these diseases is a crucial step in strengthening food security and improving the livelihoods of smallholder farmers.

### TECHNOLOGY FOR BIOLOGICAL CONTROL OF RICE PATHOGENS IS LACKING IN SUB-SAHARAN AFRICA, PARTICULARLY MALI

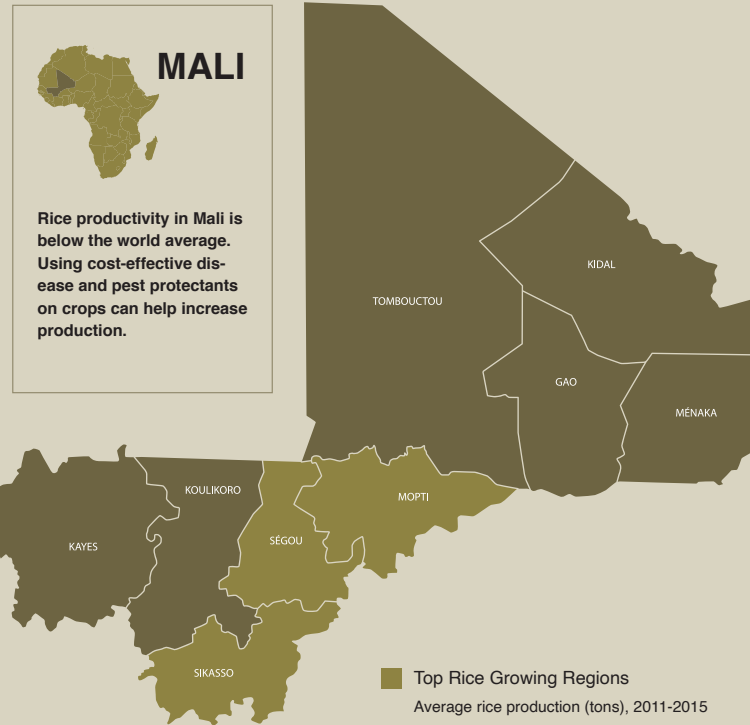
Biopesticide technology is a food security and climate-smart technology for improving rice productivity. This technology creates a healthier, stronger plant that can better withstand drought (as compared with plants treated by traditional, commercial pesticides), passing along sustainable environmental advantages that could help fight climate change. While biopesticides are well developed in Scandinavian countries, Switzerland, and Canada, their use is still emerging in many African countries.<sup>10</sup>

Options available in Mali for the biological control of rice pathogens are scarce, making farmers dependent on expensive commercial pesticides. This biopesticide technology gap can be closed, in part, through transferring and adapting existing advancements in commercial biopesticide production.<sup>11</sup> LaboREM Biotech (at the University of Sciences and Techniques of Bamako), in partnership with the multiparty international Africa-Brazil Marketplace Initiative, USAID, and the World Bank, recognized this research opportunity and developed a novel biopesticide for use on rice crops in Mali. Domestic trials have shown promising results in local production, adaptation, and integration of this specific rice biopesticide.

### ENVIRONMENTAL IMPACT

**Biopesticides play a critical role in disease and pest management where general pesticide resistance, as well as environmental concerns, exist. Biopesticides are less toxic to humans since they are generally used in smaller doses. They can also be less harmful to animals in terms of limiting exposure since their use is targeted more specifically on the plant. Biopesticides decompose more quickly than conventional pesticides, which leads to less overall pollution. For these reasons, biopesticides may be considered a less environmentally harmful alternative to commercial pesticides.**

### TOP RICE GROWING REGIONS IN MALI



Data source: Cellule de Planification et de Statistique du Secteur Développement Rural

### DOMESTIC PRODUCTION OF BIOPESTICIDES CAN GENERATE ECONOMIC SAVINGS AND INCREASED REVENUE

The government of Mali could save USD 7.2 million per year in imports by using local materials to produce biopesticides domestically rather than purchasing foreign commercial pesticides.<sup>12</sup> These savings can be passed onto smallholder farmers in the form of biopesticides that can be purchased more cheaply than commercial pesticides. Domestic trials suggest about 1,000 smallholder farmers in each county will be able to purchase the product at a local market at cheaper, local prices. Offering this product at more affordable prices than commercial pesticides enables a higher volume of purchase and expanded access for use. Wider use of these domestically produced biopesticides will protect domestic rice crops, resulting in higher yield for smallholder farmers—ensuring food security and alleviating poverty at the household level. Improved food security and improved supply of local rice will reduce national dependency on foreign rice imports.

**Biopesticides can be produced on a small scale, allowing production and use to be available in otherwise inaccessible niche markets. Local, in-house production of biopesticides allows for cheaper manufacturing as well as lower sales pricing, which increases the reach of this product to those who might not otherwise be able to afford commercial pesticides to protect their crops. This lower cost, in combination with wider reach, will increase domestic crop yields, in turn increasing both household income and national GDP.**



## RECOMMENDATIONS

Mali has existing guidelines for the commercial pesticide market. However, these guidelines cannot be applied or extrapolated to the niche market of biopesticides. Still in its infancy, this emerging technology—and its champions—need specific support and protections to expand and grow demand across targeted consumers. The following actions should be considered as a multiprong approach to the scale-up of biopesticides:

### 1. Expand reach and availability through credit mechanisms or incentive programs.

Potential producers require startup capital to develop biopesticide technology either as new producers to the market or above and beyond existing production capabilities. If a credit scheme specifically for biopesticide production is offered, domestic companies or individuals will be better positioned to purchase the initial supplies necessary to begin production and support business before profits are returned. Similarly, providing grants or other financial incentives to engage in biopesticide production would bring this innovation within reach of more farmers.

### 2. Pass national policy to protect innovation in biopesticide and biofertilizer production technologies.

Trademarks and regulation of biopesticide technology will ensure the quality and safety of its use and better insulate this market against the dangers of fraudulent or counterfeit products, while patents will serve to protect startups and innovators from being undercut by

competitors. Fraudulent versions—manufactured without proper research and development—can even encourage additional pesticide resistance in various rice pathogens. Having a thoroughly researched, quality controlled biopesticide that is applied in its recommended dosage is critical to effective use and protecting Mali's crops from more aggressive diseases.

### 3. Offer financial subsidies for use of organic products to inspire product loyalty.

Smallholder farmers may have a hard time taking the risk of investing in a relatively unknown product, such as biopesticides. Providing subsidies or vouchers for early adopters of biopesticide technology may help expedite and expand demand across Mali in the initial phases of product launch. Alleviating the financial risk of purchasing a lesser-known product may empower more farmers to try it, generate interest, and create a larger market.

### 4. Popularize biopesticides by investing in a marketing and/or communications strategy.

Without targeted communications, potential producers will not know how to acquire supplies, nor will customers know where to purchase the product. A comprehensive marketing or communications strategy is critical to getting the necessary information to the right audiences in order to launch this emerging technology. Promoting financial incentives for farmers to purchase biopesticides over commercial pesticides will also encourage greater use.





## REFERENCES

1. Mahmoud Solh, "Rice Is Life in 2004 and Beyond," *International Rice Commission Newsletter* 54 (2005): 1-10
2. Bakaye Doumbia et al, "Inhibition of root growth as mode of action of two rice yellow mottle virus pathotypes isolated in Mali," *African Journal of Agricultural Research*, 16(8) (2020):1148-1154
3. U.S. Department of Agriculture (USDA), National Agricultural Statistics Service, "Crop Production," (2012), [http://www.nass.usda.gov/Publications/Todays\\_Reports/reports/crop1012.pdf](http://www.nass.usda.gov/Publications/Todays_Reports/reports/crop1012.pdf)
4. Amadou H. Babana, David Weller and Linda Kinkel, "More Rice for Africa: Enhancing Smallholder Farmers' Rice Yields in Africa Through the Use of Efficient and Low-Cost Endophytic Bacteria Biopesticide," Report presented at the U.S. Agency for International Development (USAID) Partnership for Enhanced Engagement in Research (PEER) Forum, Accra, Ghana (2018).
5. M. Panna Ali et al., "Rice Production Without Insecticide in Smallholder Farmer's Field," *Frontiers Environmental Science* 6 (2017): 1-11.
6. International Rice Research Institute, <http://www.irri.org/>.
7. Pierre Baris, Jean Zaslavsky, and Serge Perring, « La filière riz au Mali : compétitivité et perspectives de marchés, » (September, 2005) Agence Française de Développement (2005).
8. Ramziath T. Adjao, "Analysis of the Competitiveness of the Rice Subsector in Mali: The Case of Gravitational Irrigation and Bas-Fonds Production Systems," Thesis presented to Michigan State University, (2011).
9. USDA, "Crop Production."
10. Media1Radio, "Le Mali Se Met Aux Biopesticides," Sept. 23, 2020, <http://www.medi1.com/fr/episode/170359>.
11. David M. Weller et al., "Suppression of Root Diseases of Wheat by Fluorescent Pseudomonads and Mechanisms of Action," in T. R. Swinburne Iron, Siderophores, and Plant Diseases (New York: Springer US, 1986); Cesare Accinelli et al., "Evaluation of Recycled Bioplastic Pellets and a Sprayable Formulation for Application of an Aspergillus Flavus Biocontrol Strain," *Crop Protection* 72, no. 6 (2015): 9-15; and Cesare Accinelli et al., "Leaf Application of a Sprayable Bioplastic-Based Formulation of Biocontrol Aspergillus Flavus Strains for Reduction of Aflatoxins in Corn," *Pest Management Science* 72, no. 8 (2016): 1521-28.
12. Amadou H. Babana, Proposal submitted to the USAID Partnerships for Enhanced Engagement in Research (PEER) program.

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