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Final Report:
Projet de Recherche sur les Politiques de Sécurité Alimentaire au Mali (PREPOSAM)
(February 15, 2020 to April 15, 2021)

PREPOSAM and MSU Team Members, Bamako, 2019

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Acronyms

CPS/SDR	Cellule de Planification et des Statistiques du Secteur Développement Rural
CSP	Comité Sahélien des Pesticides
FSP	Food Security Program
FSP-IL	Food Security Policy Innovation Lab
FTF	Feed the Future
IER	Institut d'Économie Rurale
INSAT	Institut National de la Statistique
IPR/IFRA	Institut Polytechnique Rural de Formation et de Recherche Appliquée
MSc	Master of Science Degree
MSU	Michigan State University
OPIB	Office des périmètres irrigués de Baguineda
OMA	Observatoire du Marché Agricole
PB	Policy brief
PhD	Doctor of Philosophy Degree
PI	Principal Investigator
PRePoSAM	Projet de Recherche sur les Politiques de Sécurité Alimentaire au Mali
RP	Research paper
USAID	United States Agency for International Development
US	Universite de Segou

1. Workplan Objectives

The PRePoSAM project aims to promote an improved agricultural policy environment. Policies matter because they affect agricultural performance in strategic ways. In Mali as elsewhere, a wide range of laws, regulations and programs affect land tenure, access to water and infrastructure, plant and animal health, availability of new agricultural technologies, transport costs, electricity availability and pricing, labor markets, input prices and trade. Together these policy incentives shape the investment, production and marketing decisions of farmers and agribusinesses. Decisions by key private sector actors, in turn, drive agricultural growth trajectories. Sound policies are a pre-requisite for broad-based, sustainable agricultural productivity gains and improved food security for Mali's citizens.

The PRePoSAM project contributes to improved agricultural policies through three major sets of activities: collaborative research, policy outreach, and capacity building. These efforts center on MSU faculty working with Malian scientists at several local and regional institutions, including:

- Institut d'Economie Rurale (IER), Mali's national agricultural research institute.
- Institut Polytechnique Rural de Formation et de Recherche Appliquée (IPR/IFRA) and Université de Ségou (both academic institutions offer BS degrees in agriculture, including agricultural economics).
- Cellule de Planification et des Statistiques du Secteur Développement Rural (CPS/SDR), the survey arm of the Ministries of Agriculture, Food Security, and Livestock and producer of the annual estimates of agricultural production.
- Observatoire du Marché Agricole (OMA), Mali's agricultural price monitoring service ; and
- Comité Sahélien des Pesticides (CPS).

This year, we also worked closely with the Office des périmètres irrigués de Baguineda (OPIB) while implementing a survey on pesticide use by vegetable growers.

During the fifth and final year of PRePoSAM, our efforts continued to emphasize improving the agricultural policy environment in Mali, with an emphasis on input policies. Substantively, we finalized our research on the impacts of the fertilizer subsidy program. We advanced our research on pesticide quality by undertaking additional survey activities and analysis. We began to expand our work on the agri-food system transformation by examining the consumption demand structure of Malian households. We conducted additional research on the impacts of COVID-19. Throughout our work, we continued to pay special attention to the cross-cutting issues of gender and nutrition.

Briefly, we consider agricultural input policy reform both important and feasible. Based on the stream of policy research, outreach and dialogue conducted by MSU faculty and Malian scientists over the five years of this project, we believe that key stakeholders in government and in the private sector are aware of shortcomings in the implementation of these policies and are open to changes. We believe, further, that our research findings will help shape the policy reflections under way in the agricultural input policy area while contributing to greater awareness about the role of gender and nutrition in agricultural and rural development. However, the combination of political transition and COVID-19 severely limited our capacity to engage in policy outreach during the final year of the project.

2. Achievements during 2020/21

As of April 2021, PRePoSAM collaborators completed 11 policy research and best practice papers, submitted 5 articles for publication in peer-reviewed journals, and supervised 5 IPR student theses, and 2 graduate students. Table 1 provides a status report on all workplan deliverables, including a listing of all tasks completed.

Table 1. Activities and ouputs from February 2020 to April 2021

	Activity	Planned	Actual
Research			
R19	The hectare focus of the fertilizer subsidy prog	1 RP	1 article
R20	Synthesis of the impacts of the fertilizer subsidy prog	1PB	1 PB, 1 RP, 1 article
R21	Synthesis of the village restitution workshop	1PB	2 RP
R22	Use of pesticides on vegetables in peri-urban Bamako	1RP	1 PB
R23	Qualitative risk assessment of pesticide use	1PB	1 RP, 1 article
R24	Elasticity of demand of food items	1RP	in progress
R25	Synthesis of dietary changes	1PB	1 PB, 2 articles
R26	Synthesis of seed policy recommendations	1PB	2 RP, 1 PB
R27	Effects of COVID-19 on the agri-food systems	1RP	1 PB
Data Collection			
D8	survey of pesticide use on vegetables in peri-urban Bamako		completed
D9	COVID-19		completed
Capacity Building			
C2a	IPR student research support and mentorship	4 students	5
C2b	US student research support and mentorship	3 students	0
C3.	Long-term student training and research: Ph.D.		
	Alpha Kergna, IER and Hanna Carlson, MSU	dissertation	in progress
	Short-term training (audience)		
C11	Field research methods	short course	2
C12	Statistical analysis with Excel	short course	1
Stakeholder Engagement			
S2.	National outreach		virtual KM workshop
	Village restitution workshops		2
	Pesticide quality	FPC, 1 WS	not feasible
	Fertilizer subsidies	FPC, 1 WS	not feasible
	Implications of the agri-food system transformations	FPC, 1 WS	not feasible
S3.	Blog	FPC, Posts	conducted
	International outreach	3	1

2.1. Research

Fertilizer policy

We completed several in-depth analyses of the impacts of the fertilizer subsidy program in 2020/21. In Policy Brief 118 (R20), we found that focus groups interviewed in two-thirds of villages reported no delays in receipt of subsidized fertilizer, about half considered the amounts received to be sufficient, and most judged the quality of the fertilizer to be adequate. However, we noted that participation in the program is differentiated with respect to gender and endowments of the farmer. 87% of plot managers who are men received subsidized fertilizer from the organizational source, as compared to less than half of plot managers who are women. While the subsidy program "reaches" a broad range of farmers and most fertilizer used by households surveyed was obtained through the program, the subsidy is more heavily utilized (in total amounts) by farmers who are better endowed in terms of equipment and traction.

In Research Report 172 (R20) we applied advanced econometric methods to our survey data and demonstrate that a) the marginal effect of the subsidy on applied fertilizer is greater for maize, rice and cotton; b) overall, the subsidy has a positive impact on crop yields, with strong effects on rice but negligible effects on cotton and millet; c) the impact of the subsidy on quantity sold is large for rice and sorghum, and d) the impact of the subsidy on income from the sale of target crops is large for rice but small for millet. The lack of effect on cotton conforms to industry reports of poor seed quality during the survey year.

Research Report 121 was revised and published as a journal paper by *Food Security* in 2020 (R20, Smale, Theriault, and Mason). We tested the effects of fertilizer subsidies on gender-differentiated value of production and sales of target crops and the diet quality of female plot managers. We found positive effects of the subsidy on production and sales whether plots are managed by men or women. However, more than half the women in our sample did not consume the minimum number of food groups needed for an adequate diet. Subsidized fertilizer significantly contributes to the chances that female plot managers will meet this threshold, and to consumption of iron-rich foods. Positive effects appear to be offset by the negative association of diet quality with all subsidized fertilizer received by other plot managers—perhaps because it leads to greater farm orientation toward targeted cereals and cotton. We concluded that disaggregating data by gender provides policy insights. Observing the low use rates of women plot managers for subsidized fertilizer that is obtained 51% of the time through others, ensuring that they have direct access may support higher application rates. If the subsidy program is to continue, considering nutrient-rich crops as part of the subsidy package might enhance nutritional outcomes.

In early 2021, we submitted a revised version of a paper about the unintended consequences of the fertilizer subsidy for crop diversity on farms in Mali to *Food Policy* (Theriault and Smale). Our hypothesis is that the fertilizer subsidy changes the agricultural landscape, incentivizing farmers to allocate land toward target crops. Applying several econometric techniques as a robustness check, our data analysis supports the hypothesis that the subsidy leads farming families to allocate a larger share of their land to target crops at the expense of non-target crops, resulting in lower crop richness and less proportional abundance among diverse crops.

Amidou Assima also finalized a journal submission from his MSc thesis, with additional analysis based on Research Report 152, entitled "Articulating Fertilizer Subsidy Effects on Women's Diet Quality by Food Supply Source in Mali." He found that subsidized fertilizer positively affects women's diet quality in the Niger Delta but has the opposite sign on the Koutiala Plateau. An examination by food source reveals no effects on the dietary diversity of on-farm production in either zone. The subsidy negatively influences dietary diversity of foods sourced as gifts in the Niger Delta. Subsidy effects on dietary diversity accessed through food purchases is strong and positive in the Niger Delta, but negative on the Koutiala Plateau—the region of the "Sikasso Paradox." Articulating diet diversity by food source suggests that income is the main pathway linking subsidized fertilizer to women's nutritional outcomes in Mali.

Pesticide policy

In light of the pandemic, the planned RCT was abandoned. Instead, we conducted a survey to focus on pesticide use of horticultural crops in the peri-urban area of Bamako, led by OPIB and Dr. Amadou Diarra. The sampling design and questionnaires were developed in November. The pre-testing of the census questionnaire took place in November and the full census questionnaire was implemented in December. The pesticide use survey was pre-tested in January 2021 and implemented in February 2021. To comply with MSU's IRB, all enumerators and supervisors participated in a training on Human Research Ethics and Safe Return to Work under COVID-19, as it related to Ethic and Regulations in Human Research. All enumerators and supervisors were also trained on the census and pesticide use questionnaires. The implementation of the survey was delayed because of COVID and new requirements put in place by MSU. Nonetheless, we have been able to produce a Policy Brief 126 (R22) from the preliminary results of this survey.

Descriptive statistics show that onions are the most cultivated crops and that 60% of horticultural farmers are women. Insects are the most common pests across all surveyed crops (i.e., tomato, onion, lettuce, okra, and jaxatu). Storage (i.e., under beds) and disposal (i.e., dumped in nature) of pesticide pose risks for human health and the environment. Most farmers do not know the Comite Sahelian des Pesticides (CSP) and how to recognize fraudulent pesticides. Together, the results suggest that there is a great need to educate and sensitize farmers on pesticide purchase, use, storage, and disposal.

A qualitative risk assessment of pesticide use in Mali compared to its neighbor countries of Ivory Coast and Ghana was published as Research Paper 180 and has been submitted for publication in a peer-reviewed journal (R23). We found that health and environmental impacts from the growing use of pesticides, despite their potential importance, remain largely unmonitored, underreported, and poorly understood by key stakeholders. In this paper, we assemble new evidence on pesticide risks for human health by identifying the most critical emerging pesticide risks and key danger cropping zones in West Africa. We rely on a three-step approach to assess potential pesticide risks across Côte d'Ivoire, Ghana, and Mali. In 2019, expert panels assembled in each country independently identified three active ingredients -- chlorpyrifos, glyphosate, and paraquat -- as potential threats to human health and the environment. To monitor and mitigate the risks associated with the growing use of pesticides, local scientists consider it essential to establish a structure in charge of toxicovigilance to coordinate and harmonize pesticide monitoring efforts. Sentinel

monitoring sites for each country are proposed. Key findings were virtually presented at the annual meeting of the *Agricultural and Applied Economics Association* and found to be of great interest to attendees.

Seed policy

The team published two research papers on seed policy (R26a and b), followed by a policy brief. The first (RP 170) was a background analysis that summarized the results of recent reviews of the Malian seed system structure, compared and assessed the pros and cons of three access to seed indices that are currently recommended to guide seed policy: The Access to Seed Index (ASI), the Enabling the Business of Agriculture monitor (EBA), and The African Seed Access Index (TASAI). We found that while the indices were largely complementary in terms of the information they provide (rather than substitutes), none of them addresses informal or pluralistic seed systems like those found in Mali. The heterogeneity of smallholder farmers is not recognized.

Given these findings, a hands-on workshop (34 participants) was convened to ascertain the perspectives of seed system stakeholders and identify additional indicators. The second research paper (RP 171f) summarized the procedure applied and the results of the workshop. The participants found 41 indicators (30 for the formal sector and 11 for informal and mixed sectors) of potential use in evaluating the access of smallholder farmers to improved seed, covering the process of varietal selection and registration, quality control and seed system governance. They suggested several innovations in regulations to take the traditional seed system into account while placing a particular emphasis on the role of governance in smallholder access to quality seed.

The team then prepared a policy brief (PB 120f), which summarizes their findings.

Diet quality

We synthesized our findings regarding changing dietary patterns (R25) and the impacts of the fertilizer subsidy on diet quality in a policy brief (PB 117). In addition to results reported above under fertilizer policy, among our key findings is that both rural and urban households are net food buyers. Processed food shares are greater in urban (60%) than rural areas (48%), but consumption of meals outside the home remains low. Average household dietary diversity scores are higher in urban than in rural areas. Women's and household diet diversity vary by season in urban and rural areas. About half of farm women interviewed did not meet minimum adequate dietary diversity during the lean season.

The research paper on the nutritional implications of dietary patterns in Mali was revised for publication in 2020 by the *African Journal of Agricultural and Resource Economics.*

Agribusiness

The working paper on the determinants of milk producers' participation in markets, led by Ryan Vroegindewey (recent PhD graduate), was accepted for publication in the peer-reviewed journal, *Journal of Tropical Livestock Science*. Three key findings emerged. First, greater investments in improved breeds and animal health and nutrition are needed. Second, policies must enhance the inclusion of female producers. Third, because producers are

responsive to price incentives, macroeconomic policies should spur domestic supply of Malian milk.

Another working paper led by Ryan Vroegindewey addressed the competitive advantage and processor demand for local and imported agricultural inputs and was accepted for publication (Journal of Agribusiness in Developing and Emerging Economies). He utilized cased study data from nine firms that use fresh and powdered milk to varying degrees, and which are representative of dairy processing in Bamako. Firms using fresh milk pay a higher input price, incur higher transaction costs, and face additional challenges in production and distribution. Firms distinguish themselves from competitors through four potential sources of differentiation: novel product types, quality enhancements, quality-signaling, and unique packaging. However, fresh milk firms are less likely to exploit each source of differentiation. This research is one of the first to investigate this issue in the under-studied middle segment of food value chains. Fresh milk firms face challenges in creating competitive disadvantage. To address this, value chain actors must increase and stabilize farm yields, improve milk quality, and build collective capacity and assets for more effective differentiation.
A third Research Paper is undergoing a second round of revisions for publication in the peer-reviewed journal, *Food Policy*. Findings suggest that better labeling regulations, government-backed certification, and policies that support packaging alternatives can improve information flows and strengthen the competitiveness of fresh milk value chains. Policymakers and manufacturers should also coordinate more closely with retailers as an information partner.

COVID-19

We have been engaged in several activities related to the impacts of COVID-19. To this end, we wrote several blog posts on the impacts of COVID-19 on the agri-food systems in Mali.

Blog posts include:

- Yenizie Kone, Melinda Smale, Veronique Thériault, Mamadou Sissoko, Amidou Assima, Naman Keita. 2020. Malian Farmers' Access to Fertilizer Is Challenged by COVID-19. Blog Post. October 1st. https://www.canr.msu.edu/news/how-is-covid-19-worsening-food-insecurity-in-mali-1
- Yenizie Kone, Mamadou Sissoko, Amidou Assima, Naman Keita. 2020. Why Could the COVID-19 Cotton Crisis Lead to an Economic and Social Crisis in Mali. July 6th. https://www.canr.msu.edu/news/why-could-the-covid-19-cotton-crisis-lead-to-an-economic-and-social-crisis-in-mali
- Louise Sperling, Niels Louwaars, Orlando de Ponti, Melinda Smale, Julie March, Dieudonne Baributsa, Jacob van Etten. 2020. SEED SECURITY RESPONSE TO COVID - 19: now and beyond. Blog Post. July 3rd. https://www.canr.msu.edu/news/seed-security-response-to-covid-19-now-and-beyond
- Yenizie Koné, Mamadou Sissoko, Véronique Thériault, Amidou Assima, Naman Keit 2020. Will the COVID-19 Pandemic Lead to a Cotton Crisis in Mali? Blog Post. June 15th. https://www.canr.msu.edu/news/will-the-covid-19-pandemic-lead-to-a-cotton-crisis-in-mali

- Yenizie Kone, Mamadou Sissoko, Amidou Assima, Naman Keita. 2020. Why Mali's 2020 Agricultural Campaign Plan Needs to Be Reviewed in Light of COVID-19. Blog Post. May 27th. https://www.canr.msu.edu/news/why-mali-s-2020-agricultural-campaign-plan-needs-to-be-reviewed-in-light-of-covid-19
- Yenizie Kone, Mamadou Sissoko, Amidou Assima, Naman Keita. 2020. Cereal Prices Have Resisted (so far) to COVID-19 in Mali. Blog Post. May 18th. https://www.canr.msu.edu/news/cereal-prices-have-resisted-so-far-to-covid-19-in-mali

The work on the policy tracking tool developed by MSU and IFPRI has come to an end. https://www.ifpri.org/blog/ifpris-covid-19-policy-response-cpr-portal-identifying-trends-and-implications-food-systems

The PREPOSAM team contributed to the design, translation, and pre-test of the cellphone survey on the effects of COVID-19 on Malian consumers. The first round of data collection was completed. The second round took place in February.

In addition to the MSU cellphone survey, we analyzed segments of the Malian national household dataset on the impact of COVID-19, collected by the National Statistical Institute (INSTAT). A policy research paper, utilizing both the MSU cellphone survey and INSTAT survey was completed in April 2021 (R27). Households in the food supply chain experienced income declines due to COVID-19. By July 2020, less than two percent of rural households in the food transport and delivery, receiving remittances, and engaged in farming reported some income increases compared to March and May 2020. In urban areas, less than one percent of households in the trade of farm/food products and in professional work reported income increase. Households in all other activities in the food supply chain continued to experience income declines. Because of declining incomes, the rate of household poverty rose by two percentage points from March to July 2020, with poverty affecting 20% of all Malian households. The declining incomes were also associated with some reductions in food consumption. Starchy staples experienced the greatest decline, followed by meat, chicken, and fish and then by whole grains.

Dr. Yenizie Kone also collaborated with IFPRI on assessing the impact of COVID-19 in Mali. A presentation of the key findings was made.

Yenizié Koné, Karl Pauw, Josée Randriamamonjy, and James Thurlow. 2021. Mali- Impacts of COVID-19 on Production, Poverty & Food Systems. Power Point Presentation. March.

2.2. Data collection

Two data collection efforts occupied our team during 2020. First, protocols for the survey design and sampling for the RCT experiment on fraudulent pesticides were reviewed in light of the COVID-19 pandemic in late August/early September and abandoned. The team designed a survey on pesticide use in the peri-urban areas of Bamako, but this was delayed by new regulations at MSU. The data were collected in December 2020-February 2021 and cleaned in February (D8).

Second, we participated in data collection on the policy decisions implemented by the government in response to COVID-19. The tracking tool developed by MSU and IFPRI is publicly available at https://www.ifpri.org/blog/ifpris-covid-19-policy-response-cpr-portal-identifying-trends-and-implications-food-systems. As reported above, we also contributed to the design, translation, pre-test, and analysis of the cellphone survey on the effects of COVID-19 on Malian consumers. (D9).

2.3. Capacity building

C2ab - IPR/IFRA and US student research support and mentorship

Each academic year, PRePoSAM mentors from MSU and local partners at IER, IPR and CPS support student thesis research in the agricultural sciences. This year, we mentored a total of five (2 males and 3 females) students from IPR/IFRA. No student from the University of Segou (US) was selected this year due to the pandemic. Malian universities, including IPR/IFRA and US, were temporarily closed for several weeks due to coronavirus concerns. Students from the US were unable to complete all their coursework to start the mentoring program on time. Due to the pandemic, no field work activity was undertaken by students this year. Students used secondary datasets to complete their theses.

Four out of five students defended their thesis in November. Their thesis topics included:1) the use of fertilizer on maize and sorghum in the Koutiala zone; 2) diet patterns in the Koutiala and the Delta Niger zones; 3) food consumption expenses in rural and urban areas; and 4) diet diversity of women. Before their defense day, a training session was organized, where each student had the opportunity to present and receive feedback on their presentation. The thesis defense for fifth and last student was postponed to February due to a faculty strike. His thesis explored the effects of farm equipment on crop diversity in the agroecological zones of the plateau de Koutiala and the Delta Niger.

Students	Progress
1- Boubacar Sidiki DIABATE	Thesis defended
2- Halouma SYLLA	Thesis defended
3- Kadidiatou Kanouté	Thesis defended
4- Bintou Traoré	Thesis defended
5- Samou S. DEMBELE	Thesis not defended yet

C3. Long-term student training and research

Mamadou Sissoko completed his public defense in February 2020 at the University of Namur, Belgium, and joined our research team in Bamako.

Alpha Kergna conducted statistical analysis comparing fertilizer subsidies received and productivity by farm types based on the augmented IER/CMDT typology that includes the minority group of mechanized farmers. Parts of his doctoral thesis are in draft.

Hanna Carlson, a second year PhD student at MSU has continued to make good progress in estimating the elasticities of demand of key food items. Analyzing food demand in Mali is essential for understanding which goods are essential to urban and rural consumers. Her work shows that staple goods still make up the majority of the Malian diet, and households are able to smooth their consumption between the harvest and lean season to some extent.

C3.1. Research training and C3.2. Statistical analysis

The five selected students participated in a week-long training program in June. During the training, the students learned about descriptive statistics, sampling and database management using the software SPSS, scientific writing, and professional preparation (C11a and C12).

To comply with MSU's IRB, all enumerators and supervisors participated in a training on Human Research Ethics and Safe Return to Work under COVID-19, as it related to Ethic and Regulations in Human Research. All enumerators and supervisors were also trained for use of tablets to implement the census and pesticide use questionnaires (C11b).

2.4. Stakeholder outreach

Planned outreach activities were curtailed by the COVID-19 pandemic and later by the governmental transition. We were able to conduct our village restitution activities, our blog posts, and participate virtually in a presentation about pesticides at the international meeting hosted by the *Agricultural and Applied Economics Association*, in August of 2020.

- Steve Haggblade. 2020. Prevalence of frauds and quality concerns. Virtual 2020 Agricultural & Applied Economics Association annual meeting. August.
- Veronique Theriault. 2020. Risks for the environment and human health from pesticide use. Virtual 2020 Agricultural & Applied Economics Association annual meeting. August.

In April of 2021, we hosted a virtual training workshop led by Professor Steve Haggblade (retired) on the Kaleidoscope Policy Model. Dr. Haggblade was one of the developers of the model. A primary goal in our research projects is to enable PIs to communicate more effectively with policy makers and stakeholders. PIs know how to analyze and draw conclusions from qualitative and quantitative evidence. They have experience interacting with policymakers in various fora. However, they do not necessarily have a full understanding of the policy process that leads to food policy change. The Kaleidoscope Model (KM) provides a set of 16 hypotheses about the policy process that can be tested empirically through a combination of exhaustive review of secondary information and semi-structured stakeholder interviews. The model can address questions as: 1) which stakeholders have proven most effective in promoting (or impeding) a specific policy

change? 2) which factors enabled policy reform after long periods of policy inertia? Policy advocates and researchers have applied the model to a range of food and agricultural policies, including detailed studies of agricultural input subsidies and micronutrient policies.

We were also able to "reach" farmers in 2020. To acknowledge the crucial role that farmers played in providing key information necessary for informing policy makers (through their participation in the 2017/18 farm household survey), the PRePoSAM team conducted village-level workshops (i.e., restitution villageoise) in the Plateau de Koutiala and the Delta du Niger. During those workshops, farmers had the opportunity to hear about key findings, pose questions to the researchers and assist researchers in interpreting empirical survey results. Overall reactions and observations from farmers in the two regions were highlighted in Research Papers 175-f and 181.

3. Research outputs 2020-2021

Assima, A., Zanello, G. and Smale, M. Articulating Fertilizer Subsidy Effects on Women's Diet Quality by Food Supply Source in Mali. Journal submission to *CABI A&B*.

Kone, Y., Smale, M., and Timbo, B. 2020. Politiques et réglementation semencière au Mali : Réflexion sur les indicateurs d'accès aux petits producteurs aux semences de qualité. FSP Research Paper 171-F.

Smale, M., Assima, A., Theriault, V., Keita, N., Kergna A., and Kone, Y. 2020. Differentiation in Receipts of Subsidized Fertilizer: Evidence from Villages, Households and Plot Managers in Mali, FSP Policy Research Brief 118.

Smale, M., Assima, A., Theriault, V., and Kone, Y. 2020. Effects of the Fertilizer Subsidy Program on Fertilizer Use, Farm Productivity and Crop Sales in Mali. FSP Research Paper 172.

Smale, M. and Kone, Y. 2020. Dans quelle mesure les indicateurs d'accès aux semences sont-elles informatives pour les politiques au Mali., FSP Research Paper 170-F.

Smale, M., Kone, Y., and Timbo, B. 2020. Politique et règlementation semencière au Mali : L'accès des petits producteurs aux semences améliorées. FSP Bulletin Politique 120F. East Lansing. Michigan State University.

Smale, M., Thériault, V. and Mason, N.M. 2020. Does subsidizing fertilizer contribute to the diet quality of farm women? Evidence from rural Mali. *Food Security*. https://doi.org/10.1007/s12571-020-01097-w.

Smale, M., Theriault, V., and Vroegindewey, R.2020. Nutrition Implications of Dietary Patterns in Mali. *African Journal of Agricultural and Resource Economics.*

Smale, M., Theriault, V., Assima, A., and Kone, Y. 2020. Nutritional Implications of Dietary Patterns in Mali, FSP Policy Research Brief 117.

Sissoko, M., Assima, A., Keita, N., and Koné Y. 2020. Restitution de l'enquête IER/MSU/2017-18 auprès des ménages agricoles sur l'utilisation des intrants dans la zone du Plateau de Koutiala. FSP Research Paper 175-F.

Sissoko, M., Keita, N., Assima, A., and Koné, Y. Restitution de l'enquête IER/MSU/2017-18 auprès des ménages agricoles sur l'utilisation des intrants dans la zone delta du Niger. FSP Document de Recherche 181.

Theriault, V., Jiang, W., Diarra, A., Haggblade, S., Edmund, J., Ipou, J. and Traore, Ab. 2020. Qualitative Assessment of Pesticide Risks in West Africa. FSP Research Paper 180.

Theriault, V, Jiang, W., Diarra, A., Haggblade, S., Edmund, J., Ipou, J., and Traore, A., 2020. Identification of key pesticide risks to human health and the environment in West Africa. Submitted to *CABI A&B.*

Theriault, V., and M. Smale. 2020. The Unintended Consequences of the Fertilizer Subsidy Program on Crop Species Diversity in Mali. Submitted to *Food Policy*.

Vroegindewey, R., Richardson, R., and Theriault, V. 2020. Analysis of the Determinants of Milk Producers' Participation in Output Markets, FSP Research Paper 178.

Vroegindewey, R., Richardson, R., and Theriault, V. 2021. Analysis of the Determinants of Milk Producers' Participation in Output Markets. Accepted. *Journal of Tropical Livestock Science*

Vroegindewey, R., Richardson, R., Theriault, V., and Chung, K. 2021. Competitive Advantage and Processor Demand for Local and Imported Agricultural Inputs: Analysis from an Urban Dairy Market in West Africa. *Journal of Agribusiness in Developing and Emerging Economies.* https://www.emerald.com/insight/content/doi/10.1108/JADEE-06-2020-0133/full/html

Vroegindewey, R., Richardson, R., Ortega, D., and Theriault, V. 2020. Consumer and Retailer Preferences for Local Ingredients in Processed Foods: Evidence from a Stacked Choice Experiment in an Urban Dairy Market. Submitted to *Food Policy*.

4. 5-Year Summary of Results Achieved

This 5-year program of applied research, capacity building and policy dialogue aimed to improve the quality of information on which Malian leaders can base policy decisions. Under the Projet de recherche sur les politiques de sécurité alimentaire au Mali (PREPOSAM), MSU faculty worked with Malian scientists to addresses key evidence and analytical gaps in priority policy areas identified in the USAID policy matrix. Over the past five years, these policy areas included agricultural inputs (i.e., seed, fertilizer, and pesticide), private sector investment, and nutrition. To be responsive to policy needs, we added policy responses to the COVID-19 pandemic on agriculture and food systems in Mali as a priority in 2020. Key project activities included research collaboration with Malian scientists, student mentoring, data collection required to support empirical analysis of critical policy questions, and dissemination of key findings.

On April 13, 2021, the team presented a summary of project outputs and highlights, in terms of three activity areas: research, capacity-building, and outreach. Several representatives from USAID/Mali and Washington D.C. and Malian institutions, such as OMA, IER, and CSP attended the close-out workshop.

4.1 Research

Research outputs included roughly 100 research policy papers (33), policy briefs (31), international presentations (21), and journal articles (14), not including all of the theses completed by students in Mali, important contributions to 4 PhD theses in Mali, Nigeria, the US, and Belgium, and 3 MSc theses in the US and UK. Other, non-technical publications were also completed, such as an article in Agrilinks, brochures, and Kakemonos. Additional journal articles are currently in review.

The team implemented 8 data collection activities which resulted in cleaned, publicly available datasets. A detailed, multi-visit survey of 2400 farming households was conducted in the Niger Delta and Koutiala Plateau. Over 1000 vegetable growers were interviewed in peri-urban Bamako about their use of pesticides. Approximately 100 pesticide retailers were surveyed. About 100 food retail outlets were surveyed regarding sales of processed foods. Over 200 dairy retailers and 10 dairy processors were interviewed, followed by more than 200 consumers of dairy products. The cellphone survey of the impacts of COVID-19 included 800 respondents. Finally, the team investigated the perceptions of 80 policymakers.

4.2 Outreach

Although engagement with policy makers was thwarted by the COVID pandemic and more recently, governmental transition, the team convened 8 policy workshops with over 500 participants in total. Team members conducted several large-scale village outreach efforts in 2016 (>151 farmers) and 2020 (>300 farmers). Media events were held, and web-based blogs were developed. All technical documents are available on the website: https://www.canr.msu.edu/fsp/countries/mali/).

4.3 Capacity-Building

Turning to capacity-building, we organized several short-term training sessions to train colleagues and students in a range of topics, including use of tablets in field research, use of GPS instruments, statistics, writing research papers, using secondary data, use of Excel, application of multi-market models, and the Kaleidoscope policy model.

Team members were involved in the long-term capacity building of 29 students from IPR and the University of Segou, 3 MSc students and 5 doctoral students.

5. Indicators in the M&E Plan

Two indicators were retained for the project:

> EG3.1.d: Milestones in improved institutional architecture for food security policy achieved with USG support.
>
> EG3.2-2: Number of individuals who have received USG supported degree granting non nutrition related food security training.

In the monitoring and evaluation plan, no baseline was reported for the milestones in improved institutional architecture for food security policy and a baseline of zero was reported for the number of trained individuals. At the end of the five-year project, 29 students from IPR and the University of Segou, 3 MSc students and 5 doctoral students were trained in food and nutrition security. As further discussed in section 7 below, milestones in improved institutional architecture for food security policy related to fertilizer and pesticide were achieved.

6. Summary of Challenges

6.1 COVID-19

Due to the global epidemic associated with the novel coronavirus, all university-related international travels were suspended. Several directives and actions were undertaken to curb the spread of the coronavirus (COVID-19). The pesticide experiment was reviewed in light of the COVID-19 pandemic. The first round of the survey needed to be implemented in April 2020, but all field work was suspended at that time. The revised pesticide survey took place in December 2020 and January/February 2021. Due to the pandemic, stakeholder workshops were canceled. COVID-19 has had implication for agricultural value chain/agri-food market activities and have impacted food and nutrition security and poverty. Through our series of activities, we provided frontline information and critical thinking on the effects of COVID-19 pandemic on Malian agri-food systems.

6.2 Insecurity

Security was a constant challenge, limiting travel throughout and to Mali. The unexpected COVID-19 pandemic, combined with political instability in Mali, led to the cancelation of some outreach activities (i.e., in-person indoor workshops) and revision of other activities (i.e., pesticide survey). Nevertheless, we made good progress due to the diligence of the PREPOSAM team and local collaborators.

7. Lessons Learned and Success Stories

7.1 Research

MSU and local collaborators made important advances in the following key policy areas:

Fertilizer policy

Utilizing a farm household dataset collected by MSU and IER in 2017/18, the PREPOSAM team contributed to bring rigorous empirical evidence on the effects of the fertilizer subsidy program on productivity, sales, diet diversity, and land allocation. Before PREPOSAM, empirical evidence was limited in Mali. Our research has been seen as independent, transparent, and timely. Several efforts were made to synthesize the main messages and policy implications regarding the impact of fertilizer subsidies within and among households. Key findings were presented directly to the Ministry of Agriculture (before the political event of August 2020) and donors, such as the World Bank and AGRA. Our findings informed policymakers on the limitations regarding the e-voucher systems and both intended and unintended consequences of the current fertilizer subsidy design. These findings are key to better design and implement the fertilizer subsidy program if continued.

Pesticide policy

A joint team of MSU and pesticide experts assembled new evidence on pesticide risks for human health by identifying the most critical emerging pesticide risks and key danger cropping zones in Mali. The active ingredient chlorpyrifos, glyphosate, and paraquat –were identified as potential threats to human health and the environment. Pesticides are the main tools used by farmers to control for insect infestation, weeds, and diseases on their crops. Results from our fieldwork indicated that fraudulent pesticide products were widely available on the markets. Yet, farmers are not well-informed on how to recognize unauthorized pesticide products on the market. Also, they do not know how to store and dispose safely of pesticide products. Regulators, researchers, and the private sector (i.e., CropLife) expressed a great interest in our pesticide work. Our empirically based research and outreach activities raised high-level awareness on the significant health and environmental risks related to the increased use of (fraudulent) pesticides. Our active engagement with local stakeholders increases the likelihood that the empirical evidence will serve to inform policy formulations.

7.2 Outreach

To acknowledge the crucial role that farmers played in providing key information necessary for informing policy makers (through their participation in the 2017/18 farm household survey), the PREPOSAM team conducted village-level workshops (i.e., village restitution). Over 300 male and female farmers participated in the village-level workshops. This outreach activity was greatly appreciated by farmers. As stated by one farmer, “the PREPOSAM village outreach efforts allow us (farmers) to come out of ignorance”. Through these workshops, farmers can learn and exchange with other farmers about new ideas and initiatives. This is also echoed by another farmer: “Without information, we (farmers) are lost”.

7.3 Capacity Building

The mentoring program of students from IPR and US was a great success. The students supervised by PREPOSAM benefited from various training courses on topics that were not covered in their academic programs. One student, Aminata Mariko, testified that she learned a lot through the mentoring program, especially on research methods, statistical analysis with Excel, and how to make a presentation with PowerPoint. Among the 29 students supervised by PREPOSAM, 8 went to pursue graduate studies and several found jobs in the Malian agri-food sector (i.e., Mali Protection des Cultures, NGO, Agro-Pastoral School, CMDT).

8. Recommendations

The integration of collaborative research, capacity-building, and outreach must be at the forefront to ensure that research results are available, understood, and appropriately integrated into the political process in Mali.

Food and nutrition security and sustainable agriculture remain major challenges in Mali. It is important to revisit the current design of the fertilizer subsidy program, if continued. Sustainable agriculture requires the promotion of diversified agricultural and food systems adapted to agro-ecological conditions. The agricultural landscape must be protected through the promotion of water and soil conservation practices and the diversification of cash and food crops.

Markets play an important role in accessing food products. Even in rural areas, the majority of households are net buyers. Household food and nutrition security requires an increase in income as well as an increase in the supply of diversified and affordable products throughout the year on markets in rural and urban areas.

It is also important to better monitor the sale and use of phytosanitary products to ensure that the risks to human health and the environment are minimized. Monitoring sites where pesticides are highly used, such as the cotton production basins, Office du Niger and Office du perimeter irrigué de Baguineda, are proposed. There is a need to continuously educate farmers on how to identify unauthorized pesticide products on the markets and how to safely use, store and dispose of them.