CLIMATE CHANGE, COLLECTIVE ACTION, & WOMEN'S ASSETS

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The Gender-Differentiated Impact of Climate Variability on Production Possibilities: Evidence from Cereal Production in Mali

Andrew Dillon and Joshua Gill

PRODUCTION VARIABILITY DUE TO CLIMATIC CONDITIONS IS A SIGNIFICANT SOURCE OF RISK IN AGRICULtural production, and a significant constraint to both agricultural growth and food security. In rainfed systems, changes in the timing and amount of rainfall have a significant impact—not only on crop growth, but also on marketed surplus levels, the proceeds of which can be used for food and nonfood expenses or invested in agricultural or other assets. Increasing evidence suggests that climate change is instigating long-term changes in rainfall and temperature levels, as well as greater frequency of droughts and floods. Climate variability directly and indirectly affects the production possibilities of both male and female farmers. The potential direct effects are greater output uncertainty and hence an increase in the costs associated with reducing risk; the potential indirect effects are the depletion of household assets to maintain subsistence consumption in response to poor harvests. This policy note summarizes research into the gender-differentiated impacts of climatic changes on farmers' production possibilities using a representative sample of farmers in rainfed and irrigated areas of the Segou region of Mali during the 2009 and 2012 growing seasons.

CONTEXT OF THE STUDY

How farmers reduce interseasonal risks and whether previous climatic variability affects current production possibilities is an open question. A farmer's "production possibility frontier"—meaning the best-case production scenario based on the combined impact of factors within and outside his or her control—depends in large part on the frequency and intensity of climatic changes and on mitigating factors such as agroecological zone, production system, water control technology, input use, and control of farm assets at critical points in the production process. Mitigating factors may allow farmers to respond more easily to climate fluctuations, and access to water control technologies and complementary inputs are likely to be key elements of "climate-smart" agricultural interventions.

Total production and marketed surplus are important outcome variables: total production levels provide insight into whether a household can produce enough to meet its minimum subsistence requirements, and marketed surplus indicates whether the household is producing a surplus that can be monetized. Differences in the effect of climatic variability on total production and marketed surplus provide some evidence that climate variability may induce risk-averse farmers to produce primarily subsistence crops, which has long-term implications for household welfare, poverty reduction, and agricultural development.

In the context of this study, two variables were utilized as proxies for climatic changes: (1) deviations from rainfall levels using 15 years of historical rainfall data and (2) deviations from 30-year historical trends in "degree days" (that is, days in which the temperature exceeds optimal growing conditions) within a given agricultural season. Men's and women's production possibility frontiers were econometrically estimated to quantify the effect of climate variability on farmers with different levels of access to assets and water control technologies.

DATA AND SAMPLE DESCRIPTIVES

The data underlying this research are a subset drawn from a long-term panel dataset collected as part of the Alatona Irrigation Project impact evaluation, funded by the Millennium Challenge Corporation. A two-stage stratified sample

was selected to be representative of rainfed and irrigated households in the Segou region of Mali. A baseline survey was conducted in 2009 and followed up in 2012. The survey questionnaire was designed to capture household production, asset holdings, and measures of well-being, among other topics. Detailed data were collected at the plot-manager and asset-owner level, permitting gender-disaggregated analysis of these variables. A detailed description of the data and methodology underlying the study can be found in Beaman et al. 2011 (see Further Reading).

Descriptive statistics of gender-differentiated production value, marketed surplus value, irrigation access, and farm assets illustrate the predominant role of men in agriculture in Mali but also show the significant role of women in household agricultural production (Table 1). Women's production is more market-oriented, which is partially explained by production patterns, seasonality, and gender roles in agriculture in the Segou region of Mali. In the primary agricultural season, cereals are produced in both irrigated and rainfed zones, and men are primarily in charge. Women primarily produce vegetables and condiments for sauce in the secondary season and provide important labor inputs in the primary season, including transplanting rice seedlings in irrigated areas, weeding in rainfed areas, and harvesting and processing.

The percentage of households reporting drought conditions increased from 7.4 percent in the 2009 growing season to 24.8 percent in the 2012 agricultural season. This self-reported information was confirmed by linking the household survey data with meteorological data. Mean production and marketed surplus increased between the two agricultural

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seasons for both men and women, likely due to an expansion of irrigation between the two years. Because male cereal production generates more revenue and hence more surpluses, it is not surprising to find higher asset ownership among men.

RESULTS

Results show that climate variability in the form of increased deviations from mean degree days has a significantly negative effect on men's production frontiers but no effect on women's production frontiers. With respect to marketed surplus, deviations in degree days have a significantly negative effect on both men's and women's marketed surplus frontiers, but for women this effect varies based on the amount of land they farm. This is consistent with women's crop choices and the seasonality of production. In the dry season, women restrict their production to small gardens with access to a water source, but as the area of land they farm

TABLE 1 Gender-differentiated descriptive statistics, 2009 and 2012 growing seasons

	2009		2012	
Characteristic	**Men**	**Women**	**Men**	**Women**
Total value of production in CFA francs (mean)	954,113	85,208	1,089,577	192,465
Value of marketed surplus in CFA francs (mean)	257,432	48,897	460,915	92,222
Share with access to irrigation (%)	19.7	42.4	17.1	16.8
Share owning farm assets (%)				
Cart	48.5	4.0	49.7	4.4
Plow	49.9	1.0	50.6	0.6
Draft animals	44.7	4.4	51.5	5.1
Wheelbarrow	4.2	0.2	5.6	0.5
Tiller	2.6	0.2	3.8	0.2
Plot size (hectares)	4.3		4.2	
Standard deviation from mean daily high temperature	0.182		0.764	
Standard deviation from mean rainfall level	0.056		0.059	
Number of households	499		503	

Source: Compiled by authors.
Notes: CFA franc = West African currency. 1 US$ = 495 CFA francs, approximately, over the 2009–2012 period.

increases they become more exposed to the effects of changing temperatures.

Comparing the effects of irrigation on men's and women's production frontiers and marketed surplus frontiers, results indicate that irrigation has a large, positive effect on agricultural production (which is expected), but that this effect is much larger for men's total production and marketed surplus than it is for women's. Irrigation allows men to increase the value of their total production almost enough to offset the negative impact of shocks caused by increased degree days. Women have much less access to irrigation, so they do not benefit from its offsetting effect. Similarly, certain farm assets (such as motorized tillers) have significantly positive effects on men's production frontiers but limited access to these same assets locks women out of this adaptation strategy as well. For assets like plows, which are more equally shared, the effect on production is similar across both men's and women's plots.

While overall production is lower in the secondary agricultural season, the seasonal division of gender-based plot management permits some agricultural production and marketed surplus to be controlled by women during the dry season, albeit to a much lesser degree than men's control during the primary agricultural season. It is important to note that the positive effects of both farm assets and irrigation access are substantially larger than the adverse impacts of climatic variability on production possibilities and marketed surplus. These results underscore the importance of inclusive, climate-smart agricultural interventions—such as access to farm assets and irrigation—that can reduce adverse effects of climate variability.

POLICY IMPLICATIONS

Evidence on the gender-differentiated production responses of farmers to climate variability and whether these effects vary by water control technology and control of farm assets is essential to the design of climate-smart interventions. Both irrigation and farm assets can potentially mitigate the effects of drought, but interventions designed to improve irrigation access may be more beneficial because access to irrigation could substantially increase both men's and women's production and marketed surplus frontiers. Further research may be required to gain understanding of how to increase women's access to irrigation and assets through climate-smart agricultural interventions.

Group-based approaches could be explored as a mechanism for expanding women's control of farm assets and ensuring access to irrigation, given that group solidarity may ensure sustained access. Nevertheless, group-based approaches could also result in asset-management conflicts or suboptimal use of farm assets if group conflicts do not result in the equitable allocation of these assets. The potential for climate-risk-reducing agricultural interventions requires attention to both the structure of potential interventions and the mechanisms through which climate variability can be addressed. As the research illustrated, not all farm assets reduced climate risk for men and women equally.

FOR FURTHER READING

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Andrew Dillon *(dillona6@msu.edu) is an assistant professor in the Agricultural, Food, and Resource Economics Department of Michigan State University, East Lansing, US.* ***Joshua Gill*** *(gilljos1@msu.edu) is a graduate student in the Agricultural, Food, and Resource Economics Department of Michigan State University, East Lansing, US.*

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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2033 K Street, NW, Washington, DC 20006-1002 USA | T. +1.202.862.5600 | F. +1.202.467.4439 | Skype: IFPRIhomeoffice | ifpri@cgiar.org | www.ifpri.org

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