The value of wild pollination services to crop productivity: What does gender of the smallholder farmer got to do with it?

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Acknowledgements: This work is part of Ecosystem Services Accounting for Development (ESAfD) project. We would like to thank ESAfD working group members for helpful comments.
We are also thankful for research assistance by Environment for Development Tanzania (EfDT) junior research fellows Fred Kasalirwe and Richard Jacobs.
We are also thankful to Jessica Chu from Resources for the Future (RFF) for the GIS support and Sida for financial support.

Introduction

"Men's crops" and "women's crops" are concepts which suggest that men and women smallholder farmers, in sub-Saharan Africa, grow different crops. Yet such an important division of crops by gender is not considered in the current valuation of pollination services to crop productivity.

We test the hypothesis that presence of gendered-crops is likely to lead to different crop pollination needs and hence variation in economic value of wild pollination services to crop productivity between male- and female-managed smallholder farms.

Methods

We integrate nationally representative plot level Tanzania national panel data on crop production with spatially and temporally matching data on land cover. Then, using robust fixed-effects panel estimation methods we identify the contribution of forest habitats supporting pollinator populations to crop revenues.

We use gender of the head of the household on the assumption that they are likely to make household decisions such as managing smallholder farms. This assumption is validated by our data.

Pollination Dependency Categories (FAO)

Essential: > crop production is reduced by more than 90% reduction (e.g., papaw, passions)

Great: 40-90% reduction (e.g., mango, avocado)

Modest: 10-40% reduction (e.g., sunflower, coffee)

Little: 0-10% reduction (e.g., beans, groundnut)

Shows an increase in seed/ breeding/yield in response to pollination (e.g., cassava, cocoyams)

Doesn't show an increase in yield in response to animal pollination (e.g., maize, paddy)

Unknown: No literature (e.g., monkey-bread, sisal)

Small-holder farmers grow an array of crops each with different pollination needs. To help identify contributions of natural habitats specific to pollinator services, we use FAO's agro-ecological assessments to separate crops into those that depend on pollinators and those that do not.

Because pollinators have limited flight distances, we assess contributions to crop productivity by forest cover within different distances from the plot.

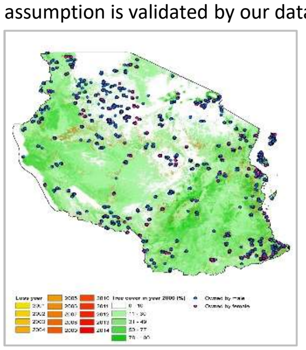
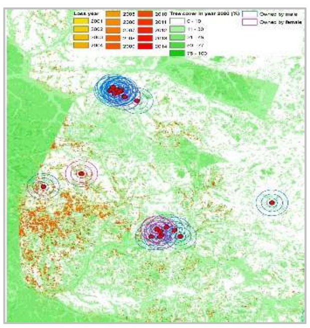


Figure 1. Smallholder farm plots (n=11484): Blue dots indicate male-managed plots, and pink women plots.



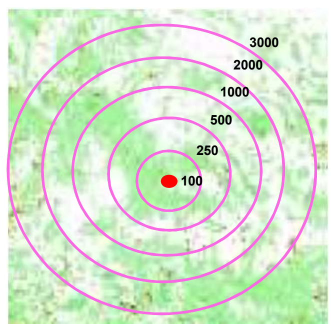


Figure 2 and 3. Wild pollination measure: plot GIS and land cover map is used, and captured by forest share (pollinator natural habitats) in each buffer of different radius (100m, 250m, 500m, 1000m, 3000m) from edge of plot.

Results

Panel 1: Male managed farms						Panel 2: Female managed farms					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Forest share (100m)	Forest share (250m)	Forest share (500m)	Forest share (1000m)	Forest share (2000m)	Forest share (3000m)	Forest share (100m)	Forest share (250m)	Forest share (500m)	Forest share (1000m)	Forest share (2000m)	Forest share (3000m)
Panel A: Outcome - pollinator-dependent crops revenue per hectare											
20,999**	30,948**	48,984**	41,019**	66,392***	82,201***	63,644**	23,384***	7,580	17,426	15,024	-67,555
(7,838)	(12,660)	(20,395)	(16,695)	(18,353)	(22,560)	(20,677)	(5,082)	(21,563)	(16,183)	(24,278)	(67,624)
Panel B:Outcome - pollinator-independent crops revenue per hectare											
1,290*	2,734*	4,589	6,721**	7,045***	7,197**	588.7	-557.5	-1,428	-472.1	-320.9	2,803
(664.7)	(1,383)	(2,624)	(2,369)	(2,152)	(2,677)	(795.7)	(768.3)	(1,821)	(2,553)	(3,671)	(3,847)

Table 1: Estimations from fixed-effects models to predict crop revenue from pollinator-dependent and pollinator-independent crops.

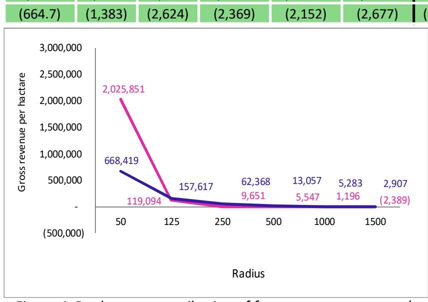


Figure 4. Per hectare contribution of forests to crop revenue (per hectare), by distance from plot. Pollinator-dependent crops (Regression estimates from Panel A in Table 1 derive value of forest to revenue per hectare. The marginal value of forests, per hectare, is declining with distance between forest and plot.

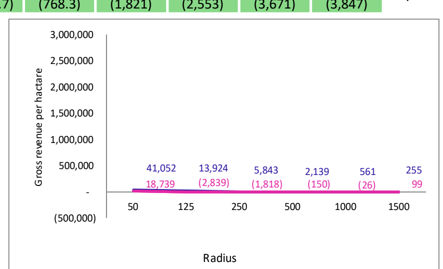


Figure 5. Per hectare contribution of forests to crop revenue (per hectare), by distance from plot. Pollinator-independent crops (Regression estimates from Panel B in Table 1 derive value of forest to revenue per hectare. The marginal value of forests, per hectare, is declining with distance between forest and plot.

Key findings

Figure 6. Small-holder male-managed watermelon farm and depends on wild pollinators. The farmer depends on farm for household income and food. Water melons fall under FAO 'essential' category.

The summary of our results is as follows: First, upon comparing the long-rains, short-rains, and annual crops (fruits and permanent crops), we find evidence of gendered-crops. Here, female-managed farms earn more revenue from seasonal and fruit crops, while male-managed farms earn more from mixed cropping.

Second, the fixed-effects production estimates show that the coefficients are more responsive amongst female-managed farms in comparison to the male-managed farms. When contrasting pollinator-dependent and pollinator-independent crops, we find the positive effects of forests emerge only for pollination dependent crops. Non-pollination dependent crops show no benefits.

Third, estimated coefficients from the six buffers of pollinator-dependent crops produces an exponential function which shows that at shorter distances female-managed farms benefit the most from wild pollination services in comparison to male-managed farms, and this tapers off as distance increases and we finally observe a convergence in benefits. Suggesting that the positive effect from proximity of forests is associated with ability of forests to support pollinator populations and boost crop production.

Conclusion

We are able to conclude that: (i) Improving natural habitants of pollinators will enhance crop revenue especially among female-managed farms. (ii) Results also point to the fact that we cannot fail to recognise importance of crop diversification in light of threat from pollinator decline. (iii) Results are also relevant to ecosystem services policy and suggest the need to consider gender, as benefits of naturally available pollination services vary by gender.

Figure 7. Women smallholder farmers at local market. The average size of the smallholder plots is approximately 2 ha. Some of the crop output is maintained for household consumption while the rest is sold.

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