Papaya Policy Brief 1

Feel the Churn: Gender, Age and Maize Productivity in Central-Eastern Africa, 2002 – 2013/15

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Gendered yield gaps within snapshot survey cross-sections hide considerable churn of households which change status between waves of a panel dataset. When we compare Afrint households which have consistently had a man or woman managing the farm in 2002, 2008 and 2013/15, gendered yield gaps for maize disappear. Women have performed as well as men. Estimates from production functions on Malawian and Zambian data reinforce this finding and also highlight how younger households in Malawi and conservation agriculture in Zambia have played unexpected roles in increasing maize productivity. Distance to density is also an unexpected factor: remoter households in Malawi have increased maize yields more, the opposite from Zambia where proximity to markets and the village centre increased yields. In Tanzania, soil improvements and education show unexpected positive influence on maize yields within the 2015 Afrint cross section. The real value of panel data is that it allows researchers to track the same households through time. Researchers need to compare groups of households which maintain consistent characteristics through time.

Gender and maize productivity

Panel data allows researchers to track the performance of the same households through time. However, households move, some households, especially elderly households, pass away, new households are formed. Between 2002 to 2013/15 33% of the original households in Malawi, 32% in Zambia and 42% in Tanzania dropped from the original sample (Andersson Djurfeldt et al, *forthcoming*). In other words, only 780 from the original 1210 households featured in the 2013/15 sample. Each new wave of Afrint panel data (2008, and 2013/15) compensated for such attrition by ensuring that for each household that dropped from the sample, a descendent household was sampled if possible, or a new respondent household was sampled which shared key observable characteristics, especially wealth status.

But this only tells part of the story about household changes. In addition to attrition, households' marital status changes through time. Families and feelings change, husbands and wives separate. Divorce is common despite the best efforts of counsellors and kin. So, in addition to the 430 households dropping from the panel data sample, the marital status of the remaining 780 *true* panel also changed.

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Why does this matter? It matters because when we compare by gender across waves (cross sections, if you like) we are not comparing the performance of the same households: some women-headed households may have married; some households will have recently divorced (which can easily lead to impoverishment when institutional constraints limits women's ability to access land and inputs). This also applies to the individual managing the farm enterprise within the household: Table 1 below shows that for the 622 households which offered maize productivity data, 194 (31.2%) of households changed the gender of farm manager between 2002 and 2013/15. This 'churn' of household and farm manager status obfuscates agricultural productivity trends with implications for policy.

Table 1 below is instructive. Maize productivity has increased significantly in all 3 countries between 2002 – 2013/15 for both farms consistently managed by men and women (using paired sample t-tests). Importantly, when we look at the percentage increase in maize productivity 2002 - 2013/15 by gender, we see that farms consistently managed by women have matched the performance of farms consistently managed by men: there is no significant difference in their productivity increases. In addition, the maize productivity performance of households which changed status in each country between 2002 – 2013/15 also shows no significance (using a one-way Anova f-test).

What does this mean? It means that the gendered yield gaps which appear when we compare married and women-headed households, or farms managed by men and women, within individual cross-sections within a panel may not be offering us a clear enough picture. For example, the Tanzanian maize productivity statistics in Table 8 which rely on comparisons of farms managed by men and women within each cross section show a significant gendered yield gap of 18% in 2015. Compare this to Table 1 which compares farms which have been consistently managed by men and women: an insignificant gendered yield gap of 3%. When we look at all three countries together, the panel data in Table 1 shows a significant gendered yield gap of 16% in 2002 but by 2013/15 this falls to an insignificant gap of 13% (driven by considerable differences in Zambia). Overall, then, the real value of panel data is that it allows researchers to track the same households through time. When doing so it is important to compare groups of households which show consistent characteristics through time.

Age and maize productivity

Definitions of youth vary by institution and country. Whilst a common UN definition suggests individuals aged 15-24 are youth, at the national level there are various definitions including ranges which stretch from 15-35. In this policy brief, we consider the performance of households who were between 15-30 at the start of the Afrint panel in 2002 and compare them to four further age groups: those in their 30s, 40s, 50s and 60 plus. Table 2 shows trends in maize productivity 2002 – 2013/15 by these age groups. A number of important trends can be seen. First, differences in maize productivity were not significant across age groups in 2002 in any country. We see a uniform range of maize yields with standard deviations around 0.6 of the mean in each country and overall. By 2013/15 we see much greater variation across age groups in Zambia and Malawi, with the latter showing significance at the 95% level for both yields in 2013 as well as increasing productivity trends. It is the youngest cohort (who were between 15-30 in 2002, and between 26-41 in 2013) showing the greatest yields and yield improvements (83% over 2002). Yield increases decline as households get older with the exception of households between 42-51 (31-40 in 2002) who show lower than expected yield increases. We see this same pattern in yield increases across all three countries: the youngest cohort displaying the greatest productivity improvements (96% over 2002) alongside yield improvements declining by age with the exception of the 42-51 cohort (31-40 in 2002). We now discuss the drivers of maize productivity increases in Malawi, Zambia and Tanzania.

Drivers of maize productivity in Malawi, Zambia and Tanzania

Prowse and Hillbom (forthcoming) untangle the relative influence of a range of factors on *trends* in maize productivity in Malawi and Zambia 2002 – 2013 through a logged OLS production function. Importantly, this uses only true panel households (as outlined above). Table 3 below shows the transformation of independent variables regressed against logged maize yield increases. Table 4 highlights that when we isolate the relative influence of each of these variables in turn five factors play a significant role. First, and reflecting Table 2 above, age has a negative influence with a 1% increase in age leading to a 0.06% decrease in maize productivity. In other words, a 100% increase in age (from 30 to 60) reduced maize yields by 6%. Second, a 1% increase in maize area reduced yields by 0.7%. In other words, a doubling of maize area (from 1 to 2 hectares) reduced yields by 70%. Third, a 1% increase in NPK application led to a 0.28% increase in yields, such that a doubling of NPK application increased yields by 28%. The fourth and fifth significant factors are spatial: distance to market and distance to the village centre with a 1% increase in the former increasing yields by 0.1% and a 1% increase in the latter increasing yields by 0.05%. In other words, distance to density (in the form of rural trading centres, a village or a rural market) increases productivity. One insignificant variable is also highly relevant: the sex of farm manager. Holding other variables constant, the sex of farm manager made no difference to increases in maize productivity between 2002-2013. In other words and reflecting Table 1 above, women farm managers have matched the performance of men in maize productivity increases during this time period in Malawi.

In Zambia we see a slightly different story. Table 5 shows the variables included in the logged model and Table 6 illustrates the regression coefficients. The model shows how, *ceteris paribus*, a 1% increase in NPK application increases yields by 0.6%, and a 1% increase in adult labour increase yields by 0.26%. We can also note that starting conservation agriculture between 2002 and 2013 has a very slight increase in yields significant at the 10% level. Both spatial variables also show significant but in the opposite direction than Malawi: a 1% increase in the distance to market reduced yields by 0.13% and a 1% increase in the distance to village centre reduced yields by 0.08%. Once again, holding all other variables constant, the sex of farm manager made no difference to increases in maize productivity between 2002-2013.

Turning to Tanzania, Msuya et al (forthcoming) show how Tanzanian maize yields and adoption of improved seed and fertilizer changed between 2002 – 2015. Table 7 shows how maize yields increased significantly, by 277kgs per hectare between 2002 and 2008 but not between 2008 and 2015 despite a significant increase in the use of improved seed. Table 8 applies a gender lens to maize yields and the adoption of improved seed but does so by comparing farms managed by men and women in each cross section, not comparing true panel houshoelds who kept the same household status in all three waves of the survey. When doing so they highlight a persistent although weakening gender yield gap which contrasts with the data in Table 1. Msuya et al (forthcoming) assess the determinants in each cross section of Afrint data from 2015 and show how soil improvements and education have the strongest positive influence on maize yields whilst land allocated to maize the strongest negative influence on maize yields (not shown).

Table 1 - Maize productivity kgs/hec by gender of farm manager 2002-2013/15 in AFRINT villages in Malawi, Zambia and Tanzania

	Farm manager	No. of HHs	2002 maize yield kgs/ha	Sig. Anova f-test	2013-15 maize yields/ha	Sig. Anova f-test	Sig. Paired T-test over time	Increase from 2002 - 2013-15	Sig. Anova f-test	% change over 2002
Malawi	Man	102	895		1247		****	352		39,3
	Woman	54	830		1313		***	483		58,2
	Change in farm manager status 2002-2013/15	95	810		1173		****	363		44,8
Zambia	Man	116	1147		2126		****	979		85,4
	Woman	28	1014		1633		***	619		61,0
	Change in farm manager status 2002-2013/15	63	1221		1951		****	729		59,7
Tanzania	Man	111	1067		1478		****	411		38,5
	Woman	17	761		1434		***	673		88,4
	Change in HH status 2002-2013/15	36	912		1354		***	442		48,5
All countries	Man	329	1041	**	1635		****	593		57,0
	Woman	99	870	**	1424		****	554		63,7
	Change in HH status 2002-2013/15	194	962	**	1459		****	496		51,6
Overall		622	989		1546		****	557		56,3

Source for Tables 1 and 2: AFRINT III dataset, Department of Human Geography, Lund University, Sweden

Table 2 - Maize productivity kgs/hec by age of farm manager 2002-2013/15 in AFRINT villages in Malawi, Zambia and Tanzania

Age group	No. of HHs	2001/2 maize yield kgs/ha	Sig. Anova f-test	2013-15 maize yields/ha	Sig. Anova f-test	Increase from 2002 - 2013-15	Sig. Anova f-test	% increase
				Malawi				
15-30	60	871		1592	**	721	**	83
31-40	56	896		1143	**	247	**	28
41-50	29	856		1454	**	598	**	70
51-60	32	819		1083	**	264	**	32
61 plus	26	903		966	**	63	**	7
Total	203	872		1288		416		48
				Zambia				
15-30	33	1027		2410		1383		135
31-40	58	1141		2059		918		80
41-50	47	1120		1817		697		62
51-60	30	1207		1995		789		65
61 plus	30	1281		1895		614		48
Total	198	1148		2026		877		76
				Tanzania				
15-30	28	883		1508		624		71
31-40	55	1185		1461		276		23
41-50	32	975		1602		626		64
51-60	22	879		1309		430		49
61 plus	22	879		1436		558		64
Total	159	1005		1473		468		47
				Overall				
15-30	121	916		1795		879	**	96
31-40	169	1074		1561		487	**	45
41-50	108	1007		1656		649	**	65
51-60	84	973		1468		495	**	51
61 plus	78	1041		1456		415	**	40
Total	560	1007		1601		594		59

Tables 3 – Descriptive statistics for Malawian production function

Dependent	N	Mean	Std. Deviation
Yields - pruned at 3SDs, logged	138	7.86	0.32
Independent			
Age of head of household, years - 68 missing values imputed with mean	138	6.36	0.95
Years of schooling of farm manager - 2013 variable logged, 7 values imputed with median	138	1.29	0.75
Estimate of trend in able workers Afrint I to III, plus constant, logged, 5 missing values imputed with median	138	1.64	0.36
Trend in maize area Afrint I to III - pruned at 3SDs, plus constant, logged, 7 missing values imputed with median	138	1.02	0.19
Ganyu nominal trend Afrint II to III, plus constant, logged, 2 missing value imputed with median	138	4.24	0.50
NPK trend Afrint I to III- pruned at 3SDs, plus constant logged	138	5.61	0.54
Started using improved seeds between Afrint I to III, dummy	138	0.39	0.49
Started hiring labour in between Afrint I to III, dummy	138	0.25	0.43
Distance to market, household level, logged, 2008	138	1.86	0.64
Distance to village centre, logged, 2013, missing values imputed	138	-1.07	1.23
Trend in maize prices in USD nominal from Afrint II to III, no outliers, plus constant, logged	138	2.74	0.30
Dummy for sex of farm manager consistent across 2008 and 2013 with 2001 HH head	138	0.64	0.48

Table 4 – Malawian production function [1]

	Unstandardized Coefficients		Standardized Coefficients	
Model	B	Std. Error	Beta	Sig.
(Constant)	7,448	,433		***
Age of head of household, years - 68 missing values imputed with mean	-,056	,025	-,163	**
Years of schooling of farm manager - 2013 variable logged, 7 values imputed with median	-,009	,030	-,020	
Estimate of trend in able workers Afrint I to III, plus constant, logged, 5 missing values imputed with median	-,017	,064	-,019	
Trend in maize area Afrint I to III - pruned at 3SDs, plus constant, logged, 7 missing values imputed with median	-,669	,123	-,386	***
Ganyu nominal trend Afrint II to III, plus constant, logged, 2 missing value imputed with median	,006	,045	,009	
NPK trend Afrint I to III- pruned at 3SDs, plus constant logged	,284	,041	,476	***
Started using improved seeds between Afrint I to III, dummy	-,030	,047	-,046	
Started hiring labour in between Afrint I to III, dummy	,038	,051	,050	
Distance to market, household level, logged, 2008	,100	,035	,198	***
Distance to village centre, logged, 2013, missing values imputed	,049	,018	,186	***
Trend in maize prices in USD nominal from Afrint II to III, no outliers, plus constant, logged	-,098	,074	-,091	
Dummy for sex of farm manager consistent across 2008 and 2013 with 2001 HH head	,003	,048	,004	

a. Dependent Variable: Yields - pruned at 3SDs, logged

Table 5 - Descriptive statistics for Zambian production function

Dependent	N	Mean	Std. Deviation
Yields - pruned at 3SDs, plus constant, logged	151	7,98	0,46
Independent			
Age of head of household, years – square rooted, 9 missing values imputed with mean	151	6,70	1,03
Years of schooling of farm manager - 2013 variable logged, 6 values imputed with mean	151	1,92	0,63
Estimate of trend in able workers Afrint I to III, plus constant, logged	151	2,58	0,29
Trend in maize area Afrint I to III, pruned at 3SDs, plus constant, logged, 7 missing values imputed with median	151	1,60	0,28
Ganyu nominal trend Afrint I to III, plus constant, logged	151	6,32	0,23
Started using Conservation Agriculture Afrint I to III, dummy	151	0,45	0,50
NPK trend Afrint I to III - pruned at 3SDs, plus constant, logged	151	7,44	0,22
Started using improved seeds between Afrint I and III, dummy	151	0,16	0,37
Started hiring in labour Afrint I to III, dummy	151	0,17	0,37
Distance to market, household level, logged, 2008	151	2,95	0.51
Distance to village centre, logged, 2013, missing values imputed	151	1,39	1.07
Trend in maize prices in USD nominal Afrint II to III, no outliers, plus constant, logged	151	2,84	0.20
Sex of farm manager consistent across Afrint II and III with Afrint I HH head, dummy	151	0.80	0.36

Table 6 – Zambian production function[2]

	Unstandardized Coefficients		Standardized Coefficients	
	B	Std. Error	Beta	Sig.
(Constant)	3,833	1,624		**
Age of head of household, years – square rooted, 9 missing values imputed with mean	,014	,035	,032	
Years of schooling of farm manager - 2013 variable logged, 6 values imputed with mean	-,034	,057	-,047	
Estimate of trend in able workers Afrint I to III, plus constant, logged	,269	,121	,174	**
Trend in maize area Afrint I to III, pruned at 3SDs, plus constant, logged, 7 missing values imputed with median	-,040	,133	-,024	
Ganyu nominal trend Afrint I to III, plus constant, logged	-,148	,147	-,075	
Started using Conservation Agriculture Afrint I to III, dummy	,129	,073	,141	*
NPK trend Afrint I to III - pruned at 3SDs, plus constant, logged	,618	,168	,303	***
Started using improved seeds between Afrint I and III, dummy	,046	,093	,037	
Started hiring in labour Afrint I to III, dummy	,094	,092	,076	
Distance to market, household level, logged, 2008	-,129	,071	-,144	*
Distance to village centre, logged, 2013, missing values imputed	-,075	,034	-,177	**
Trend in maize prices in USD nominal Afrint II to III, no outliers, plus constant, logged	,077	,170	,034	
Sex of farm manager consistent across Afrint II and III with Afrint I HH head, dummy	,010	,091	,008	

Source for Tables 3, 4, 5 and 6 – Taken from Prowse and Hillbom (forthcoming)

Table 7 – Tanzanian maize yields and adoption of improved seed and fertilizer 2002 – 2015

N - 232			Maize		
	Afrint I	Afrint II	Afrint III	Afrint I–II	Afrint II–III
Yield	1,002	1,279	1,390	277***	111
Seed	17%	23%	16%	6%	8%**
Fertilizer	20%	23%	35%	3%	12%
No fertilizer	69%	65%	60%	4%	5%
Seed only	11%	12%	4%	1%	8%
Fertilizer only	14%	12%	24%	2%	12%
Seed and fertilizer	7%	11%	12%	4%	0%

Table 8 – Tanzanian maize yields and adoption of improved seed and fertilizer 2002 – 2015 by sex of farm manager

			Maize		
		Yield	Seed	Fertilizer	N
2002					
	Male	1,048	21%	20%	186
	Female	815	4%	22%	46
	Diff	233**	16%***	2%	
2008					
	Male	1,354	25%	22%	184
	Female	992	16%	27%	48
	Diff	362**	9%	4%	
2015					
	Male	1,452	17%	34%	176
	Female	1,193	12%	39%	56
	Diff	260*	5%	4%	

Sources for Tables 7 and 8 – Taken from Msuya et al (forthcoming)

References:

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[1] Model summary Malawi

Model	R	R Square	Adjusted R Square Std.	Error of the Estimate
1	0,668a	0,447	0,394	0,25162

[2] Model summary Zambia

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,529a	0,280	0,211	0,40627

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