EVIDENCE AND DETERMINANTS OF GENDER GAPS IN LEGUME PRODUCTION- WHAT CAN WE LEARN FROM EXISTING TL-2 DATA SET.

1. Introduction

Smallholder agricultural productivity growth has been identified as a key driver of poverty reduction and increased food security as it is the predominant form of farm organization in Sub-Sahara Africa (FAO, 2009). In targeting sustainable poverty gains through smallholder-based agricultural growth, national development plans across sub-Saharan Africa have emphasized the reduction of gender differences in agricultural productivity *(Goldstein et al*, 2015).

An FAO report (2011) asserted that although women comprise an average of 50% of the agricultural labour force in Sub-Sahara Africa and are involved in all levels/types of agricultural activities, they have limited access to resources compared to their male counterparts. This gap also exists in other socio-economic characteristics that affect agricultural productivity such as level of education, membership of co-operative groups etc. As a result, female farmers are 20-30% less productive on average than their male counterparts (FAO SOFA report, 2011). Studies (Udry et al., 1995, Tiruneh et al., 2001) have also shown that this gap in productivity is explained more by resource constraints than it is by disparity in efficiency levels between male and female farmers. Eliminating this gap has the potential therefore to raise total agricultural output in developing countries by 2.5-4% while also reducing the number of hungry people in the world by 12-17% (100-150 million people) (FAO,2011). The gender gap in agricultural productivity—(measured by the value of agricultural produce per unit of cultivated Land)—ranges from 4 to 25 percent, depending on the country and the crop (World Bank 2014).

This report is part of the Tropical Legumes III project. The project is led by ICRISAT and jointly implemented by three international agricultural research centers, viz. ICRISAT, IITA and CIAT and the national research centers in the target countries. It aims to increase productivity and production of legumes and the income of poor farmers in SSA and SA by 15 percent. The focus of this report is on groundnut and pigeon pea in Tanzania and Malawi. These crops are very important food and cash crops, highly nutritious, prevent soil erosion and importantly, improve soil fertility through nitrogen fixation. Malawi and Tanzania are major producers and exporters of pigeon pea with Malawi being the largest producer in Africa, bringing in much needed foreign exchange and providing employment (Kulkarni, 2013).

According to a joint study by UN women, UNDP, UNEP and World Bank (2015), Women farmers in Malawi are older by over five years on average and also have lower levels of education as compared to male farmers. Only 25% of sole female managers are monogamously married, as compared to 87% of male managers. 70% of them are widowed, divorced, or separated, compared to only 3% among male managers.

In Tanzania, women farmers are about four years older than male farmers and have a lower educational attainment (roughly two years' less schooling). 67% of female managers are

widowed, divorced, or separated compared to only 9% in the sample of other plot managers. While women managers cultivate about 0.6 hectares of land on average, all other managers cultivate more than 1 hectare—a difference that is statistically significant(UN Women,2015). It is estimated that the gender gap amounts to $100million in Malawi and $105million in Tanzania (UN Women,2015).

With legumes being considered 'women's crops' by many researchers, this report focuses on investigating if these gaps exist amongst male and female groundnut and pigeon pea farmers in Malawi and Tanzania. Maize is also included because apart from being a staple in these countries it is also grown by most farmers, nearly 100% of farmers in Malawi grow maize (Goldstein *et al*, 2015).

2. Data and descriptive statistics

Panel data collected for 3 time periods for Malawi (2008, 2010 and 2013) and 2 time periods for Tanzania (2008, 2010) was used. Malawi has 3 regions (Central, Northern and Southern) and 28 districts within this region. Data was collected from 2 regions (central and southern) and 4 districts within this region. In the central region, data was collected from Mchinji district while in the Southern region data was collected from Balaka, Chiradzulu and Thyolo districts in 2008 and 2010, while Thyolo and Chiradzulu were excluded in 2013.

Tanzania has 30 regions and each region is further divided into 169 districts. Data was taken from 4 of these districts; Kondoa (located in the central region), Karatu and Arumeru (north eastern region) and Babati (Northern region). Kondoa is a major groundnut producing region in Tanzania while the 3 other districts are majorly pigeon pea producing regions.

Data was collected on household and farmer characteristics, plot characteristics, inputs and outputs used, household assets ownership, knowledge of improved crop varieties.

A total of 594, 439 and 208 households were surveyed in Malawi for 2008, 2010 and 2013 respectively. 582,423 and 149 observations from the 3 time periods were included in the panel giving us an unbalanced panel.

A total of 613 and 605 households were surveyed in Malawi for 2008 and 2010 respectively. 437 observations from both time periods were included in the panel giving us a balanced panel.

As this was a panel data, the results can be said to be more accurate and representative because panel data contains more sample variability and this increases the degrees of freedom and reduces collinearity as the farmers were observed in different time periods.

FARMER CHARACTERISTICS

Malawi

Each household was asked to identify who was majorly involved in the farming activities and the analysis done was based on the assumption that the person who identified as the farmer was the plot manager and decision maker for the household's agricultural activities. The data comprised of 54% female and 46% male farmers. 94% of the farmers planted maize during the period, 61% planted groundnut and 56% planted pigeon pea. From the table we see that the female farmers are 1 year older on average than the male farmers but this difference is not statistically significant. The male farmers are more educated than female farmers by 1.4 years and this difference is very significant which is in line with the study by UN Women, 2015.

Now we focus on differences that are statistically significant, female farmers have spent 6 years more on average in the village and have more years (4) of experience with pigeon pea than their male counterparts. 37% of male farmers have responsibilities in their communities compared to 18% of female farmers. With respect to marital status, there are more divorced female farmers (15%) compared to male farmers (2%), more married male farmers (92%) than female farmers (61%) and more widowed female farmers (22%) compared to male farmers(3%) and this also conforms with the study by UN Women, 2015. Majority of the male farmers (97%) are household heads as compared to 46% of female farmers who are. More male farmers (3.2%) have salaried employment as compared to female farmers (0.8%).

Table 1 A

MALAWI

Variable name	All	Female	Male	difference	
Farmer characteristics					
Age	44.16	44.71	43.54	1.17	
Education	4.45	3.76	5.17	-1.41	***
Months on farm in the last 12 months	9.64	9.62	9.66	-.044	
Number of years in village	33.05	35.98	29.7	6.28	***
Groundnut experience	9.88	10.0 4	9.69	.348	
Pigeon pea experience	14.76	16.29	12.28	4.009	***
Responsibility in community	.26	.18	.37	-.18	***
Marital status					
Divorced	.09	.15	.02	.131	***
Married	.75	.61	.92	-.311	***
Never married	.02	.01	.02	-.008	
Widow/widower	.13	.22	.03	.19	***
Relationship with hhh					
Hhh	.697	.46	.97	-.518	***
Spouse	.29	.52	.01	.51	***
Occupation					
Casual labourer on farm	.0087	.003	.015	-.0118	**
Farming	.95	.97	.92	.053	***
Salaried employment	.019	.008	.032	-.024	**
Self employed (off farm)	.014	.0098	.019	-.00899	
Farm labour participation					
Full time	.94	.96	.92	.033	***
Not a worker	.007	.0099	.0038	.0061	
Part time	.053	.034	.073	-.039	**
Plot ownership					
borrowed	0.02	0.01	0.02	-0.01	
owned	0.88	0.87	0.89	-0.02	
rented in	0.10	0.11	0.09	0.02	

Tanzania

The data comprised of 26% female and 74% male. 98% of the farmers planted maize during the period, 19% planted groundnut and 93% planted pigeon pea. From the table we see that the female farmers are 2.5 years older on average than the male farmers and this difference is statistically significant. The male farmers are more educated than female farmers but this difference is not significant.

Focusing on differences that are statistically significant, male farmers have spent 5 years more on average in the village. Only 3.5% of female farmers have responsibilities in their communities compared to 16% of male farmers. With respect to marital status, there are more divorced female farmers (8.5%) compared to male farmers (0.46%), more married male farmers (98%) than female farmers (68%) and more widowed female farmers (20%) compared to male farmers (1.2%) conforming again with the study from UN Women,2015. Majority of the male farmers (98%) are household heads as compared to 42% of female farmers who are.

Table 1 B

TANZANIA

Variable name	All	Female	Male	difference	
Farmer characteristics					
Age	46.84	44.92	47.50	-2.58	**
Education	6.32	6.17	6.38	-.207	
Months on farm in the last 12 months	11.70	11.72	11.70	.027	
Number of years in village	38.07	33.86	39.53	-5.67	***
Groundnut experience	2.96	2.63	3.079	-.45	
Pigeonpea experience	15.51	14.41	15.89	-1.48	
Responsibility in community	.124	.035	.16	-.121	***
Marital status					
Divorced	.025	.085	.0046	.080	***
Married	.899	.68	.98	-.297	***
Never married	.014	.036	.0062	.0295	***
Widow/widower	.0608	.201	.0123	.189	***
Relationship with hhh					
Hhh	.835	.42	.98	-.565	***
Spouse	.157	.58	.012	.56	***
Occupation					
Casual labourer on farm	.0011	0	.0015	-.0015	
Farming	.95	.96	.95	.017	
Salaried employment	.028	.027	.028	-.00099	
Self employed (off farm)	.017	.0045	.022	-.017	
Farm labour participation					
Full time	.94	.97	.94	.032	
Not a worker	.0011	0	.0015	-.0015	
Part time	.052	.028	.060	-.033	**
Plot ownership					
borrowed	.001	.016	.0079	.0078	
owned	.86	.87	.85	.023	
rented in	.14	.113	.144	-.031	

INPUT USE

Malawi

In Malawi we see that although female farmers use 37% less than the average quantity of manure and 56% less than male farmers, this gap is insignificant when the plot size is taken into account. The value of fertilizer used by female farmers is 46% less than the average and 65% less than that used by male farmers and even when plot size is taken into account, female farmers still use 38% less than the average value of fertilizer and 56% less than male farmers per acre of land. Value of urea used by female farmers is 32% less than the average and 51% less than that used by male. When plot size is taken into account, female farmers still use 19% less than the average value of urea and 34% less than male farmers.

Only in quantity of groundnut seeds used do we see a significant difference between male and female farmers. Male farmers used 29.5kg (36%) more seeds than female farmers (19.02kg) but this difference becomes insignificant when seed rate per acre is taken into account. Value of maize seeds used by female farmers is 61% less than that used by make farmers but again this difference becomes insignificant when plot size comes into play.

As for labour, the only significant difference between male and female farmers is the use of family labour where male farmers have 45% more family labour days than female farmers but yet again this difference becomes insignificant when plot size is taken into account.

Table 2 A

Malawi

Non –labour inputs

Variable name	All	female	Male	difference	
Manure					
Total man used (kg)	380.84	240.14	542.06	-301.93	**
Manperac (kg/ac)	88.25	53.369	128.21	-74.84	
Value of man bought (mk)	46.01	11.82	85.18	-73.36	
Fertilizer					
Amt of dap fert used (kg)	79.23	60.68	100.49	-39.81	
Fertperac (kg/ac)	17.65	16.73	18.70	-1.97	
Value of dap fert used (mk)	1997.37	1061.26	3069.99	-2008.73	***
Valfertperac (mk/ac)	487.39	304.13	697.28	-393.15	***
Urea					
Amt of urea used (kg)	110.70	87.76	136.98	-49.22	
Ureaperac	30	23.69	37.22	-13.53	
Value of urea used (mk)	2753.59	1851	3787.8	-1936.79	***
Valureaperac (mk/ac)	671.85	542.16	820.38	-278.22	***
Chemicals					
Amt of chem used(litres)	0.61	0.13	1.16	-1.03	
Chemperac (lit/ac)	0.22	0.07	0.39	-0.32	
Value of chem used (mk)	16.58	9.07	25.2	-16.13	
Seed					
Total seed used (kg)					
Pigeon pea	15.05	12.14	20.47	-8.33	
groundnut	24.5	19.02	29.52	-10.5	***
maize	51.75	23.31	83.98	-60.67	
Seedperac (kg/ac)					
Pigeon pea	8.82	9.25	8	1.21	
groundnut	26.11	21	30.76	-9.75	
maize	48.4	25.46	74.49	-49.03	
Total seed cost (mk)					
Pigeon pea	452.83	310.3	718.55	-408.24	
groundnut	1628.85	1182	2033.35	-851.1	

maize	2342.44	1352.65	3464.32	-2111.67	***
Seed cost per ac (mk/ac)					
Pigeon pea	272.8	137.65	525.53	-387.87	
groundnut	2691.87	2549	2822.11	-273.07	
maize	2490.24	2482.28	2499.3	-17.02	

Labour inputs

Variable name	**All**	**Female**	**Male**	**difference**	
Hired oxen (mk)	120.05	104.53	137.84	-33.31	
Total hired labour (labour days)	276.14	239.69	317.91	-78.22	
Hired labour per ac (labour days)	64.46	56.70	73.36	-16.66	
Total family labour (labour days)	20.91	15.25	27.98	-12.73	**
Family labour per ac (labour days)	4.42	3.71	5.31	-1.6	

Tanzania

In Tanzania we see that although female farmers use 69% less chemical than male farmers, this gap becomes insignificant when the plot size is taken into account. The value of chemical used by female farmers is 64% less than that used by male farmers and when plot size is taken into account, this gap becomes insignificant.

Only in quantity of pigeon pea seeds used do we see a significant difference between male and female farmers. Male farmers used 26.5kg (20%) more seeds than female farmers (21.3kg) but when seed rate per acre is taken into account, female farmers use more pigeon pea seeds per acre even though this difference is not significant. Female farmers use 12.36kg/ac, 32% more groundnut seeds per acre than male farmers (8.42 kg/ac).

As for labour, male farmers use 29% more hired oxen and 40% more higher hired labour than male farmers but yet again this difference becomes insignificant when plot size is taken into account.

Table 2 B

Tanzania

Non –labour inputs

Variable name	All	female	Male	difference	
Manure					
Total man used (kg)	14.26	21.46	11.73	9.73	
manperac	4.07	8.56	2.49	6.07	
Value of man bought (mk)	910	786	952.14	-166.13	
Fertilizer					
Amt of dap fert used (kg)	.695	.044	.923	-.879	
Fertperac (kg/ac)	.078	.0049	.103	-.098	
Value of dap fert used (mk)	97.17	0	130.17	-130.17	
Valfertperac (kg/ac)	76.38	0	103.17	-103.17	
Urea					
Amt of urea used (kg)	7.51	4.43	8.59	-4.16	
Ureaperac (kg/ac)	1.69	1.44	1.77	-.33	
Value of urea used (mk)	2115.37	1311.97	2388.16	-1076.19	
Valureaperac (mk/ac)	952.09	889.07	974.19	-85.12	
Chemicals					
Amt of chem used (litres)	.29	.11	.35	-.24	**
Chemperac (lit/ac)	.032	.015	.039	-.024	
Value of chem used(mk)	1381.4	600.41	1646.57	-1046.16	**
Val of chemperac (mk/ac)	313.96	183.8	358.16	-174.36	
Seed					
Total seed used (kg)					
Pigeon pea	25.18	21.3	26.5	-5.2	**
groundnut	17.92	19.55	17.41	2.14	
maize	36.81	32.82	38.19	-5.38	
Seedperac (kg/ac)					
Pigeon pea	8.52	17.9	5.34	12.57	
groundnut	9.35	12.36	8.42	3.94	**
maize	10.04	7.77	10.82	-3.05	

Total seed cost (mk)					
Pigeon pea	8117.49	7519.87	8319	-799.53	
groundnut	6914.15	7694.23	6672.27	1021.96	
maize	11521.98	10678.41	11813.39	-1134.98	
Seed cost per ac (mk/ac)					
Pigeon pea	1962.54	2141.9	1902	240	
groundnut	3666.06	4797.3	3315.28	1482.02	
maize	3396.71	3663.83	3304.44	359.39	

Labour inputs

Variable name	**All**	**Female**	**Male**	**difference**	
Hired oxen (mk)	79799.28	61117.78	86316.08	-25198.3	**
Total hired labour (labour days)	18.63	12.48	20.78	-8.3	**
Hired labour per ac (labour days)	1.71	1.43	1.81	-.38	
Hoxnperac (mk/ac)	9344.41	8855.54	9514.95	-659.41	

PRODUCTIVITY

Malawi

With all 3 crops, male farmers have more aggregate production than female farmers. However, when we look at productivity/acre (yield) this difference becomes insignificant with respect to groundnut production. Except for pigeon pea, male farmers have higher plot size than female farmers and also higher than the average. For all crops, male farmers have above average values for production, plot size and yield while the reverse is the case for female farmers.

Table 3 A

Malawi

Variable name	**All**	**Female**	**Male**	**difference**	
Production (kg)					
Pigeon pea	138.52	117.71	177.32	-59.61	***
groundnut	303.57	215.46	383.37	-167.91	***
maize	809.1	678.4	957.24	-278.84	***
Plot size(acres)					
Pigeon pea	2	1.96	2.09	-0.13	
groundnut	1.68	1.44	1.9	-0.46	***
maize	1.89	1.7	2.11	-0.41	***
Yield(kg/acre)					
Pigeon pea	108.35	92.54	137.9	-45.37	**
groundnut	252.4	215.98	285.6	-69.61	
maize	498.41	467.3	533.8	-66.5	**

Tanzania

With the exception of groundnut, male farmers have more aggregate production than female farmers and also produce more than the average which is not the case for female farmers. However, when we look at productivity/acre (yield) this difference becomes insignificant with respect to pigeon pea and disappears in groundnut where female farmers have more yield although not significant. Except for maize, male farmers have higher plot size than female farmers and also higher than the average plot size in all cases.

Table 3 B

Tanzania

Variable name	**All**	**Female**	**Male**	**difference**	
Production (kg)					
Pigeon pea	1130.81	753.98	1258.69	-504.71	**
groundnut	397.32	371.98	405.18	-33.2	
maize	2758.032	2221.56	2943.36	-721.8	**
Plot size(acres)					
Pigeon pea	5.66	4.76	5.97	-1.20	**
groundnut	2.92	1.91	3.24	-1.33	**
maize	5.22	4.72	5.4	-0.677	
Yield(kg/acre)					
Pigeon pea	237.32	186.82	254.46	-67.64	
groundnut	222.95	228.89	221.11	7.77	
maize	605.12	514.62	636.38	-121.76	***

3. Panel Analysis

In examining differences between male and female managed plots, a yield function which models the quantity of output per acre as a function of other factors of production and an indicator of the gender of the farmer will be estimated. It is expected that gender variable will not be significant when other factors are controlled for. Estimating the yield function for plot a under the management of manager b:

$$yab = \propto + gb + \sum_{x=1}^{X} m_{b^x} + \sum_{p=1}^{P} c_{ab^p} + \sum_{s=1}^{S} o_{ab^s} + \sum_{l=1}^{L} i_{ab^l} + \sum_{n=1}^{N} d_{ab^n} + e_{ab}$$

Where y is the log of plot a's harvest under manager b, α is the unknown constant, g is the gender dummy of the manager, m is the set of x individual characteristics of the farmer (age, education, marital status), c is a set of p plot characteristics (distance to market, water logging on plot), o is a set of s cropping strategies (irrigation, use of improved seeds), i is the set of L labour inputs used on the plot (hired oxen, hired labour), d is the set of n non-labour inputs used (seeds, fertilizers, manure).

The estimation was done in six steps using a progressive approach. The first step (naïve regression) considers only the gender of the manger as the independent variable. In the next steps more control variables are included. The farmer's characteristics are included in the second step, plot characteristics and plot size in the third step, cropping strategies adopted by the farmer in the fourth step, labour inputs used in the fifth step and non-labour inputs used in the sixth and final step. This estimation method was adopted from (Oseni *et al.*, 2013)

RESULTS

The results are presented in tables 4a and b.

GROUNDNUT

Malawi: The result of the naïve regression (step 1) shows that being a female has a statistically significant negative effect on productivity. However as more control variables are added, the significance of gender disappears even though the effect still remains negative (steps 5 and 6). In step 2, education has a significantly negative effect on productivity but this disappears in subsequent steps when more control variables are added. Months the farmer has spent on the farm and responsibility in the community has an 11% and 52% significantly positive effect on productivity respectively and this positive effect persists even after other control variables have been added. In step 3, plot size has a negatively significant effect on productivity which is in line with previous studies about the inverse relationship between land size and productivity. In step 4, none of the cropping strategies considered (irrigation and use of improved seeds) has significant effect on productivity. In step 5, use of groundnut improved seeds becomes significantly positive and this effect remains in the next step as well. Hired oxen has a 0.1% significantly positive effect on productivity and sustain this positive significant effect in the final step. In step 6, quantity of seed used per acre has a 0.5% significantly positive effect on productivity and is the only non-labour input that has a significant effect. The R^2 is 51%, showing that the variables listed here are responsible for 51% of the changes in productivity.

Months spent on the farm, responsibility in the community and quantity of seed used has significantly positive effect while plot size has significantly negative effect on the productivity of both male and female farmers. Additionally for male managers, age, use of improved groundnut seed, fertilizer and hired oxen used contribute significantly positive effects to male productivity.

Tanzania: being female has no statistically significant effect on productivity. In step 2, age has 2.1% negative effect on productivity and this effect diminishes in subsequent steps until it becomes statistically insignificant in steps 5 and 6. In step 3, distance to the nearest main market has a positively significant effect while distance to the agricultural field officer and plot size have a significantly negative effect on productivity and these effects are sustained in subsequent steps. In step 4, the cropping strategies considered have no significant effect on productivity. In step 5, the effect of irrigation becomes negatively significant while hired oxen and hired labour have positively significant effects on productivity. In step 6, quantity of seed used per acre remains the only non-labour input that has a significant effect on productivity. The R^2 is 59%, showing that the variables listed here are responsible for 59% of the changes in productivity.

Hired labour has significantly positive effect on the productivity of female managers and none of the explanatory variables have significantly negative effect on female productivity while distance to agricultural field officer and plot size have significantly negative effect on male productivity.

PIGEON PEA

Malawi: The naïve regression shows that being female has a 21.9% negative effect on productively though this effect is only slightly significant (10%) and it's significance and value diminishes as more control variables are added. In step 2, months the farmer spent on the farm and responsibility in the community have 5.9% and 38% significantly positive effect on productivity respectively. In step 3, distance to the nearest main market and distance to farmer's collection center have significantly positive effects while plot size has a significantly negative effect on productivity as in groundnut. In step 4, the cropping strategies have no significant effect on productivity. In step 5, hired oxen has a 1.4% positively significant effect on productivity and in step 6,quantity of manure and quantity of seed used per acre both have significantly positive effects on productivity. The R^2 is 46%, showing that the variables listed here are responsible for 46% of the changes in productivity.

As in groundnut, months spent on the farm, responsibility in the community and quantity of seed used are positively significant to female productivity while plot size has a significantly negative effect on female productivity. For male productivity, quantity of manure and seed used has significantly positive effect on productivity.

Tanzania: From the naive regression, we see that being female has a statistically significant negative impact on productivity (14%) but and it's significance and value diminishes as more control variables are added. In step 2, none of the characteristics of the farmer has a significant effect. In step 3, the positive effect of marital status on productivity becomes significant and remains so in subsequent steps. Also in step 3, distance to agricultural field officer, plot ownership and plot size have negative effects on productivity and sustains these negative effects even after other control variables are added while soil water conservation has a significantly positive effect on productivity. In step 4, use of improved seed has a 14.5% positive effect on productivity and sustains its positive effect in subsequent steps. In step 5, hired oxen has a positive effect on productivity and finally in step 6, quantity of manure used per acre has a significantly negative effect while quantity of seed used per acre has significantly positive

effect on productivity. The R^2 is 28%, showing that the variables listed here are responsible for 28% of the changes in productivity.

Marital status, hired labour and affects female productivity positively while plot size has consistent negative effect on productivity of both male and female farmers in both crops. Quantity of seed input used has significantly positive effects while plot ownership has significantly negative effects on both male and female productivity.

The results from the estimation of maize yield is also included in the table but will not be explained as this study is more interested in groundnut and pigeon pea.

Some variables were excluded to avoid multi collinearity as they were highly correlated with some explanatory variables included in the model. Number of years spent in the village, years of groundnut experience and years of pigeon pea experience are highly (1%) positively correlated with age, occupation (farming) was positively correlated at 1% with full time farm labour (and number of months a farmer spent on the farm in the last 12 months in Tanzania only), transport cost to the nearest main market was positively correlated at 1% with distance to the nearest main market, quantity of urea and chemical used per acre were positively correlated (1%) with quantity of seed used per acre and gender (female) was negatively correlated (1%) with being a household head. This implies that the omitted variables would have similar effect (move in the same direction) on productivity as the included variables they are correlated with.

Table 4A: MALAWI

Dependent variable: Log value of harvest per acre

Variables								
GROUNDNUT	1	2	3	4	5	6	Female manager	Male manager
Gender *†* (female=1)	-.248** (.116)	-.237* (.138)	-.274** (.140)	-.246* (.143)	-.223 (.142)	-.090 (.122)		
Age (years)		.003 (.004)	.007 (.005)	.008 (.005)	.0075 (.005)	.010** (.004)	.0002 (.007)	.014*** (.005)
Education (years)		-.034** (.018)	.011 (.020)	.0098 (.020)	.008 (.020)	.021 (.017)	.009 (.031)	.025 (.020)
Months on the farm in the last 12 months		.111*** (.021)	.130*** (.025)	.146*** (.026)	.142*** (.026)	.095*** (.023)	.086** (.039)	.085*** (.030)
Responsibility in the community *†* *Yes=1*		.523*** (.125)	.570*** (.127)	.550*** (.131)	.542*** (.131)	.488*** (.115)	.593*** (.213)	.437*** (.134)
Marital status *†* *Married=1*		.062 (.231)	-.051 (.217)	-.025 (.231)	.035 (.229)	.221 (.201)	.197 (.246)	1.08* (.623)
Occupation *†* *Farming=1*		.245 (.474)	.509 (.497)	.484 (.498)	.484 (.492)	.158 (.430)	-.870 (1.01)	.514 (.464)
Distance to the nearest market (km)			.007 (.009)	.005 (.009)	.0022 (.009)	.002 (.008)	.003 (.015)	-.004 (.010)
Number of months road to main market is passable			-.020 (.015)	-.025 (.016)	-.027* (.015)	-.020 (.014)	-.016 (.025)	-.026 (.016)
Distance to farmer club's collection centre (km)			.028 (.020)	.021 (.021)	.017 (.021)	.003 (.018)	-.013 (.029)	-.021 (.026)
Distance to agricultural field			-.004	-.005	-.003	.0006	.040	-.022

officer (km)			(.017)	(.018)	(.018)	(.016)	(.029)	(.020)
Plot ownership † *Owned=1*			.192 (.245)	.084 (.256)	.091 (.253)	.040 (.220)	-.131 (.361)	.450 (.288)
Soilwater conservation † *Yes=1*			-.047 (.126)	-.058 (.137)	-.041 (.136)	-.056 (.121)	.162 (.210)	-.274* (.154)
Water logging on plot † *Yes=1*			-.080 (.182)	-.140 (.194)	-.140 (.191)	-.056 (.169)	.181 (.346)	-.151 (.196)
Log (plotsize (acre))			-.782*** (.098)	-.770*** (.105)	-.770*** (.104)	-.554*** (.093)	-.636*** (.150)	-.461*** (.125)
Irrigation † *Yes=1*				.208 (.390)	-.074 (.398)	.061 (.354)	.686 (.774)	-.237 (.401)
Use of groundnut improved seed † *Used improved=1*				.425 (.132)	.400*** (.130)	.316*** (.114)	.122 (.199)	.273** 9.141)
Hired oxen per acre (mk/acre)					.001*** (.0004)	.0009** (.0004)	.001 (.0006)	.001** (.0005)
Total hired labour per acre (days/acre)					.0003 (.0002)	.0003 (.0003)	.002 (.001)	.0002 (.0003)
Manure per acre(kg/acre)						.0001 (.0002)	-.00005 (.0005)	.0001 (.0003)
Fertilizer per acre(kg/acre)						-.0004 (.0007)	-.0010 (.0008)	.016*** (.005)
Log (groundnut seed used per acre (kg/acre))						.540*** (.053)	.592*** (.094)	.496*** (.064)
R^2	0.0083	0.1048	0.3000	0.3159	0.3311	0.5058	0.55	0.55

PIGEON PEA								
Gender † (female=1)	-.219* (.119)	-.129 (.160)	-.207 (.188)	-.165 (.189)	-.207 (.193)	-.115 (.177)		
Age (years)		.006 (.005)	.005 (.006)	.007 (.006)	.006 (.006)	.007 (.006)	.009 (.008)	-.006 (.009)
Education (years)		.0003 (.023)	-.001 (.027)	.003 (.027)	-.008 (.027)	-.004 (.025)	-.056 (.039)	.006 (.037)
Months on the farm in the last 12 months		.059** (.025)	.130*** (.030)	.128*** (.030)	.139*** (.031)	.112*** (.029)	.139*** (.038)	.065 (.052)
Responsibility in the community † *Yes=1*		.383** (.174)	.425** (.187)	.442** (.192)	.518** (.188)	.404** (.174)	.504** (.256)	.401 (.261)
Marital status † *Married=1*		.350 (.236)	.111 (.244)	.160 (.244)	.063 (.243)	.087 (.223)	.206 (.242)	1.50 (1.072)
Occupation † *Farming=1*		-.130 (.444)	-.114 (.503)	-.126 (.501)	-.015 (.511)	.112 (.470)	.231 (1.07)	.461 (.577)
Distance to the nearest main market (km)			.033** (.013)	.041*** (.013)	.039*** (.013)	.030** (.013)	.012 (.020)	.061*** (.020)
Number of months road to main market is passable			.037 (.025)	.035 (.026)	.038 (.025)	.035 (.023)	.077** (.036)	.023 (.031)
Distance to farmer club's collection center (km)			.308*** (.062)	.283*** (.066)	.234*** (.065)	.209*** (.061)	.225 (.184)	.171 (.07)
Distance to agricultural field officer (km)			.023 (.021)	.020 (.021)	.022 (.021)	.017 (.019)	.091** (.039)	-.008 (.025)
Plot ownership †			-.419	-.429	-.232	-.141	-.338	.525 (.573)

Owned=1			(.353)	(.361)	(.359)	(.332)	(.454)	
Soil water conservation † *Yes=1*			-.198 (.180)	-.240 (.201)	-.205 (.198)	-.126 (.185)	-.289 (.242)	.307 (.371)
Water logging on plot † *Yes=1*			-.205 (.230)	-.258 (.244)	-.123 (.244)	-.161 (.224)	-.469 (.319)	.002 (.377)
Log plotsize(acre)			-.443*** (.114)	-.460*** (.121)	-.446*** (.119)	-.337*** (.111)	-.396*** (.145)	-.247 (.201)
Irrigation † *Yes=1*				-.619 (.692)	-.640 (.688)	-.761 (.632)	-1.14 (.807)	.225 (1.19)
Use of pigeon pea improved seed † *Used improved=1*				.058 (.220)	-.021 (.220)	-.215 (.207)	.005 (.299)	-.436 (.314)
Hired oxen per acre (mk/acre)					.014** (.007)	.013** (.007)	.012 (.009)	
Total hired labour per acre(days/acre)					.0007 (.0004)	.0003 (.0004)	.0007 (.0006)	-.0008 (.0007)
Manure per acre (kg/acre)						.002*** (.0005)	.002 (.002)	.0014** (.0007)
Fertilizer per acre (kg/acre)						-.0005 (.0008)	-.001 (.0009)	.013 (.010)
Log (pigeon pea seed used per acre (kg/acre))						.394*** (.077)	.469*** (.112)	.394*** (.120)
R^2	0.0071	0.0539	0.3168	0.3279	0.3465	0.4566	0.49	0.57

MAIZE								
Gender † (female=1)	-.193*** (.060)	-.068 (.071)	-.156** (.076)	-.154** (.078)	-.156** (.078)	-.133* (.078)		
Age (years)		.00006 (.002)	.001 (.003)	.0005 (.003)	.000 (.002)	.0007 (.003)	.004 (.004)	-.002 (.003)
Education (years)		0.003 (.010)	.0004 (.011)	-.003 (.011)	-.005 (.011)	-.003 (.011)	.001 (.018)	-.006 (.014)
Months on the farm in the last 12 months		.030** (.012)	.030** (.014)	.029** (.014)	.030** (.014)	.032** (.014)	.040** (.021)	.009 (.020)
Responsibility in the community † *Yes=1*		.080 (.070)	.067 (.074)	.089 (.075)	.081 (.076)	.080 (.076)	-.048 (.127)	.169* (.096)
Marital status † *Married=1*		.348*** (.108)	.324*** (.106)	.330*** (.109)	.324*** (.109)	.325*** (.110)	.309** (.131)	.383 (.242)
Occupation † *Farming=1*		.049 (.216)	0.030 (.227)	.093 (.234)	.118 (.234)	.094 (.234)	-.215 (.488)	.295 (.269)
Distance to the nearest main market (km)			-.004 (.005)	-.008 (.006)	-.007 (.006)	-.008 (.006)	-.009 (.009)	-.004 (.007)
Number of months road to main market is passable			.007 (.009)	.006 (.009)	.007 (.009)	.007 (.009)	.013 (.015)	-.005 (.012)
Distance to farmer club's collection center (km)			.012 (.013)	.013 (.013)	.014 (.014)	.013 (.014)	.044** (.021)	-.013 (.019)
Distance to agricultural field officer (km)			.002 (.009)	.003 (.009)	.004 (.009)	.002 (.010)	.008 (.016)	-.012 (.013)
Plot ownership †			-.271**	-.247*	-.230*	-.220	-.366*	.092 (.205)

Owned=1			(.134)	(.137)	(.138)	(.137)	(.198)	
Soil water conservation † *Yes=1*			-.004 (.070)	.012 (.073)	.000 (.074)	.002 (.074)	-.008 (.112)	.022 (.105)
Water logging on plot † *Yes=1*			-.069 (.093)	-.093 (.097)	-.092 (.097)	-.090 (.10)	-.0008 (.151)	-.172 (.132)
Log (plotsize (acre))			-.270*** (.052)	-.281** (.055)	-.276*** (.055)	-.257*** (.055)	-.250*** (.081)	-.249 *** (.080)
Irrigation † *Yes=1*				.308 (.237)	.325 (.241)	.296 (.242)	-.121 (.430)	.437 (.301)
Use of maize improved seed † *Used improved=1*				.094 (.071)	.084 (.071)	.100 (.071)	.115 (.109)	-.014 (.101)
Hired oxen per acre(mk/acre)					-.000 (.000)	-.0001 (.0003)	-.0005 (.0005)	.0002 (.0004)
Total hired labour per acre(days/acre)					.0003* (.0001)	.0003* (.0002)	.0003 (.0004)	.0002 (.0002)
Manure per acre (kg/acre)						.0002 (.0001)	.0005 (.0003)	.00004 (.0002)
Fertilizer per acre(kg/acre)						.0002 (.0006)	.0001 (.0006)	.006** (.003)
Log (maize seed used per acre (kg/acre))						.077** (.036)	.077 (.054)	.084 (.051)
R^2	0.0107	0.0306	0.0974	0.1073	0.1126	0.1229	0.17	0.12

Table 4B: TANZANIA

Dependent variable: Log value of harvest per acre

	Variables								
		1	2	3	4	5	6	Female manager	Male manager
GROUNDNUT	**Gender** † (female=1)	.337 (.235)	.021 (.287)	-.183 (.253)	-.101 (.255)	.028 (.254)	.023 (.225)		
	Age (years)		-.021** (.010)	-.020** (.009)	-.019** (.009)	-.013 (.009)	-.006 (.008)	-.015 (.016)	-.013 (.010)
	Education (years)		.005 (.035)	.006 (.029)	.008 (.029)	.009 (.028)	.010 (.025)	-.012 (.066)	-.029 (.045)
	Marital status † *Married=1*		-.627 (.975)	.661 (.824)	.822 (.825)	.788 (.804)	1.19* (.713)	-.105 (.592)	
	Occupation † *Farming=1*		.775 (.800)	.572 (.697)	.612 (.696)	.643 (.677)	.060 (.605)	-1.058 (2.65)	-.419 (.660)
	Distance to the nearest main market (km)			.020** (.010)	.021** (.010)	.019** (.010)	.014 (.009)	.004 (.028)	.012 (.010)
	Number of months road to main market is passable			-.026 (.040)	-.015 (.040)	-.015 (.039)	-.017 (.034)	.046 (.066)	-.032 (.041)
	Distance to agricultural field officer (km)			-.023** (.011)	-.024** (.011)	-.020** (.010)	-.024** (.010)	-.014 (.016)	-.046*** (.014)
	Plot ownership † *Owned=1*			-.361 (.376)	-.380 (.374)	-.226 (.368)	-.195 (.325)	-.307 (.663)	-.059 (.390)
	Soil water conservation † *Yes=1*			-.133 (.183)	-.130 (.185)	-.106 (.180)	-.078 (.160)	-.321 9.307)	.061 (.186)
	Water logging on plot † *Yes=1*			-.057 (.416)	-.069 (.414)	.043 (.405)	-.120 (.359)	-.834 (1.22)	-.347 (.403)
	Log (groundnut plotsize (acre))			-.832*** (.110)	-.861*** (.111)	-.765 (.113)	-.349*** (.121)	-.502 (.284)	-.322** (.136)
	Irrigation † *Yes=1*				-1.47 (1.11)	-1.98** (1.13)	-1.57 (5.01)	574.05 (775.2)	
	Use of groundnut improved seed † *Used improved=1*				.254 (.226)	.342 (.221)	.318 (.195)	.316 (.357)	.196 (.224)
	Hired oxen used per acre for groundnut (tsh/acre)					.00001** (6.00e-06)	5.01e-06 (5.42e-06)	.0000233 (.00001)	1.41e-06 5.79e-06
	Total hired					.105**	.068	.581***	.017

	labour used per acre for groundnut(days /acre)					(.049)	(.044)	(.136)	(.048)
	Total manure used per acre for groundnut (kg/acre)						.00001 (.002)	-.290 (.388)	.0003 (.002)
	Log (groundnut seed used per acre (kg/acre))						.607*** (.099)	.044 (.195)	.726 (.113)
	R^2	0.013	0.053	0.408	0.430	0.470	0.593	0.8823	0.6314
PIGEON PEA	**Gender** *†* (female=1)	-.147** (.080)	-.098 (.092)	-.111 (.092)	-.116 (.092)	-.110 (.092)	-.117 (.084)		
	Age (years)		-.002 (.003)	.003 (.003)	.002 (.003)	.003 (.003)	.001 (.003)	.0010 (.006)	.002 (.003)
	Education (years)		.012 (.011)	.018 (.012)	.016 (.012)	.014 (.012)	.009 (.011)	.008 (.017)	.009 (.015)
	Marital status *†* *Married=1*		.271 (.231)	.541** (.226)	.514** (.226)	.521** (.226)	.500** (.213)	.413** (.208)	1.23 (.680)
	Occupation *†* *Farming=1*		-.143 (.226)	-.132 (.215)	-.138 (.221)	-.084 (.222)	-.085 (.204)	.188 (.394)	-.185 (.247)
	Distance to the nearest main market (km)			.004 (.003)	.004 (.003)	.004 (.003)	.003 (.004)	.007 (.008)	.0012 (.004)
	Number of months road to main market is passable			-.010 (.012)	-.013 (.012)	-.013 (.012)	-.012 (.011)	.002 (.026)	-.016 (.013)
	Distance to agricultural field officer (km)			-.008** (.004)	-.006* (.004)	-.006* (.004)	-.006* (.003)	-.015** (.006)	-.003 (.004)
	Plot ownership *†* *Owned=1*			-.360*** (.111)	-.348*** (.111)	-.331*** (.111)	-.261** (.102)	-.380** 9.196)	-.247** (.119)
	Soil water conservation *†* *Yes=1*			.157** (.068)	.159** (.068)	.160** (.068)	.083 (.063)	-.071 (.130)	.102 (.073)
	Water logging on plot *†* *Yes=1*			.225 (.202)	.207 (.202)	.223 (.201)	-.022 (.188)	.584 (.385)	-.123 (.215)
	Log (pigeon pea plotsize (acre))			-.372*** (.043)	-.369*** (.044)	-.356*** (.044)	-.174*** (.043)	-.142* (.084)	-.201*** (.051)
	Irrigation *†* *Yes=1*				.148 (.321)	.106 (.321)	.195 (.294)	-.122 (.445)	.220 (.390)

	Use of pigeon pea improved seed † *Used improved=1*				.145** (.070)	.152** (.070)	.118** (.065)	.173 (.134)	.090 (.075)
	Hired oxen used per acre for pigeon pea (tsh/acre)					5.90e-06 ** (2.55e-06)	5.05e-06 ** (2.34e-06)	1.63e-06 (5.43e-06)	4.38e-06 2.70e-06
	Total hired labour used per acre for pigeon pea (days/acre)					-.00007 (.00008)	-.00005 (.00008)	.084** (.038)	-.00005 (.00008)
	Total manure used per acre for pigeon pea (kg/acre)						-.001*** (.0005)	-.0009 (.0009)	-.002*** (.0006)
	Total fertilizer used per acre for pigeon pea (kg/acre)						-.007 (.055)	-.220 (.438)	.006 (.058)
	Log of pigeon pea seed used per acre(kg/acre)						.530*** (.049)	.513*** (.088)	.543*** (.058)
	R^2	0.004	0.010	0.120	0.1248	0.132	0.278	0.429	0.2651
MAIZE	**Gender** † (female=1)	-.190** (.076)	-.140 (.088)	-.160* (.087)	-.126 (.083)	-.120 (.083)	-.123 (.081)		
	Age (years)		-.0007 (.003)	.001 (.003)	.002 (.003)	.002 (.003)	.001 (.003)	.008 (.006)	.001 (.003)
	Education (years)		.024** (.010)	.028*** (.011)	.030*** (.011)	.026** (.010)	.021** (.010)	.017 (.017)	.038*** (.014)
	Marital status † *Married=1*		.530** (.214)	.578*** (.203)	.725*** (.223)	.612** * (.202)	.532*** (.200)	.688*** (.214)	.031 (.523)
	Occupation † *Farming=1*		-.117 (.191)	-.034 (.186)	-.019 (.181)	.041 (.181)	-.0001 (.178)	.190 (.373)	-.093 (.210)
	Distance to the nearest main market (km)			-.005* (.003)	-.005* (.003)	-.006** (.003)	-.006** (.003)	-.006 (.009)	-.007** (.003)
	Number of months road to main market is passable			-.007 (.011)	-.010 (.011)	-.010 (.011)	-.006 (.011)	-.023 (.022)	-.002 (.012)
	Distance to agricultural field officer (km)			.003 (.003)	.007** (.003)	.006* (.003)	.003 (.003)	.010 (.006)	.0006 (.004)
	Plot ownership			-.339***	-.295***	-	-.248**	-.278	-.214**

	† *Owned=1*			(.102)	(.100)	.275*** (.100)	(.098)	(.210)	(.110)
	Soil water conservation † *Yes=1*			.143** (.064)	.107* (.063)	.107* (.062)	.076 (.062)	-.014 (.139)	.112 (.070)
	Water logging on plot † *Yes=1*			-.037 (.195)	.002 (.193)	.017 (.191)	.029 (.188)	-.606 (.407)	.167 (.213)
	Log (maize plotsize(acre))			-.220*** (.035)	-.216*** (.034)	-.210*** (.034)	-.152*** (.035)	-.202*** (.069)	-.122*** (.042)
	Irrigation † *Yes=1*				-.345** (.175)	-.347** (.174)	-.282 (.171)	.086 .348	-.350* (.198)
	Use of maize improved seed † *Used improved=1*				.401*** (.065)	.375*** (.064)	.436*** (.065)	.673*** (.138)	.359*** (.074)
	Hired oxen used per acre for maize(tsh/acre)					7.65e-06 *** (2.11e-06)	6.75e-06 *** (2.08e-06)	7.59e-06* (4.17e-06)	6.44e-06** (2.50e-06)
	Total hired labour used per acre for maize(days/acre)					-.0001 (.00007)	-.00009 (.00007)	.062* (.038)	(-.00008) (.00007)
	Total manure used per acre for maize (kg/acre)						-.0002 (.0002)	-.001 (.001)	-.0002 (.0002)
	Total fertilizer used per acre for mazie (kg/acre)						.008 (.007)		.007 (.007)
	Log of maize seed used per acre(kg/acre)						.293*** (.060)	.248* (.150)	.290*** (.067)
R^2	***R^2***	0.0089	0.0359	0.1071	0.1710	0.1835	0.2087	0.3773	0.1859

Standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1. *†=dummy variable*

4. OAXACA DECOMPOSITION OF GENDER DIFFERENTIAL IN AGRICULTURAL PRODUCTIVITY

The panel analysis done identifies variables that have an effect on productivity but does not help us understand how these factors contribute to differences in productivity amongst male and female managers. Doing a decomposition analysis helps isolate the relative quantitative importance of explanatory variables in explaining the gender gap (*Fortin et al*,2011, *Goldstein et al,* 2015). Following previous studies (*Kilic et al*,2013, Oseni et al, 2013, *Goldstein et al,2015*), Oaxaca-Blinder decomposition method will be used in the decomposition analysis.

Given that the expected yield per acre is:

$$E(yg) = \alpha g + E(Xg)'\beta g \qquad (2)$$

Where g is the gender of the plot manager (m) or (f), X is a vector of all explanatory variables, α is the intercept and β is the vector of intercepts and slope coefficients, the gender gap G expressed as the mean outcome difference will be:

$$G = E(ym) - E(yf) \qquad (3)$$

Where $E(eg) = 0$ by assumption, $G = \alpha m + E(Xm)'\beta m - \alpha f - E(Xf)'\beta f$ (4)

this difference can be categorized in two parts by including non-discriminatory coefficients which will be used to determine the contribution of the differences in predictors (Jann,2008). This results in a "two-fold" decomposition:

$$G = Q + U \qquad (5)$$

Where Q is the part which accounts for differences in endowment of explanatory variables (evaluated at the mean of the estimated coefficients for the male and female samples) (Goldstein et al, 2015) and is referred to as the "explained" or "endowment" effect. It is estimated as:

$$Q = [E(Xm)' - E(Xf)']\,\beta \qquad (6)$$

And U which is referred to as the "unexplained" or "structural" effect reflects differences in returns to endowment for female and male farmers. It is estimated as:

$$U = (\alpha m - \alpha) + [E(Xm)'\,(\beta m - \beta^*)] + (\alpha - \alpha f) + [E(Xf)'(\beta^* - \beta f)] \qquad (7)$$

This equation can be further divided into two parts. One part which estimates the structural advantage (discrimination in favor) of one group:

$$Um = (\alpha m - \alpha) + [E(Xm)' (\beta m - \beta^*)] \quad (8)$$

And another part which estimates the structural disadvantage (discrimination against) the other group:

$$Uf = (\alpha - \alpha f) + [E(Xf)' (\beta^* - \beta f)] \quad (9)$$

(*Oseni et al*, 2013, Jann, 2008)

The aggregate contribution of endowments (equation 6) is equal to the difference between the raw productivity gap and the remaining gap once all characteristics in the decomposition are accounted for. This term can be interpreted as the change in the value of output that would occur if female plot managers had the same values of X as male plot managers. The aggregate unexplained contribution (equation 7) is equal to the remaining gap once all characteristics in the decomposition are accounted for (Bowen et al,2015). The sum of these terms can be interpreted as the change in female value of output that would occur if men and women had the same returns to the coefficient vector X. Decomposition results should not be interpreted as causal effect but can show how each variable contributes to the gender gap.

Explained and endowment effect will be used interchangeably from here as they mean the same thing. Structural and unexplained effect will also be used interchangeably for the same reason.

DECOMPOSING GENDER DIFFERENTIALS
GROUNDNUT

Malawi: the result shows that male farmers are 28% more productive than female farmers, 21.3% of this difference is accounted for by the endowment effect which is statistically significant and explains 76% of the mean gender differential while 6.7% of this difference is the structural /unexplained (portion due to differences in returns) effect. Gender disparity is driven more by the endowment than the structural effect.

In the detailed decomposition we see how much each factor contributes to or reduces the disparity. Positive coefficient widens the gap while negative coefficient reduces the gap. For the explained gender gap which accounts for most of the disparity, the factors which contribute significantly to widening it are age, responsibility in the community and marital status. The summary statistics (table 1A) for Malawi shows that female farmers tend to be older than male farmers and the panel analysis (table 4A) shows that age makes significant positive contribution to male productivity. For marital status, table 1A indicates that male farmers are more likely to be married and female farmers are 86% more likely to be widows, this could have a relationship with age as widows then to be older and from the panel analysis, we observe that being married makes significant positive contribution to male productivity. Although having a responsibility in contributes higher returns to female productivity (table 4A), we observe from table 1A that female farmers are 49% less likely to have responsibility in the community.

Only months spent on the farm in the last 12 months reduces the gender gap significantly and table 1A indicates that male and female farmers spent about the same amount on months on the farm (12) while table 4A indicates that factor contributes about the same returns to productivity for male and female farmers.

Moving on to the unexplained part of the gender gap, we still see age and marital status significantly widening the gender gap. Other factors which widen the gender gap are plot ownership, fertilizer used and occupation. Table 2A shows that male farmers use 11% more fertilizer/acre and 40% more fertilizer overall than female farmers and this makes significant contribution to male productivity (table 4A). Distance to agricultural field officer reduces the unexplained gap.

Tanzania: the decomposition result shows that women are 22.5% more productive than male groundnut farmers but this gap is not significant. From the aggregate decomposition, 20.9% of this difference can be accounted for by the endowment effect which explains 93% of the gender differential 1.6% (7%) of the difference is the structural (unexplained effect).

From the detailed decomposition, there are no factors which make positive significant contribution to the endowment effect but the factors which reduce this gap significantly are plot size (18%) and seed used (26%). The summary statistics (table 2B) show that female

farmers use more seeds/acre (32% more) than male farmers but this difference is not significant. Also though insignificant, returns to seed input is higher for male than female farmers perhaps this is why seed input contributes highest in reducing the endowment effect. Like in most cases, female farmers manage smaller plots than male farmers and this difference is significant (table 3B), but the returns to this is significantly negative for male farmers as compared to female farmers (table 4B).
For the unexplained part, marital status reduces the gap for male farmers and widens the gap for female farmers significantly. Other factors which reduce the gap significantly are occupation, distance to agricultural field officer, hired oxen and hired labour. The major factor which widens the gap is seed used.

PIGEON PEA

Malawi: the result shows that male farmers are 29% more productive than female farmers but this gap is not statistically significant. 21.6% (not statistically significant) of this difference is accounted for by the endowment effect which explains 74% of the mean gender differential while 7.5% of this difference is the structural (unexplained) effect.
The detailed decomposition indicates that the only factor which widens the explained gender gap is responsibility in the community and there are no statistically significant factors that reduce the gap.
For the unexplained gender gap, education, marital status, distance to the nearest main market and plot ownership has significantly positive effects on it's increase. Table 1A indicates that female farmers are 27% less educated than male farmers. Factors that decrease the gap significantly are age and distance to agricultural field officer. Table 4A shows that even though not significant, both factors have a negative effect on the productivity of male pigeon pea farmers in Malawi with distance to agricultural field officer having a significant positive effect on female productivity.

Tanzania: the decomposition result shows that male farmers are 8.4% more productive than female pigeon pea farmers. From the aggregate decomposition, 0.3% of this difference can be accounted for by the endowment effect which explains 4% of the gender differential 8.1% (96%) of the difference is the structural (unexplained effect). A large portion of the gap here is due to the structural than the endowment effect.

For the detailed decomposition, marital status is the only factor that widens the gap in endowment effect significantly, although being married has a significant positive effect on female productivity (table 4B), only 68% of female farmers in Tanzania are married compared to 98% of the male farmers (table 1B). This perhaps explains why marital status widens the endowment gap significantly. The only factor which reduces the endowment effect significantly is plot size. Table 3A shows that although male farmers have significantly larger plots than female farmers, this does not have positive effect on their productivity as can be seen from table 4B. Plot size has negative effect on male and female productivity but this effect is more and highly significant (at 1%) for male managed plots.

For the unexplained effect which is responsible for the bulk of the gap, marital status is the only factor which widens the gap significantly. Distance to the nearest market and hired labour used are the only factors which reduce this gap significantly.

MALAWI

groundnut

A. *Mean Gender differential*			
Mean male-managed plot agricultural productivity 4.78*** (.087)			
Mean female-managed plot agricultural productivity 4.50*** (.114)			
Mean gender differential in agricultural productivity 0.280** (.143)			
B. Aggregate Decomposition	*Endowment effect*	*Male structural advantage*	*Female structural disadvantage*
Total	.213** (.111)	.027 (.043)	.041 (.060)
Share of gender differential	76%	10%	14%
C. Detailed decomposition			
Age	.037* (.021)	.150 (.153)	.382* (.212)
Education (years)	.0378 (.025)	.0019 (.060)	.056 (.084)
Months on the farm in the last 12 months	-.066** (.031)	-.097 (.218)	.116 (.333)
Responsibility in the community	.086*** (.031)	-.024 (.036)	-.022 (.038)
Marital status	.050* (.029)	.795*** (.261)	.063 (.109)
Occupation	-.0013 (.0051)	.375** (.198)	.964** (.424)
Distance to the nearest main market (km)	.0066 (.011)	-.067 (.063)	.017 (.100)
Number of months road to main market is passable	.007 (.010)	-.055 (.098)	-.008 (.192)
Distance to farmer club's collection centre (km)	.00025 (.0018)	-.030 (.025)	.019 (.022)
Distance to agricultural field officer (km)	.00014 (.0022)	-.118 (.077)	-.203** (.093)
Plot ownership	.00069 (.00357)	.382* (.219)	.177 (.291)
Soilwater conservation	-.0047 (.0102)	-.160* (.089)	-.151 (.115)
Water logging on plot	-.0034 (.0104)	-.011 (.016)	-.018 (.018)
Log (plotsize (acre))	-.027 (.037)	.134 (.156)	.158 (.15)
Irrigation	.0016 (.005)	-.009 (.007)	-.009 (.008)
Use of groundnut improved seed	.0111 (.016)	-.025 (.063)	.109 (.097)
Hired oxen per acre (mk/acre)	.009 (.013)	.006 (.010)	-.0028 (.005)
Total hired labour per acre (days/acre)	.007	-.004	-.020

	(.007)	(.005)	(.022)
Manure per acre(kg/acre)	.003 (.005)	-.002 (.007)	.0063 (.012)
Fertilizer per acre(kg/acre)	.006 (.007)	.159 *** (.051)	.0098 (.010)
Log (groundnut seed used per acre (kg/acre))	.051 (.064)	-.132 (.143)	-.117 (.262)

Pigeon pea

A. *Mean Gender differential*			
Mean male-managed plot agricultural productivity	4.21*** (.146)		
Mean female-managed plot agricultural productivity	3.914*** (.118)		
Mean gender differential in agricultural productivity	.291 (.187)		
B. Aggregate Decomposition	*Endowment effect*	*Male structural advantage*	*Female structural disadvantage*
Total	.216 (.152)	.044 (.085)	.030 (.056)
Share of gender differential	74%	15%	11%
C. Detailed decomposition			
Age (years)	.043 (.032)	-.664** (.294)	-.015 (.244)
Education (years)	.0036 (.029)	.015 (.145)	.251* (.137)
Months on the farm in the last 12 months	-.032 (.046)	-.466 (.376)	-.243 (.254)
Responsibility in the community	.062* (.035)	.011 (.065)	-.025 .032
Marital status	.035 (.045)	1.33*** (.325)	-.039 (.094)
Occupation	-.0022 (.020)	.392 (.275)	-.185 (.433)
Distance to the nearest main market (km)	.065* (.038)	.216* (.115)	.169 (.103)
Number of months road to main market is passable	-.023 (.023)	-.138 (.232)	-.434 (.279)
Distance to farmer club's collection center (km)	.037 (.042)	-.011 (.013)	-.004 (.021)
Distance to agricultural field officer (km)	.022 (.024)	-.141 (.114)	-.332** (.132)
Plot ownership	-.0042 (.009)	.739** (.355)	.083 (.230)
Soil water conservation	-.015 (.022)	.369 (.249)	.119 (.107)
Water logging on plot	-.008 (.014)	.035 (.047)	.032 (.032)

Log plotsize(acre)	-.055 (.038)	.164 (.266)	.074 (.134)
Irrigation	.003 (.013)	.012 (.014)	.006 (.009)
Use of pigeon pea improved seed	.014 (.017)	-.196 (.185)	-.167 (.189)
Hired oxen per acre (mk/acre)	-.018 (.018)		.0012 (.007)
Total hired labour per acre(days/acre)	.001 (.005)	-.033 (.026)	-.014 (.015)
Manure per acre (kg/acre)	.021 (.035)	-.012 (.016)	-.006 (.023)
Fertilizer per acre (kg/acre)	.006 (.007)	.113 (.071)	.012 (.010)
Log (pigeon pea seed used per acre (kg/acre))	.061 (.062)	-.006 (.182)	-.103 (.128)

Maize

A. *Mean Gender differential*			
Mean male-managed plot agricultural productivity	6.00*** (.046)		
Mean female-managed plot agricultural productivity	5.81*** (.053)		
Mean gender differential in agricultural productivity	.194*** (.070)		
B. Aggregate Decomposition	*Endowment effect*	*Male structural advantage*	*Female structural disadvantage*
Total	.093** (.043)	.048 (.029)	.053* (.031)
Share of gender differential	48%	25%	27%
C. Detailed decomposition			
Age (years)	.0095 (.011)	-.168* (.093)	-.083 (.114)
Education (years)	.006 (.015)	-.047 (.054)	.005 (.064)
Months on the farm in the last 12 months	-.013 (.009)	-.209 (.163)	-.093 (.157)
Responsibility in the community	.014 (.013)	.027 (.028)	.028 (.024)
Marital status	.066*** (.021)	.031 (.166)	.058 (.053)
Occupation	-.0004 (.006)	.243* (.141)	.240 (.413)
Distance to the nearest main market (km)	-.006 (.008)	.027 (.047)	.025 (.059)
Number of months road to main market is passable	-.002 (.005)	-.089 (.078)	-.071 (.105)

Distance to farmer club's collection center (km)	.009 (.009)	-.038** (.019)	-.022 (.014)
Distance to agricultural field officer (km)	.0004 (.002)	-.066 (.046)	-.018 (.057)
Plot ownership	-.005 (.005)	.274** (.130)	.141 (.104)
Soil water conservation	.002 (.011)	.0007 (.056)	.0094 (.048)
Water logging on plot	-.0004 (.002)	-.013 (.014)	-.014 (.015)
Log plotsize(acre)	-.021 (.015)	.016 (.082)	-.002 (.076)
Irrigation	.003 (.004)	.004 (.005)	.006 (.006)
Use of maize pea improved seed	.007 (.007)	-.067 (.047)	-.013 (.040)
Hired oxen per acre (mk/acre)	-.001 (.002)	.0053 (.005)	.0030 (.0030)
Total hired labour per acre(days/acre)	.006 (.005)	-.005 (.003)	-.0006 (.003)
Manure per acre (kg/acre)	.006 (.005)	-.008* (.005)	-.007 (.008)
Fertilizer per acre (kg/acre)	-.0012 .002	.082 .053	.0012 .004
Log (pigeon pea seed used per acre (kg/acre))	.015 (.010)	-.013 (.108)	.016 (.099)

Standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1.

TANZANIA

groundnut

A. *Mean Gender differential*			
Mean male-managed plot agricultural productivity	4.66***		
	(.131)		
Mean female-managed plot agricultural productivity	4.89***		
	(.172)		
Mean gender differential in agricultural productivity	-.225		
	(.217)		
B. Aggregate Decomposition	*Endowment effect*	*Male structural disadvantage*	*female structural advantage*
Total	-.209	-.003	-.013
	(.207)	(.038)	(.152)
Share of gender differential	93%	1%	6%
C. Detailed decomposition			
Age (years)	-.043	-.324	.344
	(.044)	(.289)	(.513)
Education (years)	-.018	-.227	.168
	(.036)	(.197)	(.307)
Marital status	.081	-1.17***	1.19***
	(.063)	(.416)	(.401)
Occupation	.0005	-.467*	1.08
	(.004)	(.271)	(1.34)
Distance to the nearest main market (km)	.024	-.017	.055
	(.020)	(.018)	(.102)
Number of months road to main market is passable	-.006	-.165	-.724
	(.015)	(.261)	(.608)
Distance to agricultural field officer (km)	.103	-.152**	-.118
	(.075)	(.062)	(.153)
Plot ownership	.0001	.126	.105
	(.010)	(.141)	(350)
Soil water conservation	.006	.066*	.135
	(.014)	(.040)	(.133)
Water logging on plot	-.002	-.012	.025
	(.008)	(.009)	(.037)
Log plotsize(acre)	-.183**	026	.055
	(.082)	(.044)	(.071)
Irrigation	.052		-19.847
	(.059)		(26.865)
Use of groundnut improved seed	.011	-.025	.0002
	.026	(.022)	(.044)
Hired oxen used per acre for groundnut (tsh/acre)	-.004	-.023	-.129*
	(.013)	(.014)	(.071)
Total hired labour used per acre for groundnut(days/acre)	.036	-.073**	-.484***
	(.030)	(.033)	(.183)
Total manure used per acre for groundnut (kg/acre)	.0003	.0014	20.05
	(.023)	(.0017)	(27.0)
Log (groundnut seed used per acre (kg/acre))	-.266**	.195**	1.185***
	(.130)	(.076)	(.378)

Pigeon Pea

A. *Mean Gender differential*			
Mean male-managed plot agricultural productivity 5.068*** (.041)			
Mean female-managed plot agricultural productivity 4.983*** (.073)			
Mean gender differential in agricultural productivity .084 (.084)			
B. Aggregate Decomposition	*Endowment effect*	*Male structural advantage*	*Female structural disadvantage*
Total	.003 (.056)	.017 (.014)	.064 (.053)
Share of gender differential	4%	20%	76%
C. Detailed decomposition			
Age (years)	.009 (.012)	.031 (.070)	.068 (.246)
Education (years)	.0009 (.005)	.008 (.052)	-.002 (.10)
Marital status	.055** (.027)	.642** (.328)	.154 (.107)
Occupation	-.001 (.003)	-.128 (.121)	-.369 (.349)
Distance to the nearest main market (km)	.004 (.008)	-.028** (.011)	-.052 (.045)
Number of months road to main market is passable	-.002 (.003)	-.050 (.056)	-.089 (.237)
Distance to agricultural field officer (km)	.013 (.009)	.028 (.019)	.076 (.052)
Plot ownership	.0002 (.007)	.023 (.043)	.152 (.148)
Soil water conservation	.015 (.010)	.010 (.015)	.048 (.045)
Water logging on plot	-.00001 (.0010)	-.003 (.002)	-.012 (.011)
Log (pigeon pea plotsize (acre))	-.042** (.017)	-.027 (.034)	-.025 (.10)
Irrigation	-.002 (.002)	-.0002 (.0008)	.003 .004
Use of pigeon pea improved seed	.002 (.006)	-.014 (.014)	-.029 (.048)
Hired oxen used per acre for pigeon pea (tsh/acre)	-.002 (.006)	-.003 (.011)	.035 (.048)
Total hired labour used per acre for pigeon pea (days/acre)	-.001 (.001)	.0003 9.0003)	-.107** (.055)
Total manure used per acre for pigeon pea (kg/acre)	.005 (.009)	-.002 (.001)	-.009 (.009)
Total fertilizer used per acre for pigeon pea (kg/acre)	.0005 (.0009)	.0008 (.0008)	.003 (.003)
Log (pigeon pea seed used per acre (kg/acre))	-.050 (.038)	.017 (.045)	-.016 (.134)

Maize

A. *Mean Gender differential*			
Mean male-managed plot agricultural productivity	6.12***		
	(.037)		
Mean female-managed plot agricultural productivity	5.98***		
	(.072)		
Mean gender differential in agricultural productivity	.145*		
	(.081)		
B. Aggregate Decomposition	*Endowment effect*	*Male structural advantage*	*Female structural disadvantage*
Total	.046	.021	.077
	(.045)	(.015)	(.055)
Share of gender differential	32%	15%	53%
C. Detailed decomposition			
Age (years)	.010	-.026	-.233
	(.012)	(.067)	(.223)
Education (years)	-.004	.010	.063
	(.011)	(.065)	(.082)
Marital status	.060**	-.526	-.063
	(.024)	(.417)	(.120)
Occupation	-.00002	-.098	-.185
	(.0012)	(.069)	(.268)
Distance to the nearest main market (km)	-.013	-.006	.006
	(.008)	(.013)	(.071)
Number of months road to main market is passable	-.0005	.047	.206
	(.002)	(.086)	(.191)
Distance to agricultural field officer (km)	-.011	-.018	-.055
	(.009)	(.018)	(.054)
Plot ownership	.003	.038	.030
	(.007)	(.043)	(.179)
Soil water conservation	.015	.017	.043
	(.009)	(.014)	(.043)
Water logging on plot	-.00002	.003	.016
	(.0003)	(.002)	(.010)
Log (maize plotsize (acre))	-.029**	.036	.062
	(.015)	(.030)	(.073)
Irrigation	.003	-.004	-.015
	(.006)	(.003)	(.013)
Use of maize improved seed	.023	-.037*	-.086
	(.023)	(.021)	(.070)
Hired oxen used per acre for maize (tsh/acre)	-.002	-.008	-.016
	(.008)	(.012)	(.033)
Total hired labour used per acre for maize (days/acre)	-.0023	.0003	-.087
	(.0016)	(.0003)	(.057)
Total manure used per acre for maize (kg/acre)	.0002	.0005	.010
	(.0011)	(.0006)	(.012)
Total fertilizer used per acre for maize (kg/acre)	.0018	-.0003	
	(.0016)	(.0003)	
Log (maize seed used per acre (kg/acre))	-.0083	-.0057	.075
	(.013)1	(.059)	(.296)

Standard errors in parentheses. ***p<0.01, **p<0.05, *p<0.1

DISCUSSION

MALAWI: for both crops, the endowment effect is responsible for a large chunk of the productivity difference between male and female farmers. This implies that disparities in access to resources and asset ownership are responsibility for most of the gap. If women had access to the same quantity of resources as men, this gap would reduce greatly (76% for groundnut and 74%) for pigeon pea.

For groundnut, the gap is significant but for pigeon pea it is not. In both cases, responsibility in the community widens the gap between male and female farmers and male farmers in Malawi are 51% more likely to have responsibility in their communities. This can be referred to as a social capital effect as people who hold positions in their communities have a higher social capital than those who don't and men are more likely to be involved and take up these responsibilities. Women may be more restricted in taking up community responsibilities as they are also majorly responsible for their homes and carrying out household chores. Encouraging women to participate and involving them in community activities will enhance their social capital, hence reducing the productivity gap amongst male and female farmers.

Age is another factor which significantly widens the gap especially amongst groundnut farmers. This could be because younger farmers are more willing to take risks, try new planting strategies or use improved seeds. Older farmers are more risk averse and female farmers are older on the average than male farmers. Younger females should be encouraged to get involved in agriculture so as to bridge this gap.

TANZANIA: Unlike Malawi, both explained and unexplained effects have a large role to play in reducing the gender gap. Female groundnut farmers (although not significant) are more productive than male groundnut farmers and the endowment effect explains most of this gap. Male farmers manage larger plots than female farmers. This explains why plot size has a significant effect on reducing this gap.

As for pigeon pea, male farmers are more productive than female farmers but only slightly (8%) and this gap is not significant. Most of this gap is accounted for by the structural effect. Hired labour input reduces the gap as female farmers have significantly positive returns to labour and male farmers have negative returns to labour (not significant) even though male farmers use significantly more hired labour input than female farmers.

Marital status significantly widens the unexplained gap for both groundnut and pigeon pea farmers. This may be because married people have better access to resources and asset ownership and this finding should be further investigated

In contrast to Malawi where female farmers are older, female farmers in Tanzania are 3 years younger on average than male farmers and age does not widen the productivity gap.

5. CONCLUSION

In this report, we study the productivity differences amongst male and female groundnut and pigeon pea farmers in Tanzania and Malawi as part of ICRISAT's tropical legume project. This report aims at tackling one of the objectives of the project which is "*leveraging gender and learning to minimize poverty and food security impacts for small holder household farmers in Sub-Sahara Africa and South Asia".* A summary statistics was done to have a general idea of data and the statistics show that in all cases, male farmers manage bigger plots than female farmers. A panel analysis was also done to find out which factors have the most effect on productivity and finally a decomposition analysis was done to quantify the extent to which various factors contribute to the gender productivity gap.

The result shows that for the gender gap productivity gap between male and female groundnut and pigeon pea farmers in Malawi is 28% and 29% respectively. Disparities in endowment effect accounts for most of this gap and the gap would be reduced by 76% (for groundnut) and 74% (for pigeon pea) if female farmers had equal asset to resources as their male counterparts. (Kilic et al, 2013) found that female managed plots are 25% less productive than male managed plots in Malawi (similar to this study) with 82% of this gap accounted for by endowment effect, which is a bit higher than the result from this study.

Tanzania on the other hand tells a different and more positive story as female groundnut farmers are more productive than male groundnut farmers and the gap is a lot less for pigeon pea farmers (8%) as compared to Malawi. A large proportion of this gap (pigeon pea) is accounted for by the unexplained/ structural effect (96%). This is in contrast with the study by (Mukasa and Salami 2015) who find that female managed plots are 27% less productive than male managed plots in Tanzania.

The varying results obtained from both countries show that policies should be country specific to target the different issues that persist in both countries. For Malawi policies that encourage increased access to resources such as more inclusive property rights for women, promoting time and labor-saving sustainable technologies for household chores so that women can take up responsibilities in their communities would help reduce the gap. For Tanzania, exploring further the reasons for different returns to women should be done as providing more access to resources would not close the gap.

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