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Gender Divide in Irish Potato Production among Farming Households in Uasin-Gishu County, Kenya

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Abstract
Women contribute substantively to the agricultural sector and support food security. However, gender-based differences in terms of control and access to financial and productive resources inhibit their sustainability, resilience, and agricultural productivity. This study investigates the gender-based productivity differences in Irish potato production in Uasin-Gishu County, Kenya, and identifies the factors driving this disparity. This study adopted a cross-sectional field survey and simple random sampling to collect quantitative data from 256 respondents (67 female and 189 male farmers). The Oaxaca-Blinder decomposition model decomposed the gap into the endowment (differences in resource endowments) and structural (differences in return to the endowment factors) effects. Our study finds a production gap of 11% favoring male farmers, with a structural effect (53 %) larger than the endowment effect (33%). This study confirms that a notable number of factors, including land, education, climate-smart technologies, and fertilizer, cause the gap. Therefore, these factors represent the potential intervention areas in any attempt to reduce the gender gap. Policymakers should devise interventions through a gender lens against using a one-fits-all intervention to uplift female farmers from their low productivity traps.
Keywords: Oaxaca-Blinder, Female, male, agricultural, farmers, gap
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1. Introduction

Africa's regional and local economies identify agriculture as an important driver for growth; the sector supports food security and employs a large part of the population. Agricultural activities support the livelihoods of 86% of people who live in the rural areas and offer food to people in urban and peri-urban areas of Africa (Kiriti & Tisdell, 2003). Several distinct features characterize Africa's agricultural sector. First, it is mainly comprised of small-scale farmers. Second, it is the primary source of income for women. Third, women display lower productivity than men (Kilic et al., 2013). The stagnant and sometimes slow economic growth of most nations in Sub-Saharan Africa poses a major development problem. Gender disparities, inexistent or ineffective policies for market functioning, social conflict, and the impact of climate change are among the many cited issues that contribute to lacking or sluggish development (Van Oort & Zwart, 2018; Norton et al., 2021). Africa's agricultural sector is currently characterized by increased research outputs, access to credit facilities, and technology (Bachewe et al., 2018). In the face of this progress in the agricultural sector, gender is also a significant determinant that plays a vital role in the productivity, allocation of resources, and decision-making of farming households. In all societies, gender affects resources and power for females and males (Othman et al., 2017).

The effect of gender on power in the agricultural sector is evidenced where women account for between 40% to 65% of the time spent producing and processing agricultural products (Sabo, 2006). The effect of gender on resources is also evident in the ability of male farmers to obtain more credit, use advanced technologies, and access agricultural extension services compared to female-managed farms (Thapa, 2008). Over 70% of women are involved in agricultural activities such as livestock rearing and cultivating commercial or subsistence crops (Kiriti & Tisdell, 2003). Despite their leading role in agriculture, female farmers display lower agricultural productivity levels than their male counterparts (Osuafor & Anarah, 2015). Gender division in agricultural activities exists in most Sub-Saharan African locations and is based on tasks, crops, or both (McPeak & Doss, 2006). Males dominate export and commercial crops because men are the primary breadwinners of most families, while women cultivate subsistence crops (Njuki et al., 2011). These arguments indicate that gender can be a complex feature in agriculture and relies on the prevailing socio-cultural setting. The dynamic nature of gender relations indicates that these relations can change to respond to innovation and commercialization (Ibnouf 2011; Sorensen 1996) activities that may affect productivity.

In Kenya, food insecurity and poverty are significant challenges to economic development. Inequalities in access to resources and climate change are worsening the condition. These factors affect the productivity of staple crops such as Irish potatoes, which are essential for food security (Government of Kenya, 2016). Irish potato is among the leading food crops produced in Kenya and is ranked fourth after wheat, maize, and rice around the globe (Alam et al., 2012). In Uasin-Gishu County, 30% to 60% of the population is engaged in potato farming (Government of Kenya, 2017). Regardless of this potential, Irish potato farmers in Kenya experience challenges such as changes in climate, poor quality of seeds, inadequate funding, fertilizer, labor, land, and infestation of pests and diseases, which affect productivity (Karanja et al., 2014).

In 2021, Kenya's gender gap index score increased to 0.69, denoting that males were more likely to have better opportunities than females (Jattani & Okadia, 2021). Nonetheless, the literature review displays the relative neglect of gender issues in research on agriculture and Irish potato farming in Uasin-Gishu and Kenya. Most studies theorized gender based on the socially constructed roles and positions of women and men (Thapa, 2008; Kiriti & Tisdell, 2003; Othman et al., 2017; Sabo, 2006). These notwithstanding, most studies on Irish potato farming in Kenya have concentrated on production interventions, technical efficiency, and constraints without addressing gender issues in depth (Daniel et al., 2010; Muthoni et al., 2013; Nyagaka et al., 2009). Against this background, this study examines the gender inequality in Irish potato productivity among farming households in Uasin-Gishu County, Kenya.

This study contributes to the gender gap literature by introducing the gender dimension, which is critical in enhancing productivity in the country. The current study focuses on potato production-gender and includes the climate change-gender nexuses. Regarding the empirical approach, this study goes beyond investigating factors that explain the production differences between female and male farmers and offers estimations of how the factors contribute to the production gap using the Oaxaca-Blinder decomposition model.

2. Theoretical Framework

Two theories will help guide this study. The first is the human capital theory, which proposes that gender gaps are elucidated by differences in human capital endowments such as work experience and education (Said & El-Hamidi, 2008). The human capital theory is widely used in the neoclassical field. It is founded on the assumption of human capital heterogeneity in labour supply, where the workers' qualification level determines their productivity and is the main determinant of wage level. Men with more political and professional knowledge find it easier to make independent decisions than women. Therefore, this influences their wages, motivation, and competence. Mincer & Polachek (1974) initially used the human capital theory to explain wage differentials between women and men and maintained that differences in individual characteristics cause gender gaps. Human capital, a factor that determines the wage levels, embodies an investment in the labour market's demand and supply sides and permits individuals to get higher wages for a similar amount of work (Lecourt, 2011). Moreover, Becker's theory of human capital (2009) justifies the gender differences in wages.

The second theory is Becker's (1971) discrimination theory, which explains the gender gaps between women and men by arguing that competition has a negative impact on discriminatory outcomes. Becker introduced the discrimination concept as the unequal treatment of two individuals with similar observable productive characteristics because of a recognizable non-productive aspect.

The Oaxaca-Blinder model by Blinder (1973) and Oaxaca (1973) combines the human capital theory and discrimination theory to break down the wage differentials between women and men into differences in labour market discrimination and characteristics between sexes. The Oaxaca-Blinder model is employed to calculate the mean differences of two groups' dependent variables and identify how each variable contributes to the differences between groups.

3. Methods

3.1. Study Setting

The data used for this study were collected in a cross-sectional survey in Uasin Gishu County, Kenya. Uasin Gishu is chosen for the study due to its status as a major agricultural production area with farming potential and high poverty levels, with 47% of the county's population living below the poverty line (Government of Kenya, 2017). The survey was conducted in February 2022 and was limited to Irish potato farming households in three sub-counties- Soy, Ainabkoi, and Kesses, which have the highest rates of Irish potato farming in Uasin-Gishu County.

3.2. Sampling Design

The study employed a simple random sampling technique. 256 Irish potato farmers participated in the survey; the sampling was done based on a 95% confidence level to get a +5 or -5% precision level. The sample was distributed based on the number of farmers in each sub-county. This distribution restricted the study to Soy, Ainabkoi, and Kesses sub-counties. Participant screening was done, and Irish potato farmers were randomly selected from each sub-county. Farmers that did not practice Irish potato farming or refused to participate in the study were skipped.

3.3. Data Collection

With the Kobo-Collect software application, a questionnaire with closed-ended questions was administered to collect data from 256 Irish potato farming households. The questionnaire was standardized through a pilot study that conducted three focus group discussions and administered questionnaires to 25 Irish potato farming farmers not examined in the main study. Participants who were not ready to respond or responded negatively were asked subsequent questions through skip patterns in the data collection software.

3.4. Data Analysis

The South Texas Art Therapy (STATA version 16) statistical software and Microsoft Excel were used for quantitative analysis and statistical tests. Regression analysis and frequency distribution of study variables were done, and significant variables associated with the gender gap in productivity with a p-value lower than 0.05 were identified.

3.5. Empirical Estimation

Counterfactual decomposition techniques are primarily used to partition the differences between two groups. An Oaxaca-Blinder decomposition technique is first utilized to assess the factors that generate differences between genders (Kilic et al., 2013; Aguilar et al., 2015; Backiny-Yetna & McGee, 2015). Estimating production gaps has shown significant improvements from Oaxaca (1973) decompositions to recent investigations using Oaxaca-Blinder decomposition by scientists such as Rios-Avila (2019). The Oaxaca-Blinder model has been used in previous studies to decompose agricultural yield (Mugisha et al., 2019) and wages (Kwenda & Ntuli, 2018; Hotchkiss & Rios-Avila, 2013) by gender. The Oaxaca-Blinder decomposition method has also been used recently in agricultural research. Kilic et al. (2013) introduced this approach to investigate gender gaps in agricultural production. Other studies have since followed and utilized this approach to assess agricultural productivity in Sub-Saharan Africa (Backiny-Yetna & McGee, 2015; Aguilar et al., 2015, Kilic & Oseni, 2015; Oseni et al., 2015; Ali et al., 2015).

Remarkably, Oaxaca-Blinder estimations have been extended to decompose gaps in yields. Without discrimination favouring a particular group, the coefficient values are expected to be the same for each group. Controlling for other factors, Oseni et al. (2015) employed this decomposition method and found men produce 28% more output than women. The fundamental assumption is that differences in mean outcomes are caused by coefficients (different strengths of interactions between yield and response variables) and covariates (different endowments). Consider the Oaxaca-Blinder approach in a linear regression model, which estimates gender separately, g=m, f, where; f and m denote female farmers and male farmers, respectively, is expressed as;

$$Y_g = \beta_{go} + \sum_{k=1}^{k} X_{gk}\beta_{gk} + e_g$$
(Equation 1)

Where Y is the log measure of yield, g is the gender of the farmer, X is a vector of k covariates that can be observed, β is the coefficient, and e is the error term. Therefore, decomposing the Irish potato productivity gap between genders into the abovementioned components encompasses a counterfactual assessment of the coefficients in Equation 1 and those corresponding to a situation lacking discrimination between genders. These are calculated through an O.L.S. model using data from both female and male Irish potato farmers:

$$Y = \beta_O + \sum_{K=1}^{K} X_k\beta_k + \beta_g G + e$$
(Equation 2)

Where G is a dummy variable for gender.

With these two equations (assuming E (e)=0), the productivity gap is calculated as the mean difference between the productivity of female and male Irish potato farmers:

$$E(Y_m) - E(Y_f) = \beta_{mo} + \sum_{k=1}^{k} E(X_{mk})\beta_{mk} - \beta_{fo} - \sum_{k=1}^{k} E(X_{fk})\beta_{fk}$$
(Equation 3)

Rearranging Equation 3 by subtracting and adding the intercept (β_0) and the productivity of female and male farmers valued at $\beta_k(\sum_{k=1}^{k} X_{fk}\beta_k)$ and $\beta_k(\sum_{k=1}^{k} X_{mk}\beta_k)$ generates the cumulative decomposition as shown in Equation 4 below:

$$\underbrace{E(Y_m)-E(Y_f)=\sum_{k=1}^{k}[E(X_{mk})-E(X_{fk})]\beta_k}_{\text{Endowment effect}}+\underbrace{(\beta_{mo}-\beta_o)+\sum_{k=1}^{k}[(X_{mk})(\beta_{mk}-\beta_k)]+(\beta_o-\beta_{fo})+\sum_{k=1}^{k}[X_{fk})(\beta_k-\beta_{fk}]}_{\text{Structural Effect}}$$

(Equation 4) The main advantage of using this model compared to other techniques existing in the literature on yield differences between genders is the ease of finding the detailed decomposition results of each variable (Rios-Avila, 2019).

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4. Results and Discussion

4.1 Summary Statistics

Table 1 below presents summary statistics of the study variables. Additional statistics with standard deviations and means for the total sample are provided in Appendix 1.

	Female		Male		
Variables	**Mean**	**SD**	**Mean**	**SD**	**Difference**
Socio-economic factors					
Education (years)	8.029851	3.713	10.39153	3.711	-2.362 ***
Age (years)	51.1791	13.62	47.71429	14.129	3.465
Married (Yes=1, No=0)	.2238806	1.708	.957672	.2019	-.7338 ***
Farming Experience (years)	18.86567	4.897	15.18577	3.420	3.679 ***
Land and Production					
Cultivated land (acres)	2.82388	1.737	3.557143	1.851	-.7333 **
Yields (kg/acre)	2394.89	848.5	2685.39	869.3	-290.5 **
Use of Inputs					
Improved seeds (Yes=1, No=0)	.1492537	.0528	.1128571	.0566	.0364 ***
Fertilizer (Yes=1. No=0)	.880597	.3267	.978836	.1443	-.0982 ***
Herbicides (Yes=1, No=0)	.4328358	.4992	.3650794	.4827	.0678
Traction (Yes=1, No=0)	.6567163	.4784	.539683	.4997	.1170
Labor (man-days)	65.53731	32.10	57.07937	28.87	8.458 *
Market and Price Information					
Information access (Yes=1, No=0)	.238806	.1296	.291005	.1354	-.0522 **
Access to Credit and Extension					
Request for credit (Yes=1, No=0)	.2238812	.4199	.2010582	.4019	.0228
Extension contacts (number)	3.08333	1.066	3.428571	1.152	-.3452 *
Climate Change					
Perception (Yes=1, No=0	.223881	.4868	.428571	.4954	-.2047 **
Climate-smart technologies (number)	2.522388	1.223	6.518519	1.1696	-3.997 ***
***, **, and *** denote statistical significance at 0.05, 0.01, and 0.001 respectively**					

Table 1: Summary Statistics of Irish Potato Farmers

The results in Table 4.1 confirm the presence of a yield difference of (290.5 kg/acre), which is statistically significant at 1%. The mean yield of the sampled households is 2609.36 kg/acre. Male farmers had significantly higher Irish potato yields (2685.39 kg/acre) than female farmers (2349.89 kg per acre). The difference in education between female and male farmers is significant at 0.1%. The difference indicates that female farmers have 23% lower education than male farmers. This finding coincides with a study showing that males have higher education levels than females (Kapur, 2019). Burke, Li & Banda (2018) also find that gender gaps manifest in differences in education level.

The difference between male and female farmers was significant at 0.1% in terms of marital status. A higher number of male farmers were married than female farmers, as shown by a difference of 77%. This finding aligns with Bahta & Myeki (2022), who find that married men are highly engaged in agricultural activities. Sam (2019) also found that more male farmers are married than female farmers.

Bahta & Myeki (2022) argue that land access is critical for agricultural production. Research shows land ownership allows control over expenditures and production decisions (Badstue et al., 2020). In terms of cultivated land, this study found the difference between female and male farmers was significant at 1%. On average, male farmers owned larger land sizes than female farmers, as shown by a 21% difference. In line with this finding, other studies found that females possess smaller land in acreage than males (Sam, 2019; Guttierez, 2016). The difference in fertilizer use between female and male farmers was significant at 0.1%. On average, male farmers indicated that their fertilizer use was 27% higher than female farmers. Sheremenko & Magnan (2015) argue that male farmers are loss averse and opt to utilize fertilizer to avoid losses caused by adverse shocks. Kehinde et al. (2016) also note that males have a higher fertilizer adoption rate than females.

The difference in market and price information access between female and male farmers was significant at 1%. On average, male farmers indicated that their access to market and price information was 18% higher than that of female farmers. Access to market information is considered necessary in supporting production decisions; the more actors present, the more farmers demand information (David-Benz et al., 2016). This finding denotes that farmers are more likely to produce agricultural products when they receive adequate and positive market information. F.A.O (2017) also argues that market information is needed for short-term and long-term decision-making to support agricultural development.

Concerning perception of climate change and variability, the difference between female and male farmers was significant at 1%. The number of male farmers who perceived climate change and variability was 48%

higher than that of female farmers. Alhassan et al. (2018) found that male farmers were more aware of climate change, making them less vulnerable to climate change impacts than female farmers. Awareness of climate change allows farmers to foresee potential climate change issues and implement strategies that help them adapt and deal with the effects of climate change to prevent agricultural losses.

Concerning contacts with extension officers, the difference between female and male farmers was statistically significant at 5%. On average, contact with extension officers was 10% higher among male farmers than female farmers. This finding aligns with Raney et al. (2011), who argue that significant gender differences exist in access to agricultural extension services. Ragasa et al. (2013) also find female farmers are less likely to access extension services than their male counterparts. Ragasa et al. (2013) attribute increased access to extension services to formal education and larger land size. Similarly, the summary statistics indicate that male farmers have higher education levels and larger land sizes than female farmers.

The difference in the number of climate-smart technologies used was significant at 0.1%. Male farmers used more climate-smart technologies than female farmers, as shown by a 61% difference. Correspondingly, Alhassan et al. (2018) found that male farmers are less sensitive to climate change and variability as they have the most adaptive capacities than female farmers. A different study found that male farmers, on average, are more adaptable and resilient than female farmers, and only half of the difference is attributed to characteristics that can be observed (Fuller & Lain, 2020).

The difference in farming experience between female and male farmers was significant at 1%. The farming experience was 20% higher among female farmers than among male farmers. Similarly, a study by Nyikahadzoi et al. (2012) found that the farming experience of female farmers was significantly higher than that of male farmers. Farming experience is vital in technology adoption and sustainable agricultural Production (Ainembabazi & Mugisha, 2014).

Concerning improved seeds, the difference between female and male farmers was significant at 0.1%. The use of improved seeds was 24% higher among female farmers. Otieno et al. (2021) found that women have higher access to more diverse seed varieties because of their involvement in extensive networks than men. Improved seed varieties support agricultural productivity (Karanja et al. 2014).

The difference in the quantity of labour between female and male farmers was significant at 5%. As seen in the results, the amount of labour is higher by 13% among female farmers compared to male farmers. Donald et al. (2020) argue that female farmers have increased their use of household labour compared to male farmers. Research shows that adequate labour leads producers to adopt labour-intensive practices, whereas lacking it inhibits both the efficient use and adoption of such practices (Udimal et al., 2017). This finding shows that female

4.2 Base Determinants of Irish Potato Production

This section uses a productivity-based approach that presents yield per acre as a function of the covariates in Table 2.

Table 2: Base Determinants of Irish Potato Production

Variable	**Pooled Model N=256**	**Female Model N=67**	**Male Model N=189**
Gender	0.1142**		
	(0.0348)		
Cultivated land	0.0409*	0.0115	0.0185**
	(0.013)	(0.0126)	(0.005)
Labor	-0.00083	-0.000185	-0.000403
	(0074)	(0.009)	(0.003)
Education	0.00872*	0.0213*	0.0163**
	(0.0039)	(0.0101)	(0.005)
Extension contacts	0.0426*	0.0811	0.0327
	(0.0213)	(0.136)	0.155)
Farming experience	0.00156*	0.00338*	0.00423
	(0.0007)	(0.0016)	(0.003)
Climate smart technologies	0.0486**	0.0191*	0.0579**
	(0.0156)	(0.008)	(0.018)
Age	-0.0252	-0.0704	- 0.0567
	(0.044)	(0.069)	(0.0515)
Fertilizer	0.0848***	0.0902*	0.0229 **
	(0.0141)	(0.039)	(0.0007)
Herbicides	0.0460	0.0868	0.0557
	(0.061)	(0.153)	(0.059)

Variable	Pooled Model N=256	Female Model N=67	Male Model N=189
Seed variety	0.0332**	0.0506**	0.0289*
	(0.0107)	(0.0158)	(0.013)
Credit access	0.0158	0.0344	0.0208
	(0.0180)	(0.172)	(0.0194)
Perception of climate change	0.0109	0.0142	0.0102
	(0.0116)	(0.0163)	(0.0188)
Marital status	0.0625**	-0.0497	0.0686**
	(0.0201)	(0.029)	(0.021)
Market and price information	0.122**	0.256*	0.0733*
	(0.039)	(0.121)	0.032)
Mechanical traction	0.106	0.0200	0.131
	(0.145)	(0.12)	(0.148)
_Constant	7.471***	8.040***	7.391***
	(0.1397)	(0.106)	(0. 127)

Note: Standard errors in parentheses; *p<0.05, **P<0.01, ***p<0.001

The objective of this O.L.S. estimation is to explain the gender-productivity nexus of all Irish potato farmers (pooled model) and the differences in the effects of production factors between female (female model) and male farmers (male model). The pooled sample (Column 2) shows that gender is a statistically significant variable explaining the farmers' productivity. Columns 3 and 4 in Table 2 provide separate results and estimates for female and male farmers, as shown below:

The gender variable was included in Column 2 (Pooled sample) to assess the gender effect on Irish potato production. The results show that the gender coefficient is statistically significant at 1%, which confirms the study hypothesis that gender affects potato productivity. Similarly, other studies (Joe-Nkamuke et al., 2019; Bello et al., 2021) found that gender significantly affects agricultural productivity. From Columns 3 and 4, we find education, use of fertilizer, access to market and price information, use of climate-smart technologies, improved seed varieties, and access to market and price information are positively significant for both female and male farmers. However, the education and seed variety coefficients are bigger for female farmers, signifying that improved access to these factors has a lower effect on male farmers than female farmers. The implications of these results are discussed further below:

Education has a positive association with the production level of the farmers. This positive association could be accredited to how education improves decision-making and supports agricultural technologies that boost productivity (Durán & Wives, 2018; Oduro-Ofori et al., 2014). The importance of education is also shown in a study that argues gender gaps manifest in low education levels and limited economic activities or low economic participation between genders Burke, Li & Banda (2018). Said & El-Hamidi (2008) note that education has a beneficial impact on productivity.

Education also improves the allocative efficiency of people by allowing them to be critical thinkers and utilize knowledge efficiently. Farmers with high levels of education are conversant with new information sources and are more competent in assessing and using the information on innovation than those who are less educated (Mo, 2011). Most specifically, it was found that education positively affects the use of improved technologies (Mo, 2011; Sánchez-Toledano et al., 2018).

The use of improved seeds has a positive association with the production level of the farmers. This positive association is because increasing seeds' quality can significantly boost yields since they are among the most efficient and economical agricultural inputs (Abebe & Alemu, 2017). The lack of clean seeds is the second leading challenge in Irish potato production. However, high production levels are enabled by improved access to clean seeds (Karanja et al., 2014; Government of Kenya, 2016).

The number of climate-smart technologies positively affects the farmers' production levels. This positive association is in line with arguments by Mutabazi et al. (2015). They note that non-adopters of climate-smart agricultural technologies are more likely to experience low agricultural production, poverty, and other challenges. It is argued further that climate-smart agriculture enables a sustainable increase in food security, resilience or adaptation, productivity, and reduces the emission of greenhouse gases, thus supporting productivity and development goals (Kasirye, 2013). The adoption of climate-smart technology is influenced by mental, socio-economic, and physical elements as well as the attitudes of farmers towards the technology, information sources, knowledge, farmer education, size of family, age of farmer, and agro-ecological conditions (Udimal et al., 2017).

Access to market and price information has a significant positive association with production. This association could be attributed to findings that access to market information is vital for supporting production decisions; the more actors present, the more farmers demand information (David-Benz et al., 2016). This finding denotes that farmers are more likely to produce agricultural products when they receive adequate and positive market information. F.A.O. (2017) notes that market information is needed for short-term and long-term decision-making to support agricultural development. Therefore, higher access to information by farmers is likely to motivate them to produce more.

The use of fertilizer has a significant positive effect on Irish potato production. Sheremenko & Magnan (2015) support this finding by arguing that loss-averse farmers opt to use fertilizer to avoid higher losses caused by adverse shocks. Moreover, Liu, Xu & Yi (2021), and Wang et al. (2020) note that fertilizers allow farmers to increase yields by offsetting nutrient outputs. Fertilizer use is also associated with an approximately 50% increase in yields in the 20th century (Yousaf et al., 2017)

4.3 Aggregate Decomposition of the Irish Potato Production Gap

The aggregate Oaxaca-Blinder decomposition was used to estimate the gender performance gap associated with gender differences in returns to resource endowments (structural effect), and gender differences in resource endowments (endowment effect) are presented in Table 3

Table 3: Aggregate Decomposition of the Irish Potato Production Gap

Mean Gender Differential		
Male log yields	7.8955***	
	(0.043)	
Female log yields	7.7811***	
	(0.0789)	
Difference	0.1144**	
	(0.0381)	
Aggregate Decomposition	**Endowment Effect**	**Structural Effect**
Total	0.03824*	0.06043*
	(0.0166)	(0.0302)

Note: Standard errors in parentheses; *p<0.05, **P<0.01, ***p<0.001

As indicated in the mean gender differential section of Table 3, there is a production gap of 11%, which is statistically significant at 1%. This result suggests that the productivity of male farmers surpasses that of female farmers by 11%. In a study of 250 farmers, Bello et al. (2021) found statistically significant results indicating that male farmers surpassed the production of female farmers by 11%. Gebre et al. (2021), Auma et al. (2010), and Gutierrez Pionce (2016) also argue that the productivity of male farmers is higher than that of female farmers.

Estimates from the aggregate decomposition section show that about 33% of the production gap is explained by gender differences in the endowment of production factors. Further, 53% is caused by gender differences in returns to the production factors, and the remaining 14% is linked to the interaction. The interaction measures the concurrent effects of differences between the structural effect and endowment effect. This finding is in line with Gutierrez Pionce (2016), who found that the endowment effect was associated with a smaller part of the gender gap while a larger part was associated with the structural effect.

4.4 Detailed Decomposition of the Irish Potato Production Gap

The summary results presented in Table 1 indicate that female and male farmers had significant differences in education level, size of cultivated land, marriage status, fertilizer use, access to market and price information, climate change perception, number of climate-smart technologies, farming experience, and use of improved seeds. This study finds that some of these factors significantly affect yields, as seen in Table 2. Therefore, it is expected that some of these factors will substantially impact the gender gap. The extent to which the significant factors account for the endowment effect and the structural effect was calculated by the ratio of coefficients over the gender difference (0.1144), over the explained part, or the endowment effect (0.03824), and the unexplained part or structural effect (0.06043) respectively. The detailed decomposition results are presented in Table 4 below:

Table 4: Detailed Oaxaca-Blinder Decomposition

Variable	Endowment Effect	Structural Effect
Land	0.0149*	-0.0254
	(0.0085)	(0.0182)
Labor	-0.00315	0.08192
	(0.012)	(0.144)
Education	0.02880**	0.38875
	(0.0163)	(0.3534)
Extension contacts	0.00308	0.03217
	(0.0023)	(0.0247)
Farming experience	-0.00714	0.01343
	(0.0062)	(0.0746)
Climate-smart technologies	0.01327*	0.014557**
	(0.008)	(0.006)
Age	0.02047	0.63111
	(0.020)	(0.590)
Fertilizer	0.02205	0.040339*
	(0.031)	(0.0224)
Herbicides	-0.00379	0.00709
	(0.0038)	(0.0625)
Improved seeds	-0.0185***	-0.037826**
	(0.005)	(0.0157)
Credit access	-0.00851	0.10578
	(0.013)	(0.146)
Perception of climate change	0.00002	0.06693
	(0.005)	(0.1459)
Marital status	0.10937	0.11614
	(0.198)	(0.1266)
Market and price information	0.00393	-0.23234
	(0.0035)	(0.1936)
Mechanical traction	-0.00853	-0.17405
	(0.010)	(0.2303)
_Constant		2.36053***
		(0.264)
Observations	256	256

Z statistics in parentheses * p<0.05, **p<0.01, ***p<0.001

Results in Table 4 indicate that land, education, the number of climate-smart technologies, and fertilizer use significantly cause the existence of the gender production gap among Irish Potato farmers in Uasin-Gishu. Land size explains 38% of the endowment effect. Many studies (Aguilar et al., 2015; Oseni et al., 2015; Slavchevska, 2015) have maintained that land is an important factor that affects efficiency and causes the gender productivity gap. Gutierrez Pionce (2016) notes that women's constrained access to resources such as land inhibits their productivity. Bahta & Myeki (2022) found that limited access to land lowers farmers' productivity. Land ownership allows control over expenditures and production decisions (Badstue et al., 2020). Therefore, the small land size of female farmers compared to male farmers disadvantages female farmers in production and cause the gender gap by inhibiting their control over expenditures and production decisions.

Climate-smart technologies explain 35% of the endowment effect and 24% of the structural effect. In the use of climate-smart technologies, the yield gap favours male farmers. A possible reason for this could be the use of more climate-smart practices among male farmers or their higher resource endowments than female farmers. The summary statistics indicate that male farmers use more climate-smart technologies than female farmers. This finding aligns with Kasirye (2013), who argues that climate-smart agriculture enables a sustainable increase in food security, resilience or adaptation, productivity, and reduces greenhouse gas emissions, thus supporting development goals.

Education explains 75% of the endowment effect and has the largest significant impact on the explained part of the gender gap. The summary statistics show that male farmers are more educated than female farmers. In line with this finding, Burke, Li & Banda (2018) argue that gender gaps manifest in differences in education level. Kapur (2019) notes that females are discriminated against and have lower participation levels in education than their male counterparts, leading to poor performance of females in economic activities, thus increasing the prevalence of gender gaps.

Fertilizer use explains 68% of the structural effect and has the largest significant impact on the unexplained part of the gender gap. The summary statistics indicate that female farmers use less fertilizer than male farmers. Diiro, Ker & San (2015) find that low fertilizer use by female farmers is attributed to their low education levels. Similarly, the summary statistics indicate female farmers are less educated than male farmers. Sheremenko & Magnan (2015) argue that fertilizer use prevents agricultural losses caused by negative shocks. Therefore, the fact that female farmers are less educated is associated with using lower quantities of fertilizer, which reduces their production levels and causes the gender gap.

The use of improved seeds is a statistically significant factor that closes the gender yield gap. Improved seeds explain 48% of the endowment effect and 63% of the structural effect. The summary statistics indicate that more female farmers use improved seeds than male farmers. Improved seed varieties have been highlighted as a production factor supporting agricultural productivity through better germination (Karanja et al., 2014). Differences in the use of productive inputs such as seeds explain the gender gap in agricultural production, where the low use of productive inputs expands gender gaps (Peterman et al., 2011; Quisumbing et al., 2001). Therefore, this finding infers that the difference would be larger if male and female farmers used similar quantities of improved seeds.

5. Conclusions and Policy Recommendations

This research studied the gender-based productivity gap in Irish potato farming in Uasin-Gishu County, Kenya, using cross-sectional field survey data. The study aimed to determine the gender-based productivity differences in Irish potato production and identify factors driving these disparities. This study makes the following conclusions:

Employing the Oaxaca Blinder method confirms that a gender-based productivity gap exists in Irish Potato production among farmers in Uasin-Gishu County. Male farmers have higher production levels than female farmers, with a difference of about 11% per acre. This gap means that women farmers are less productive because of their gender.

Secondly, the gender productivity gap was broken down into two major components: the endowment effect and the structural effect. The endowment effect represented 33% of the gap, while the structural effect represented 53% of the gap, and the remaining 14% was attributed to the interaction. The endowment effect is smaller than the structural effect, suggesting the production differences will still exist even if female farmers have equal access to production resources or have the same characteristics as male farmers. Therefore, policymakers should devise Irish potato farming strategies through a gender lens against using a one-fits-all intervention to uplift women farmers from their low productivity traps. Given the existing inequalities, gender-neutral policies are not enough, as overcoming gender differences necessitates much more.

Thirdly, the study confirms that a notable number of factors cause the gender-based productivity gap in Irish potato farming. These include land size, education level, use of fertilizer, and the number of climate-smart technologies. Therefore, policymakers attempting to reduce the gender gap should consider these factors as potential areas for intervention.

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Abebe, G., & Alemu, A. (2017). Role of improved seeds towards improving livelihood and food security at Ethiopia. *International Journal of Research-Granthaalayah*, *5*(2), 338-356. https://doi.org/10.5281/zenodo.376076

Aguilar, A., Carranza, E., Goldstein, M., Kilic, T., & Oseni, G. (2015). Decomposition of gender differentials in agricultural productivity in Ethiopia. *Agricultural Economics*, *46*(3), 311-334. https://doi.org/10.1111/agec.12167

Ainembabazi, J. H., & Mugisha, J. (2014). The role of farming experience on the adoption of agricultural technologies: evidence from smallholder farmers in Uganda. *Journal of Development Studies*, *50*(5), 666-679. https://doi.org/10.1080/00220388.2013.874556

Alam, A., Kobayashi, H., Matsumura, I., Ishida, A., & Mohamed, E. (2012). Technical efficiency and its determinants in potato production: Evidence from Northern Areas in Gilgit-Baltistan region of Pakistan. *International Journal of Research in Management, Economics and Commerce*, *2*, 1-17
https://www.researchgate.net/profile/Mohamed-Esham/publication/224952511_TECHNICAL_EFFICIENCY_AND_ITS_DETERMINANTS_IN_POTATO_PRODUCTION_EVIDENCE_FROM_NORTHERN_AREAS_IN_GILGIT-BALTISTAN_REGION_OF_PAKISTAN/links/02bfe50db0b483cb50000000/TECHNICAL-

EFFICIENCY-AND-ITS-DETERMINANTS-IN-POTATO-PRODUCTION-EVIDENCE-FROM-NORTHERN-AREAS-IN-GILGIT-BALTISTAN-REGION-OF-PAKISTAN.pdf?origin=publication_detail

Alhassan, S. I., Kuwornu, J. K., & Osei-Asare, Y. B. (2018). Gender dimension of vulnerability to climate change and variability: Empirical evidence of smallholder farming` households in Ghana. *International Journal of Climate Change Strategies and Management*. https://doi.org/10.1108/IJCCSM-10-2016-0156

Ali, D., Bowen, D., Deininger, K., & Duponchel, M. (2016). Investigating the gender gap in agricultural productivity: Evidence from Uganda. *World Development*, *87*, 152-170.https://doi.org/10.1016/j.worlddev.2016.06.006.

Auma, J. O., Lagat, J. K., & Nagigi, M. W. (2010). A comparison of male-female household headship and agricultural production in marginal areas of Rachuonyo and Homa Bay District, Kenya. *Jordan Journal of Agricultural Sciences*, *6*(4).

https://www.researchgate.net/profile/Joseph-Auma/publication/323512396_Gender_Differentials_in_Agricultural_Production_and_Productivity_in_Smallholder_Marginal_Farms_Rachuonyo_and_Homa-Bay_District_Kenya_Journal_of_agriculture_and_rural_development-ISSN1990-3375_Volume7_/links/5b67cf90299bf1b9303ca616/Gender-Differentials-in-Agricultural-Production-and-Productivity-in-Smallholder-Marginal-Farms-Rachuonyo-and-Homa-Bay-District-Kenya-Journal-of-agriculture-and-rural-development-ISSN1990-3375-Volume7.pdf

Bachewe, F. N., Berhane, G., Minten, B., & Taffesse, A. S. (2018). Agricultural transformation in Africa? Assessing the evidence in Ethiopia. *World Development*, *105*, 286-298. https://doi.org/10.1016/j.worlddev.2017.05.041

Backiny-Yetna, P. & McGee, K,. (2015). "Gender differentials and agricultural productivity in Niger", *Policy Research Working Paper, No.7199, The World Bank. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2568933*

Badstue, L., Petesch, P., Farnworth, C. R., Roeven, L., & Hailemariam, M. (2020). Women farmers and agricultural innovation: Marital status and normative expectations in rural Ethiopia. *Sustainability*, *12*(23), 9847. https://doi.org/10.3390/su12239847

Bahta, Y. T., & Myeki, V. A. (2022). The Impact of Agricultural Drought on Smallholder Livestock Farmers: Empirical Evidence Insights from Northern Cape, South Africa. *Agriculture*, *12*(4), 442. https://doi.org/10.3390/agriculture12040442

Becker, G. (1971). The economics of discrimination Chicago: University of Chicago Press. https://doi.org/10.7208/chicago/9780226041049.001.0001

Becker, G. S. (2009). Human Capital. A Theoretical and Empirical Analysis, with Special Reference to Education. University of Chicago Press.

*https://books.google.com/books?hl=en&lr=&id=9t69iICmrZ0C&oi=fnd&pg=PR9&dq=Becker,+G.+S.+(1964).+Human+Capital.+A+Theoretical+and+Empirical+Analysis,+with+Special%09Reference+to+Education.+University+of+Chicago+Press&ots=WyAqnUTzgS&sig=X_2O1rgg4LY4xqquZgMj0fM9ciE

Bello, L. O., Baiyegunhi, L. J., Danso-Abbeam, G., & Ogundeji, A. A. (2021). Gender decomposition in smallholder agricultural performance in rural Nigeria. *Scientific African*, *13*, e00875. https://doi.org/10.1016/j.sciaf.2021.e00875

Blinder, A. S. (1973). Wage discrimination: reduced form and structural estimates. *Journal of Human resources*, 436-455. https://doi.org/10.2307/144855

Burke, W. J., Li, S., & Banda, D. (2018). Female access to fertile land and other inputs in Zambia: why women get lower yields. *Agriculture and Human Values*, *35*(4), 761 775. https://doi.org/10.1007/s10460-018-9872-6

Daniel, O. N., Gideon, A. O., John, M. O., & Wilson, N. (2010). Technical efficiency in resource use: Evidence from smallholder Irish potato farmers in Nyandarua North District, Kenya. *African Journal of Agricultural Research*, *5*(11), 1179-1186. https://academicjournals.org/journal/AJAR/article-full-text-pdf/276971A33009

David-Benz, H., Andriandralambo, N., Soanjara, H., Chimirri, C., Rahelizatovo, N., & Rivolala, B. (2016). Improving access to market information: a driver of change in marketing strategies for small producers?. EAAE. Retrieved

fromhttps://agritrop.cirad.fr/584174/1/David-Benz%20et%20al%20_Improving%20access%20to%20market%20information_EAAE%2016%2009%202016.pdf

Donald, A., Lawin, G., & Rouanet, L. (2020). *Reducing the Agricultural Gender Gap in Cote d'Ivoire*

https://openknowledge.worldbank.org/bitstream/handle/10986/33325/Reducing-the-Agricultural-Gender-Gap-in-Coted'Ivoire-How-has-it-Changed.pdf?sequence=1

Diiro, G. M., Ker, A. P., & San, A. G. (2015). The role of gender in fertiliser adoption in Uganda. *African*

Journal of Agricultural and Resource Economics, *10*(311-2016-5630), 117-130. http://dx.doi.org/10.22004/ag.econ.208922

Durán, C. A., & Wives, D. G. (2018). Decision making and agriculture: a recent review of organic farming. *Desenvolvimento em Questão*, *16*(43), 175-199. https://doi.org/10.21527/2237-6453.2018.43.175-199

F.AO. (2017). Building Agricultural Market Information Systems: A Literature Review. Retrieved from https://www.fao.org/3/i7151e/i7151e.pdf

Fuller, R., & Lain, J. (2020). Are female-headed households less resilient? Evidence from Oxfam's impact evaluations. *Climate and Development*, *12*(5), 420-435. https://doi.org/10.1080/17565529.2019.1637330

Gebre, G. G., Isoda, H., Rahut, D. B., Amekawa, Y., & Nomura, H. (2021). Gender differences in agricultural productivity: Evidence from maize farm households in southern Ethiopia. *GeoJournal*, *86*(2), 843-864. https://doi.org/10.1007/s10708-019-10098-y

Gutierrez Pionce, E. G. (2016). *Agricultural performance in northern Ghana: a gender decomposition* (Doctoral dissertation, Kansas State University). http://hdl.handle.net/2097/32637

Hotchkiss, J. L., & Rios-Avila, F. (2013). Identifying factors behind the decline in the U.S. labor force participation rate. *Business and Economic Research*, *3*(1), 257. http://dx.doi.org/10.5296/ber.v3i1.33

Ibnouf, F. O. (2011). Challenges and possibilities for achieving household food security in the Western Sudan region: the role of female farmers. *Food Security*, *3*(2), 215-231. https://doi.org/10.1007/s12571-011-0118-3

Jattani, D., & Okadia, F. (2021). *Exploring the Global Gender Gap Index 2021: Kenya's Policy Choices*. http://weehub.ku.ac.ke/wp-content/uploads/2021/08/IEA-GLOBAL-GENDER-GAP-POLICY-BRIEF.pdf

Joe-Nkamuke, U., Olagunju, K. O., Njuguna-Mungai, E., & Mausch, K. (2019). Is there any gender gap in the production of legumes in Malawi? Evidence from the Oaxaca Blinder decomposition model. *Review of Agricultural, Food and Environmental Studies*, *100*(1), 69-92. https://doi.org/10.1007/s41130-019-00090-y

Sánchez-Toledano, B. I., Kallas, Z., Palmeros Rojas, O., & Gil, J. M. (2018). Determinant factors of the adoption of improved maize seeds in Southern Mexico: A survival analysis approach. *Sustainability*, *10*(10), 3543. https://doi.org/10.3390/su10103543

Kapur, R. (2019). Inequality in Educational Opportunities. *International Journal of Transformations in Business Management*, *9*, 13-18 https://ijtbm.com/admin/upload/02%20Dr%20Radhika%20Kapur%20Jan_2019.pdf

Karanja, A. M., Shisanya, C., & Makokha, G. (2014). Analysis of the key challenges facing potato farmers in Oljoro-Orok Division, Kenya. *Agricultural Sciences*, *2014*. http://www.scirp.org/journal/PaperInformation.aspx?PaperID=48689

Kasirye, I. (2013). Constraints to Agricultural Technology Adoption in Uganda: Evidence from the 2005/06-2009/10 Uganda National Panel Survey. *African Journal of Agricultural and Resource Economics*, 8(2), 90-107. http://dx.doi.org/10.22004/ag.econ.159669

Kehinde, A. D., Adeyemo, R., Amujoyegbe, B. J., & Bamire, A. S. (2016). Gender differentials and fertilizer adoption among smallholder farmers in cocoa-based farming system of Southwestern, Nigeria. http://dx.doi.org/10.15739/IJAPR.16.029

Kilic, T., A. Palacios-Lopez., & Goldstein. M. (2013), "Caught in a productivity trap: A distributional perspective on gender differences in Malawian agriculture." Policy Research Working Paper, No. 6381, The World Bank. https://doi.org/10.1016/j.worlddev.2014.06.017

Kiriti, T., & Tisdell, C. A. (2003). *Gender inequality, poverty and human development in Kenya:Main indicators, trends and limitations* (No. 1745-2016-141001). 10.22004/ag.econ.105587

Kwenda, P., & Ntuli, M. (2018). A detailed decomposition analysis of the public-private sector wage gap in South Africa. *Development Southern Africa*, *35*(6), 815-838. https://doi.org/10.1080/0376835X.2018.1499501

Lecourt, A. J. (2011). *Du Capital Humain aux Capabilités: une analyse des parcours de Validation des Acquis de l'Expérience* (Doctoral dissertation, Université Aix Marseille II). https://tel.archives-ouvertes.fr/tel-00664202/document

Liu, Q., Xu, H., & Yi, H. (2021). Impact of fertilizer on crop yield and C: N: P stoichiometry in arid and semi-arid soil. *International journal of environmental research and public health*, *18*(8), 4341. https://doi.org/10.3390/ijerph18084341

McPeak, J., & Doss, C. (2006). Are household production decisions cooperative? Evidence on pastoral migration and milk sales from Northern Kenya. *American Journal of Agricultural Economics, 88*(3), 525–541. https://doi.org/10.1111/j.1467-8276.2006.00877.x

Mincer, J., & Polachek, S. (1974). Family Investment in Human Capital: Earnings of Women. *Journal of Political Economic, 82,* S76-S108. https://doi.org/10.1086/260293

Government of Kenya. (2017). Climate Risk Profile for Uasin Gishu County. *Kenya County Climate Risk Profile Series.* The Ministry of Agriculture, Livestock and Fisheries (MoALF), Nairobi, Kenya.

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwj38erhzv_3AhUB3IUKHfkWC28QFnoECAwQAQ&url=https%3A%2F%2Fccafs.cgiar.org%2Fresources%2Fpublications%2Fclimate-risk-profile-uasin-gishu-county-kenya-county-climate-risk&usg=AOvVaw2pjzkJve98YIbZ-kEJyY04

Government of Kenya. (2016). The National Potato Strategy 2016- 2020.

https://npck.org/Books/THE%20NATIONAL%20POTATO%20STRATEGY%20(2016%20-%202012)%20(2).pdf

Mugisha, J., Sebatta, C., Mausch, K., Ahikiriza, E., Kalule Okello, D., & Njuguna, E. M. (2019). Bridging the gap: decomposing sources of gender yield gaps in Uganda groundnut production. *Gender, Technology and Development*, *23*(1), 19-35. https://doi.org/10.1080/09718524.2019.1621597

Mutabazi, K. D., Sieber, S., Maeda, C., & Tscherning, K. (2015). Assessing the determinants of poverty and vulnerability of smallholder farmers in a changing climate: the case of Morogoro region, Tanzania. *Regional Environmental Change*, *15*(7), 1243-1258. https://doi.org/10.1007/s10113-015-0772-7

Muthoni, J., Shimelis, H., & Melis, R. (2013). Potato production in Kenya: Farming systems and production constraints. *Journal of Agricultural Science*, *5*(5), 182. http://dx.doi.org/10.5539/jas.v5n5p182

Mo, M. A. (2011). Analysis of adoption of improved maize varieties among farmers in Kwara State, Nigeria. *International Journal of Peace and Development Studies*, *2*(1), 8-12.

https://www.internationalscholarsjournals.com/articles/analysis-of-adoption-of-improved-maize-varieties-among-farmers-in-kwara-state-nigeria.pdf

Njuki, J., Kaaria, S., Chamunorwa, A., & Chiuri, W. (2011). Linking smallholder farmers to markets, gender and intra-household dynamics: does the choice of commodity matter? *European Journal of Development Research, 23*(3), 426–443. https://doi.org/10.1057/ejdr.2011.8

Norton, G. W., Alwang, J., & Masters, W. A. (2021). *Economics of agricultural development: World food systems and resource use*.Routledge. https://doi.org/10.4324/9780203076217

Nyagaka, D., Obare, G. A., & Nguyo, W. (2009). *Economic efficiency of smallholder Irish potato producers in Kenya: A case of Nyandarua North District* (No. 1005-2016- 79081). http://dx.doi.org/10.22004/ag.econ.49917

Nyikahadzoi, K., Samati, R., Motsi, P. D., Siziba, S., & Adekunle, A. (2012). Strategies for improving the economic status of female-headed households in eastern Zimbabwe: The case for adopting the IAR4D framework's innovation platforms. *Journal of Social Development in Africa*, *27*(2), 59. https://search.proquest.com/openview/3bef994939ffb3529661c5d7369e272f/1?pq

Oaxaca, R. (1973). Male-female wage differentials in urban labor markets. *International economic review*, 693-709. https://doi.org/10.2307/2525981

Oduro-Ofori, E., Aboagye, A. P., & Acquaye, N. A. E. (2014). Effects of education on the agricultural productivity of farmers in the Offinso Municipality. *International Journal of Development Research, 4(9),* 1951-1960. https://www.journalijdr.com/sites/default/files/issue-pdf/1839.pdf

Oseni, G., Corral, P., Goldstein, M., & Winters, P. (2015). Explaining gender differentials in agricultural Production in Nigeria. *Agricultural Economics*, *46*(3), 285-310. https://doi.org/10.1111/agec.12166

Osuafor, O., O. & Anarah, S, E. (2015). Determinants of Gender Contribution to Farm Income Decision Making Among Rural Farming Households in Enugu State, Nigeria. *International Journal of Science and Research (IJSR)*, 2319-7064

Othman, M.K., Lawal, A.O. & Iyiola-Tunji, A.O. (2017). Gender and family nutrition. *NPOWER Agricultural Extension Master Trainers' Manual*. 259- 354. https://searchworks.stanford.edu/view/13709674

Otieno, G., Zebrowski, W. M., Recha, J., & Reynolds, T. W. (2021). Gender and Social Seed Networks for Climate Change Adaptation: Evidence from Bean, Finger Millet, and Sorghum Seed Systems in East Africa. *Sustainability*, *13*(4), 2074. https://doi.org/10.3390/su13042074

Peterman, A., Quisumbing, A., Behrman, J., & Nkonya, E. (2011). Understanding the complexities surrounding gender differences in agricultural productivity in Nigeria and Uganda. *Journal of Development Studies*, *47*(10), 1482-1509. https://doi.org/10.1080/00220388.2010.536222

Ragasa, C., Berhane, G., Tadesse, F., & Taffesse, A. S. (2013). Gender differences in access to extension services and agricultural productivity. *The Journal of Agricultural Education and Extension*, *19*(5), 437-468. https://www.tandfonline.com/doi/abs/10.1080/1389224X.2013.817343

Raney, T., Anríquez, G., Croppenstedt, A., Gerosa, S., Lowder, S. K., Matuschke, I., & Skoet, J. (2011). *Gender differences in assets*. http://dx.doi.org/10.22004/ag.econ.289009

Rios Avila, F. (2019). Recentered influence functions in Stata: Methods for analyzing the determinants of poverty and inequality. *Levy Economics Institute, Working Paper*, *927*. https://dx.doi.org/10.2139/ssrn.3378811

Sabo, E. (2006). Participatory assessment of the impact of women in agriculture programme of Borno, Nigeria. *Journal of Tropical Agriculture*, 44(1-2), 52-56.

http://jtropag.kau.in/index.php/ojs2/article/download/151/151

Said, M., & El-Hamidi, F. (2008). *Have Economic Reforms Paid Off? Gender Occupational Inequality in the New Millennium in Egypt* (No. 128). ECES Working Paper. http://d-scholarship.pitt.edu/id/eprint/5755

Sam, V. (2019). Access to Formal Credit and Gender Income Gap: The Case of Farmers in Cambodia. https://www.nbc.org.kh/download_files/research_papers/english/1.2.Credit-and-gender-income-gap.pdf

Sheremenko, G., & Magnan, N. (2015). *Gender-specific risk preferences and fertilizer use in Kenyan farming households* (No.330 2016-13422). http://dx.doi.org/10.22004/ag.econ.205766

Sorensen, P. (1996). Commercialization of food crops in Busoga, Uganda, and the renegotiation of gender. *Gender & Society*, *10*(5), 608-628. https://doi.org/10.1177/089124396010005007

Thapa, S. (2008). Gender differentials in agricultural productivity: evidence from Nepalese household data. *Munich Personal RePEc Archive (MPRA),* Paper No. 13722. R. https://mpra.ub.uni-muenchen.de/13722/1/

Udimal, T. B., Jincai, Z., Mensah, O. S., & Caesar, A. E. (2017). Factors influencing the agricultural technology adoption: The case of improved rice varieties (Nerica) in the Northern region, Ghana. *Journal of Economics and Sustainable Development*, *8*(8), 137-148. https://core.ac.uk/download/pdf/234647853.pdf

Van Oort, P. A., & Zwart, S. J. (2018). Impacts of climate change on rice production in Africa and causes of simulated yield changes. *Global change biology*, *24*(3), 1029 1045. https://doi.org/10.1111/gcb.13967

Wang, Z., Hassan, M. U., Nadeem, F., Wu, L., Zhang, F., & Li, X. (2020). Magnesium fertilization improves crop yield in most production systems: a meta-analysis. *Frontiers in plant science*, *10*, 1727. https://doi.org/10.3389/fpls.2019.01727

Yousaf, M., Li, J., Lu, J., Ren, T., Cong, R., Fahad, S., & Li, X. (2017). Effects of fertilization on crop production and nutrient supplying capacity under rice-oilseed rape rotation system. *Scientific reports*, *7*(1), 1-9. https://doi.org/10.1038/s41598-017-01412-0

Appendix

Appendix 1

Appendix 1: Summary Statistics of all Sampled Irish Potato Farming Households

Variables	Mean	SD
Socio-Economic Characteristics		
Education (years)	9.773438	3.846
Age (years)	48.62109	14.05
Marital Status (1 =Married, 0=otherwise)	.765625	.1894
Farming Experience (years)	16.14887	4.328
Land and production		
Cultivated land (acres)	3.36523	1.595
Yields (kg/acre)	2609.36	863.9
Use of Inputs		
Improved seeds (Yes=1, No=0)	.123383	.0413
Fertilizer (Yes=1. No=0)	.953125	.2118
Herbicides (Yes=1, No=0)	.3828125	.4870
Traction (Yes=1, No=0)	.5703132	.4960
Labor (man-days)	59.29297	32.76
Access to Market and Price Information		
Information access (Yes=1, No=0)	.277344	.1486
Access to Credit and Extension		
Request for credit (Yes=1, No=0)	.2070311	.4059
Extension contacts (number)	3.338216	1.613
Climate Change		
Climate change perception (Yes=1, No=0)	.375	.8944
Number of climate-smart technologies	5.472657	1.181