frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 03 October 2023
DOI 10.3389/fsufs.2023.1155756

OPEN ACCESS

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RECEIVED 31 January 2023
ACCEPTED 14 September 2023
PUBLISHED 03 October 2023

CITATION
Mkuna E and Wale E (2023) Gender differentials among small scale irrigation farmers' income: empirical evidence from cabbage farmers in KwaZulu-Natal, South Africa.
Front. Sustain. Food Syst. 7:1155756.
doi: 10.3389/fsufs.2023.1155756

Gender differentials among small scale irrigation farmers' income: empirical evidence from cabbage farmers in KwaZulu-Natal, South Africa

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Introduction: Agricultural productivity and income disparities prevail between male and female farmers in Sub-Saharan Africa. South Africa is not an exception to this ominous reality.

Methodology: Using data from smallholder irrigation farmers in KwaZulu-Natal, South Africa, this study analyzed the gender on-farm income gap by applying the Blinder-Oaxaca (OB) decomposition framework.

Results: The findings indicate that there is a significant difference in farm income between male and female farmers. Male farmers earn significantly higher on-farm income than female farmers by about R26,788/cropping season.

Discussion: The findings suggest that existing and future programs should focus on institutional factors (land tenure) that affect access to resources and services. In addition to strategies to empower women, interventions to reduce the gender-induced farm income gap should focus on improving access to resources and services such as land with tenure security, agricultural input and output markets, training, information, and credit. Increasing the resource endowment and access to services by the female-managed farms is likely to significantly close the observed gender-induced farm income gap and improve the well-being of female farmers and their households.

KEYWORDS

Blinder-Oaxaca, gender-induced farm income gap, South Africa, gender differentials, cabbage (*Brassica camperstris L.*)

1. Introduction

In recent years, there has been a marked increase in the level of attention paid globally to gender, its significance for development, and the disparities (income or otherwise) that exist between men and women (Pachauri and Rao, 2013; Kiptot et al., 2014; Wondimagegnhu et al., 2019). In sub-Saharan Africa, for example, gender inequality costs about 95 USD billion annually, and if women and men were treated equally in terms of economic or other opportunities, 12–28 USD trillion could be added to the global economy (McKinsey Global Institute, 2015; UNDP, 2016; Anderson et al., 2021). Additionally, Gebre et al. (2021) showed that the degree of agricultural productivity disparities between male and female farmers vary in sub-Saharan Africa. Thus, a crucial policy agenda now is closing the gender gap in agricultural production and the food value chain. To achieve equity in resource allocation and household-level food security in low- and middle-income countries, it is crucial for policy makers and

program planners to have a deeper grasp of the gender gap (Owusu et al., 2018), mainly focusing on the how and why.

The notion of gender has been described as the socio-economic and cultural traits that are associated with men and women in regard to their roles, responsibilities, rights, obligations and other privileges (Masamha et al., 2018; Adegbite and Machethe, 2020). It is embedded in cultural norms and institutions, making written or unwritten societal rules on what is right or acceptable or otherwise. Sub-Saharan Africa's agriculture is characterized by two main attributes: the predominance of female labor (30% and 60% of all agricultural labor) and the existence of a gender gap in agricultural productivity. This is because various cultural and societal roles, obligations, restrictions, and expectations are imposed on both men and women that affect their capacity and motivations to take part in agriculture and the value chains therein (Palacios-López and López, 2015; Masamha et al., 2018; Gebre et al., 2019). Among these challenges, statutory and customary regulations continue to prevent women in many developing nations from accessing land and other resources. Because of the insecurity of land tenure, there is less access to capital and inputs, which results in inefficient land use and poorer yields (Palacios-López and López, 2015; Chigbu, 2019; Chigbu et al., 2019).

A number of empirical studies have demonstrated the crucial role that women play in African agriculture (Uduji et al., 2019; Wekesah et al., 2019; Ampaire et al., 2020; Mpanza and Mbatha, 2021). Moreover, other studies explored the choice of livelihoods on culturally determined roles, social mobility, and access to and ownership of livelihood assets, extension services, credit, technology with the focus on gender disparities (Palacios-López and López, 2015; Loison, 2019; Wondimagegnhu et al., 2019; Adegbite and Machethe, 2020; Sá et al., 2020). In this context, access to inputs, modern technologies, education, healthcare, and other resources is disproportionately in favour of men. Most women are marginalized in developing nations, where they have limited access to and power over resources like land, information, markets, education, extension services, and agricultural loans (Sharaunga et al., 2015; Lutomia et al., 2019; Paudel et al., 2020). Moreover, who makes production and marketing decisions would affect the productivity of the available livelihood assets and opportunities. Not only access to inputs, technology and information about cultural practices but also these decisions influence agricultural productivity. These suggest that gender-disaggregated analysis generates information crucial for identifying the respective factors influencing the livelihoods of households headed by men and women, aiming to articulate targeted typologies of policy actions (Wondimagegnhu et al., 2019).

Agriculture in general and smallholder farming in particular can disproportionately contribute to poverty reduction. The South African government has invested in irrigation infrastructure to address the challenges of water scarcity and drought in the sub-sector. To increase food security and the well-being of small-scale irrigation operators and their communities, investment in small-scale irrigation must be made more productive and profitable (Davis et al., 2017; Bjornlund et al., 2019). However, in South Africa, post-apartheid governments have tried to empower rural people through interventions in agriculture by reducing gender gap and empowering women in rural areas (Sharaunga et al., 2015, 2019). Women are less mobile and often stay in rural areas due to household commitments. That is why they are over-represented in smallholder farming, especially in the irrigation schemes. The empirical evidence from studies in the past confirms that, when the differences in access to inputs, resources and information are taken into account, estimates of the gender income gap become important (Tibesigwa and Visser, 2016; Flatø et al., 2017; Bjornlund et al., 2019; Cheteni et al., 2019; Gebre et al., 2021).

Other studies from other Sub-Saharan African countries looked at gender differentials in the context of agricultural productivity (e.g. Kang et al., 2020; Gebre et al., 2021), farm mechanization (e.g. Fischer et al., 2018), farm management decision-making (e.g. Sell and Minot, 2018), food security (Carranza and Niles, 2019) and climate change adaptation strategies (Owusu and Bravo-Ureta, 2022). However, these studies cannot necessarily be generalized to farm income and the South African context is different because of the country's distinct history, traditional setting, and policy environment. Moreover, there is scant literature on gender-induced farm income differences among smallholder farmers within irrigation schemes in South Africa. Therefore, the objective of this study is to examine gender differentials in farmers' income among small-scale irrigation farmers. This study makes policy-relevant knowledge contribution to understanding gender-induced farm income differentials, considering socio-economic, resource access, institutional, and structural differences. Given that households headed by women tend to be among the poorest segments of society, these gender inequalities in terms of access to resources and opportunities for livelihood diversification have consequences for pro-poor economic growth (Loison, 2019).

Given this motivation, the rest of the paper is structured as follows. The next section presents the theoretical and conceptual framework. This is followed by the empirical methodology in Section 3 where the study area, data collection, sampling and empirical model are described. The results and discussion are contained in Section 4. Finally, the last section concludes the paper and makes recommendations.

2. Theoretical and conceptual framework

Over the past 50 years, economists' perspectives on household behavior and gender dynamics have been affected by theoretical and empirical studies on rural households (Doss and Quisumbing, 2020). Boserup's (1970) and Becker's (1981) earlier studies have affected methods for comprehending rural households as well as developing agricultural development strategies and initiatives. For instance, Boserup suggested that agriculture requires more male labor in densely populated areas than it does in areas with low population density where women perform more farm work than men. Boserup contended that the more effective "conventional" farming methods, particularly plough agriculture, mostly employed male labor. When state-directed innovation accelerated technological development in rural areas of Africa, this correlation between gender and "traditional" technology forms new significance. Accordingly, while women continued to grow food crops using conventional techniques, males chose to use more sophisticated and scientifically-proven empirical methods to do so. A unitary model of the household was developed by Becker (1981), which made the assumption that either all members of the household share the same tastes, pool their resources, and reach consensus on all decisions, or that one household member takes decisions on behalf of the entire group. Accordingly, social

conventions about gender roles are exogenous, with males specializing in activities related to production and women specializing in activities related to reproduction. Doss and Quisumbing (2020), on the other hand, asserted that fresh approaches to data collection at the farm level frequently contained details on the farm manager or owner. Due to this, agricultural productivity can now be analyzed at a personal rather than a household level. The investigation of how shocks differed among household members is made possible by sex-disaggregated data on assets and income. Therefore, in most cases, each farm has a single decision maker and that the decisions on each farm are made independently.

In particular, Sharaunga et al. (2015, 2019) noted that closing the gender gap contributes to the production of more food for domestic consumption and local markets and is the best way to lessen household vulnerability to poverty and food insecurity in South Africa by raising agricultural incomes and enhancing food availability. This argument has been made with a focus on women's empowerment, which has often received little attention in the literature despite the fact that they are crucial to achieving all four pillars of food security in rural areas as food producers, wage earners, and guardians of household food and nutrition security. Moreover, there is mounting evidence that closing the gender gap contributes to better overall development outcomes in terms of health, education, eradicating poverty, lowering household vulnerability to food insecurity, and promoting economic growth (Sharaunga et al., 2015; Mugisha et al., 2019). To contribute to these rural development goals, this study argues that gender dimensions of smallholder farm incomes should be studied to empirically establish gender-induced income gap and understand the factors thereof.

3. Methodology

3.1. Study area

The data comes from a sample of smallholder farmers in four irrigation schemes (Makhathini, Ndumo B, Tugela Ferry, and Bululwane) in KwaZulu-Natal (see Figure 1). Rural residents in the province rely heavily on smallholder agriculture for their livelihoods. The area gets low rainfall, ranging from 500 to 850 mm annually. The size of the farms operated by smallholders in the schemes ranges from 0.1 to 10 ha, depending on the program and whether they farm individually or as a cooperative. Those living outside of the schemes typically own larger pieces of land. The land is typically operated on a permission to occupy basis, although there are various land leasing agreements amongst farmers as well (Wale et al., 2021). The potential of KwaZulu-Natal province is underutilized despite the fact that its diversified geography, climate, and soil nearly make it a "world-in-one." Irrigation projects have been prioritized as crucial areas of intervention by the provincial administration to combat rural poverty, food insecurity, and unemployment. Irrigation programs are viewed as strategic investment portfolios in the province to address frequent drought and increasingly chronic water shortage. Thus, the province made significant capital investments in irrigation projects (Joubert, 2012; Chipfupa and Wale, 2018). Similar to the overall situation in the country, the majority of the irrigation projects are located in areas with the highest rates of poverty. As a result, these projects are expected to have great potential for improving rural livelihoods.

3.2. Data collection

Questionnaires were designed and administered to acquire relevant information. This involved intensive engagement of the research team with the communities in the study areas at the irrigation schemes in an attempt to unpack the challenges with the intention of shedding light on outcomes such as improved farm income, employment generation, and entrepreneurial attributes of smallholder farmers. The KwaZulu-Natal Department of Agriculture and Rural Development (DARD) offices in the study sites played a vital role in mobilizing farmers and communities in the schemes.

3.3. Sampling strategy

The project team obtained a sampling frame of small-scale irrigators in the schemes from the local offices of the DARD. Stratified random sampling was used to select the participants and a total of 332 smallholder farmers growing cabbage were interviewed. Input–output data were collected at the plot level. The dataset employed in this study was collected as part of the Water Research Commission (WRC) project entitled "Entrepreneurial development for establishing small farming businesses and employment by youth in rain-fed crop farming (K5/2789//4)." Poverty is more severe in rural areas where gender is a major factor in household decision-making (Cheteni et al., 2019). That is why women are over-represented among the rural poor. The total number of farmers interviewed per area are 155, 70, 55 and 52 in Makhathin, Ndumo B, Tugela Ferry, and Bululwane, respectively. Also, out of the total 332 sampled farmers, 111 were male and 221 were female. In addition, cabbage farmers were sampled owing to the importance of the crop in the irrigation schemes. In South Africa, cabbage is one of the most cultivated and consumed vegetables. Although it is farmed all over the country, Mpumalanga and KwaZulu-Natal have the highest concentrations (Mhazo, 2018).

3.4. Empirical model

The Blinder-Oaxaca model was used to investigate the variables that contribute to the gender differentials in farm income among smallholder irrigation farmers in KZN. This model was first introduced by Blinder (1973) and supported by Oaxaca (1973), and later applied by Cotton (1988) and Neumark (2004). It has been widely used in measuring gaps of various outcomes between groups. The B-O theory allows the decomposition of the differences in an outcome variable between two groups into a part that is attributable to differences in the observed characteristics of these two groups and the part that is ascribed to differences in the estimated coefficients of these groups (Danso-Abbeam et al., 2020a; Addai et al., 2021). In this context, this study aimed to estimate the gender-induced farm income gap between male and female farmers in the study areas, i.e., groups L_M and L_F, an outcome variable Y, and a set of predictors. For example, think of males and females, farmers' income as the outcome variable, and human capital indicators (such as education and work experience) as predictors. Following Jann (2008), the difference in the farmers' income will be expressed as:

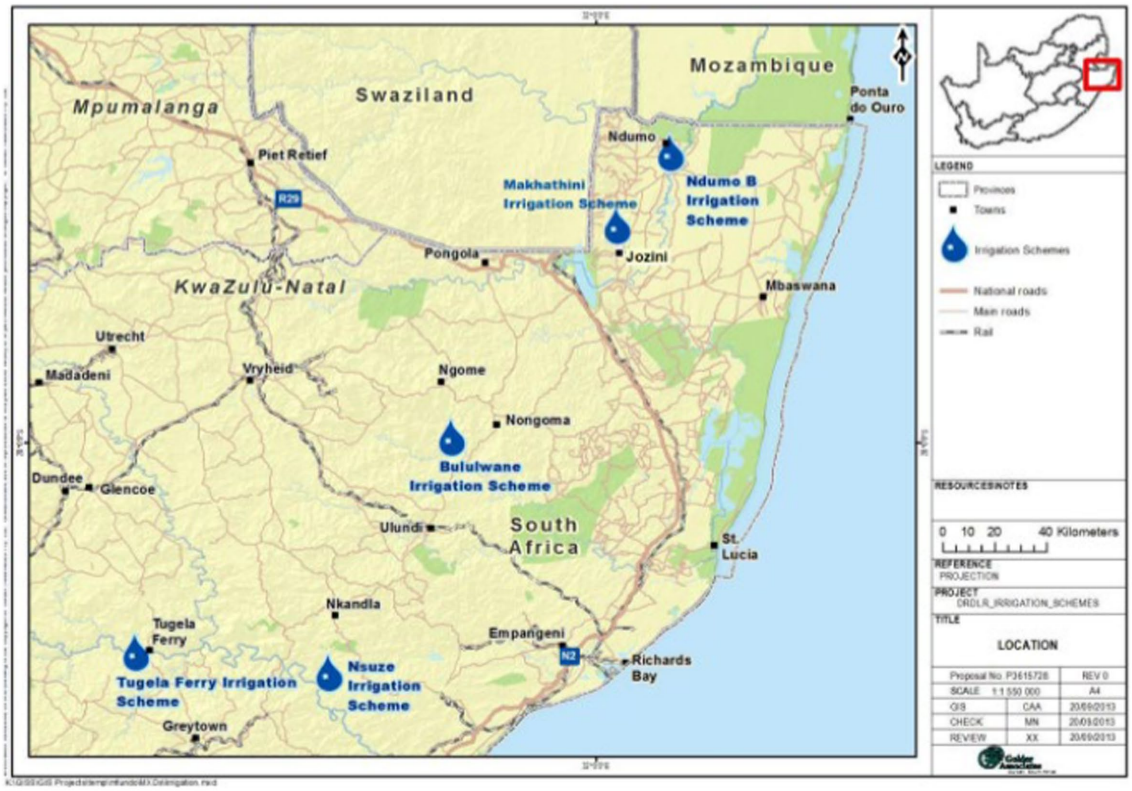

FIGURE 1
Location of Makhathini, Ndumo-B, Tugela Ferry and Bululwane irrigation schemes. Source: Wale and Chipfupa (2018).

$$L = E(L_M) - E(L_F) \tag{1}$$

where $E(L)$ denotes the expected value of the outcome variable i.e. income for male (L_M) and female (L_F), is accounted for by group differences in the predictors. Again, based on the linear model, further equations may be expressed as:

$$L_\ell = X_\ell'\beta_\ell + \varepsilon_\ell,\ E(\varepsilon_\ell) = 0,\ \varepsilon_\ell\{M,L\} \tag{2}$$

where X is a vector containing the predictors and a constant, β contains the slope parameters and the intercept, and ε_ℓ is the error, the mean outcome difference can be expressed as the difference in the linear prediction at the group-specific means of the regressors. This can also be expressed as:

$$L = E(L_M) - E(L_F) = E(X_M)'\beta_M - E(X_F)'\beta_F \tag{3}$$

This equation can be expressed as

$$E(L_\ell) = E\left(X_\ell'\beta_\ell + \varepsilon_\ell\right) = E\left(X_\ell'\beta_\ell\right) + E(\varepsilon_\ell) = E(X_\ell)'\beta_\ell \tag{4}$$

with the assumption that $E(\beta_\ell) = \beta_\ell$ and $E(\mu_i) = 0$.

To identify the contribution of group differences in predictors to the overall outcome difference, Eq. 4 can be rearranged as follows (see Daymont and Andrisani, 1984; Jann, 2008):

$$L = \left[E(X_M) - E(X_F)\right]'\beta_F + E(X_F)'(\beta_M - \beta_F) + \left[E(X_M) - E(X_F)\right]'(\beta_M - \beta_F) \tag{5}$$

This is a "three-fold" decomposition, that is, the outcome difference is divided into three components:

$$L = A + B + C \tag{6}$$

i.e. $$A = \left[E(X_M) - E(X_F)\right]'\beta_F,$$

This indicates the portion of the differential that is due to group differences in the predictors such as socio-economic and institutional factors (the "endowments effect" or "the effect explained").

$$B = E(X_F)'(\beta_M - \beta_F),$$

This measures the contribution of differences in the "coefficients" or commonly referred to as "returns" or "structural effect" or "unexplained" (including differences in the intercept). In other words, this component measures the change in female's income when male's coefficients are applied to female's characteristics.

$$C = \left[E(X_M) - E(X_F)\right]'(\beta_M - \beta_F)$$

This measures the interaction term accounting for the fact that differences in endowments and coefficients exist simultaneously between the two groups.

Component A which has been derived from the decomposition (Eq. 7) is formulated from the viewpoint of female group. That is the group differences in the predictors are weighted by the coefficients of female group to determine the endowment effect (*E*). This implies that the *E* component measures the expected change in female's mean outcome, if female had male's predictor levels. Similarly, for the second component (*B*), the differences in coefficients are weighted by female's predictor levels. That is, the second component measures the expected change in female's mean outcome if female had male's coefficients. Naturally, the differential can analogously be expressed from the viewpoint of the male, yielding the reverse three-fold decomposition:

$$L = \left[E(X_M) - E(X_F)\right]'\beta_M + E(X_M)'(\beta_M - \beta_F) + \left[E(X_M) - E(X_F)\right]'(\beta_M - \beta_F) \quad (7)$$

In this case, the "endowments effect" amounts to the expected change in the male's mean outcome, if the male had female predictor levels. The "coefficient effect" quantifies the expected change in male's mean outcome if male had female's coefficients. In addition, Neumark (1998) and Oaxaca and Ransom (1994) proposed that a pooled model should be estimated in deriving the counterfactual coefficient vector. Since this is an extension of the standard-B model, the Neumark command in Stata was also used to show the male and female advantages over gender farm income (Danso-Abbeam et al., 2020b; Bello et al., 2021a,b).

3.5. Computation of on-farm income

Since the majority of the inputs used by farmers did not vary significantly, gross income per hectare was used instead of gross margin. However, the overall costs of inputs used (seedlings, fertilizer, pesticides, herbicides, and transport expenses) were relatively small to affect the gross income per hectare of farmers as the amount of output targeted was little (Mkuna and Wale, 2022).

4. Results and discussion

4.1. Disaggregating gender characteristics among farmers

Table 1 lists the variables, measurement, and gender analysis of the demographic, farm-specific, and institutional variables used to create the models from the sampled farmers.

Table 1 indicates that the farms managed by male had a significantly higher farm income (R26,788) than farms managed by females (R13,152). These results are similar to those in Table 2. They will further be discussed after the presentation of the Blinder-Oaxaca decomposition model results (second step). Moreover, the variable

TABLE 1 Gender disaggregated descriptive statistics.

Variables	Measurement	Male	Female	*t*-test
AGE	Number of years	49.62	48.84	0.595
MARITAL	1 = Married, 0 = Otherwise	0.45	0.45	0.994
EDUC	Years of education	5.08	4.33	0.155
HHSIZE	Number of household members	7.2	7.22	0.936
RELATION_HH	1 = Head of household, 0 = Otherwise	0.059	0.112	0.0018**
OCCUP	1 = Full time farmer, 0 = Otherwise	0.86	0.87	0.933
IRRIG_EXP	Years of experience in irrigation farming	9.43	10.19	0.550
FARM_INCOME	Farm income from selling cabbage (Rands/ha)	26787.7	13151.99	0.001***
FARM_EXP	Years of experience in farming	13.91	16.49	0.080*
CREDIT	1 = Access to credit, 0 = Otherwise	0.288	0.390	0.066*
REMITTANCE	1 = Access to remittance, 0 = Otherwise	0.629	0.529	0.0618*
DIST_IRR	Walking distance (in minutes) from home to irrigation scheme	11.4	14.2	0.137
DIST_MKT	Walking distance (in minutes) from home to market	39.54	44.90	0.241
CABB_QTY	Quantity of cabbage produced (Kg)	5867.18	3115.76	0.001***
TRAINING_MKT	1 = Access to training on marketing, 0 = Otherwise	0.46	0.4	0.235
TRAINING_PROCESSING	1 = Access to training on processing, 0 = Otherwise	0.35	0.3	0.3448
TRAINING_PRICING	1 = Access to training on pricing, 0 = Otherwise	0.342	0.277	0.2234
TRAINING_PLANNING	1 = Access to training on business planning, 0 = Otherwise	0.198	0.159	0.3752
TRAINING_MGT	1 = Access to training on farm management, 0 = Otherwise	0.243	0.2681	0.627

***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

TABLE 2 Blinder Oaxaca model results for farm income gap that can be attributed to gender.

Variables	Coefficient	S.E	z	p > z
Differential				
Mean farm income/ha for female-managed farm	13,515.93	1,748.058	7.73	0.000***
Mean farm income/ha for male-managed farm	27,148.97	4,800.195	5.66	0.000***
Difference	−13,633	5,108.579	−2.67	0.008*
Decomposition				
Endowments	−12,538.1	4,655.774	−2.69	0.007*
Coefficients	−2,549.77	2,942.419	−0.87	0.386
Interaction	1,454.785	1,958.1	0.74	0.458
Decomposition share (percent)				
Endowments	−91.968			
Coefficients	−18.702			
Interaction	10.665			

1 USD = 10 Rands in 2016, survey year.
***, **, and * are significant at 1%, 5%, and 10% levels, respectively.

(HHS) which indicates farmers' role in the household was significantly different between the two groups. This implies that most of the households were headed by female who also are more experienced in farming than their male counterparts. This finding echos that of Kom et al. (2022) in the Vhembe District of South Africa where they found that female farmers dominated agricultural operations in rural areas. It was also noted that females comprised most of the small-scale farmers and were mostly heads of households.

Again, the difference in CREDIT was statistically significant between the two groups of farmers, implying that access to credit was relatively better to women than men. This result is consistent with those of Baba et al. (2015) and Berger (2021) who found that female farmers are more likely to obtain agricultural financing from formal institutions than male farmers. This is because the majority of lending programs created by banks and other development organizations like NGOs place a greater emphasis on women (Lenka and Agarwal, 2017). Furthermore, women are more prone than men to choose credit because they are seen as the most vulnerable, disadvantaged, and creditworthy groups (Chen et al., 2017).

However, the REMITTANCE variable was also statistically significant and different between the two groups which implies that access to remittance was relatively higher to male household heads than their female counterparts. The Variable CABB_QTY, which indicates the quantity of cabbage produced, was statistically significant and different between the two groups which implies that access to credit was relatively higher to female than male farmers. The findings suggest that male-managed farms had higher level of output than female managed farms which is why it translated into higher farm income to male household heads than their female counterparts.

In sum, the descriptive findings confirm gender differences among farmers. This imbalance is caused by the existence of socio-cultural constraints (Fatoki and Chindoga, 2011), by and large unwritten but entrenched. According to Jones and George (2008), socio-cultural constraints are pressures emanating from the social structures and traditions of a community or a country. Such constraints mainly faced by females include difficulties in securing credit (Gorji and Rahimian, 2011) and owning productive resources such as land or water rights in their communities. Moreover, most females are constrained by their reproductive roles of being wives and mothers, restricted to their homestead duties, and hence cannot engage in other economic activities other than farming. Consequently, males are more likely to be entrepreneurial compared to their female counterparts. This is not because males are more entrepreneurial in their inherent attributes but their freedom and mobility connects them to information and opportunities.

4.2. Determinants of gender income gap among smallholder irrigation farmers

Table 3 presents the determinants of farm income of the overall sample and disaggregated by gender.

EDUC was found to be statistically significant and negatively influencing the income of male managed farms. This evidence suggests that an educated male farmer is earning less farm income than a counterpart. Most of the educated farmers are part-time farmers. This finding is in line with other studies that found that educated female farmers have a higher propensity to adopt improved farming technologies and practices compared to educated male farmers. For example, education enhances adoption of improved varieties by female farmers more than it does for their male counterparts (Anang et al., 2020). Also, other studies found that, in households where women are more educated, there is a higher degree of consensus in farm decision-making, leading to an increase in farm productivity and eventually farm income (Anderson et al., 2017; Bjornlund et al., 2019). However, Wilkening (2019) found contrary findings with this study, and he argued that educated farm women are more likely to be inclined to work outside of the farm.

IRRI_EXP was also statistically significant and positively influenced the farm income for female than male farmers. This implies that female farmers are benefiting more from irrigation experience than their male counterparts. Irrigation experience helps farmers with efficient water management practices which, in turn, increases crop outputs and contribution to household incomes (Belay and Bewket, 2013).

OCCUP was statistically significant and negatively influenced the farm income of overall sample and female farmers. This implies that if the overall sample of respondents as well as female farmers are full time farmers, the farm income will decrease. This could be due to the fact that full time farmers might not have sufficient funds for financing the agricultural operations such as purchases of inputs and hiring of labor. Eventually, full time farmers might not get more income as compared to part-time farmers who can outsource funds from other income generating activities such as business and employment. In addition, CREDIT was statistically significant and negatively influenced the farm income of pooled sample. The reasons could be that farmers in general receive informal credit which is mainly used for consumption and addressing immediate cash-flow issues.

CABB_QTY was statistically significant and positively influenced the overall farm income as more so female farmers than their male counterparts. This suggests economies of scale in cabbage production and marketing. According to Mkuna and Wale

TABLE 3 Model results decomposing farm income by gender and the determinants.

	Pooled sample		Male-managed farm		Female-managed farm	
Variables	Coefficient	S.E	Coefficient	S.E	Coefficient	S.E
AGE	−65.444	350.712	−48.525	66.099	−38.379	108.756
EDUC	204.913	699.388	−481.689	163.899**	−240.401	254.702
HHS	575.563	730.885	57.598	130.519	147.649	218.921
IRRI_EXP	448.305	381.348	105.131	63.002*	182.946	109.112*
TRAINING_MKT	−8,661.783	6,552.248	−205.870	1547.253	−3281.438	2,407.452
OCCUP	−13,625.030	8,058.435*	−2,908.588	1,946.344	−6,229.050	3,033.902**
DIST_IRRI	−75.055	76.508	−0.415	15.588	−24.603	25.639
CABB_QTY	4.527	0.301***	4.157	0.113***	4.382	0.1416***
DIST_MKT	−70.893	159.754	64.855	42.792	−34.261	63.441
CREDIT	−10,594.420	6,334.185*	−1,101.509	1,308.537	−3,116.229	2,135.198
MARITAL	3,180.207	6,701.490	−1,152.727	1,353.585	244.722	2,215.711
TRAINING_MGT	14,453.620	7,567.072*	2,115.977	1,664.817	6,135.946	2,663.586***
EXP_FARM	253.780	361.098	−82.199	64.231	35.615	108.578
_cons	8,173.483	2,0316.700	6,674.733	4,116.105	7,334.977	6,695.056

***, **, and * are significant at 1%, 5%, and 10% levels, respectively.

(2022), increasing cabbage output also helped farmers escape poverty by significantly raising their incomes and lowering poverty. In addition, TRAINING_MGT was also found to be statistically significant and positively influencing the overall income and the incomes of female-managed farms. The findings suggest that female farmers who received training on farm management are earning more income than their male counterparts. Thus, investing on training female farmers has better welfare impact. Therefore, ongoing farm management training on sound agronomic practices and commercial orientation will promote more market participation by female farmers, which will lead to an increase in farm income (Kabir et al., 2019; Martey et al., 2021).

4.3. Blinder Oaxaca model results and discussions

Table 2 shows the findings from the Blinder Oaxaca decomposition method that was used to calculate the percentage of gender differences that could be attributed to: (i) variations in the average characteristics of farm income (endowment effects), (ii) variations in their unexplained part of farm income (coefficients/structural effects), and (iii) interactions of endowments and coefficients.

In Table 2, the mean value of farm income reflects R27,148.97 for men and R13,515.93 for women, leading to a significant positive difference (R13,633). This suggests an uneven situation between men and women regarding farm output and in this case male managed farms earned higher farm incomes than their female counterparts. Similar findings were reported by Anang et al. (2020) who found that in most rural communities, men typically have more ownership and control over the resources and assets used for agricultural production. In addition to farming, women often do petty trading and take other responsibilities at home (e.g. caring for children and the elderly, managing family issues and serving as the first point of call when any shock strikes the family or other families in the community). This limits the amount of time they can spend on the farm and lowers their level of agricultural income.

Furthermore, the findings show that the main source of the gap after decomposing it was the resources/endowments which accounted for about 92% of the farm income gap. The endowment effect is negatively related to the gender income gap, i.e., increasing the endowment/resources held by the female-managed farms is likely to significantly reduce the observed gender farm income gap and improve the well-being of female-headed households. These results are consistent with Mukasa and Salami (2015) who found that female-managed farms have clear endowment disadvantages in farm size, use and intensity of non-labor inputs/services. Dolan (2004) also found that male-managed farms obtained significantly higher incomes compared to female-managed farms. This was attributed to cultural norms and inequality of access to productive resources, mainly land and capital. Simtowe (2010) further found that the male-managed farms obtained significantly higher incomes compared to female-managed farms. As a result, women were pushed into low-wage labour. On the other hand, the coefficient and interaction terms are not significant sources of the income gap though they collectively account for almost 8% of the gender income gap.

4.4. Further decomposition of farm income gap

Since the results in Table 2 show that the income gap between men and women in the study area was statistically influenced by endowment factors while coefficient (structural) and interaction factors were not significant, further decomposition (Table 4) of the determinant factors focused on the endowment part of the farm income gap. A positive and significant coefficient means that a given

TABLE 4 B-O decomposition results for farm income endowment factors.

Variables	Coefficient	S.E	*T*	*p* > *t*
AGE	0.024	0.013	1.86	0.068*
RELATION_HH	−0.091	0.053	−1.73	0.090*
EDUC	−0.024	0.037	−0.64	0.527
HHS	0.014	0.030	0.47	0.643
OCCUP	−0.684	0.420	−1.63	0.109
EXP_FARM	−0.025	0.014	−1.81	0.076*
REMITTANCE	0.083	0.041	2.00	0.050**
CREDIT	0.612	0.340	1.8	0.077*
DIST_MKT	0.009	0.010	0.9	0.374
DIST_IRR	0.006	0.003	1.71	0.093*
TRAINIG_PROCESSING	−0.367	0.476	−0.77	0.444
TRAINING_PRICING	−0.393	0.516	−0.76	0.449
TRAINING_PLANNING	−0.424	0.629	−0.68	0.502
TRAINING_MGT	0.569	0.540	1.05	0.297
_cons	7.456	0.875	8.52	0.000

** and * designate significance at 5% and 10%, respectively.

TABLE 5 Decomposition results of the income differential using the Neumark method.

Results	Coefficients	Percentage
Omega=1 (Men)		
Characteristics	12,538.05	91.97
Coefficients	1,094.983	8.03
Omega=0 (Women)		
Characteristics	11,083.27	81.30
Coefficients	2,549.768	18.70
Omega=wgt (Neumark weight)		
Productivity	11,891.57	87.23
Advantage	1,153.859	8.46
Disadvantage	587.6135	4.31
Raw	13,633.04	100

variable increases the gender endowment gap or it makes men disproportionately benefit in terms of resource the endowment difference between male and female farmers. On the contrary, a negative and significant coefficient means that the variable reduces the gap.

AGE was a statistically significant factor and increases the gender-based resource access/endowment gap. In addition, since there are more older male farmers than female farmers, they have better resource endowment. To the extent that resource endowment translates to better farm income, older men will earn higher income than women most of whom are relatively younger. Other studies also found that older farmers with longer farming experience invest more of their accumulated wealth of experience and resources than the younger ones (Adimassu et al., 2012; Oduniyi and Olawuyi, 2020). Sharaunga et al. (2016) also found that older farmer's households tend to earn more from smallholder farming. Such households are more likely to have accumulated assets, have adult children who can contribute labour to the household's own production.

The variable RELATION_HH was found to be statistically significant and reduces the gender-based resource access/endowment gap. This further suggests that being a head of household reduces the farm income gap in terms of gender. Specifically, most of the female farmers, on average, were the head of the household which indicates that women farmers who are head of household earn higher than their counterparts. This could be because being head of household enables women to have access to household resources, making it possible to allocate and invest on their farm.

On the other hand, REMITTANCE and CREDIT were both statistically significant and increases the gender-based resource access/endowment gap. This indicates that both access to remittance and credit increase the farm income gap in terms of gender. Specifically, male received more remittance than women (see Table 1) which suggests that they are employing these funds to enhance the profitability of their farms and earn higher farm income. On the other hand, women receive more credit than men which also suggests that women who receive credit earn higher farm income than men in the South African context.

In addition, EXP_FARM was also found statistically significant and reduces the gender-based resource access/endowment gap. This indicates that farming experience reduces farm income gap. In this study, female farmers who, on average, were found to be more experienced in farming than their male counterparts, earn higher income. This might be attributed to the fact that more experienced female farmers usually diversify their income sources to earn off-farm income, invest on the farm and support their livelihoods. Ma et al. (2019) have also found that years of farming experience may also affect revenue earned off the farm. As farming experience grows, so does the possibility that household heads will make money off the farm.

DIST_IRR was also found statistically significant and increases the gender-based resource access/endowment gap. This suggests that distance taken by female farmers to the irrigation farms increases the farm income gap with their male counterparts. This is because the time taken from their homes to the farms consumes most of their energy but also hinders them to be productive. In some cases, they are also expected to be back home early for house chores.

4.5. Neumark decomposition results

Table 5 presents a detailed decomposition using the methodology proposed by Neumark for a given set of socioeconomic, institutional, and input factors. It presents the income differential between men and women.

The decomposition results show gender-induced income differences and the advantage of the favoured group which is men (that is, a group advantaged in terms of access to assets). Also demonstrated is the disadvantage of women (that is, a group disadvantaged in terms of access to assets), contributing to the farm gap (Nchanji et al., 2020). The results indicated that differences in farm income between male and female farmers contributed about 87.23% to the overall farm income. The income advantage of men over women contributed 8.46% to the farm income gap while the disadvantage of women over men contributed 4.31%. These findings point to the fact

that farm income gaps between men and women are to a large degree a result of gender differences that could, in turn, be attributed to socio-economic, cultural, historical and institutional factors.

5. Conclusions and recommendations

Low agricultural productivity, which eventually translates into low levels of farm income, has been linked to the high rates of poverty among rural farming communities in Sub-Saharan Africa (SSA) in general in South Africa in particular. Recent research into this topic has shown that a substantial component of this issue is caused by the gender gap in terms of resources and services which, in turn, results in productivity and income gaps. This study estimates the gender gap in farm income among smallholder irrigation farmers in KwaZulu-Natal, South Africa. It unpacks this gap into portions accounted for by differences in farm-manager characteristics and in returns to these characteristics. Evidence from this study shows that there is a significant difference in the determinants of farm income between male and female farmers. Furthermore, there is an uneven gender-based farm income gap, i.e., male farmers earn significantly higher farm income than female farmers. Further analysis employing the Blinder Oaxaca decomposition procedure indicates that differences in farm incomes between male and female farmers can be explained by differences in resource endowments and access to services. In addition, different socio-economic and institutional factors influence the endowment portion of the farm income gap between male and female farmers.

These findings suggest that existing and future programs should focus on resource accumulation for farmers (e.g., increasing productive capacity and building technical knowledge through training programs) since the quantity of cabbage output seems to influence the farm income for both male and female farmers. Specifically, investing on training female farmers has better welfare impact. Also, since the gender-based farm income gap was found to be largely influenced by farmers' endowment factors and not because of being male or female (unexplained factors), any intervention to reduce the gap should focus on improving women farmers' access to resources, technology and services. This is reinforced by the evidence that both access to credit and remittance were significant factors influencing farm endowment income. Access to finance can aid in financing the investments required to increase competitiveness and distribute the advantages of competition among communities.

There is a need for mindset shift and cultural transformation on value systems that have long existed and are still held by communities and traditional leaders in rural areas. These changes should be able to redress the gender and age-based stereotypes and improve equitable access to land, inputs, technology and other services, regardless of their age, gender, and marital status. Women have to be empowered in terms of access to services and resources such as land with tenure security, agricultural input and output markets, training, information, and credit. It is possible to achieve this by expanding and deepening the range of private sector financial services available to fund small-scale farming, which has a significant potential to boost smallholder competitiveness because credit was found to be statistically significant factor in influencing farm income. Further analysis of the significant endowment effects from the Blinder Oaxaca framework shows that increasing the endowment/resources held by the female-managed farms is likely to significantly close the observed gender-based farm income gap and improve the well-being of female-headed households.

In addition, it would be of interest for future studies to focus on the spatial analysis of gender differentials across different localities to find out if variations in on-farm income between male and female plot farm owners is due to locality or other aspects beyond what this study has covered.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

EM analyzed data and wrote the original draft of the manuscript while EW also supervised, corrected and involved in the management of the entire project. All authors contributed to the article and approved the submitted version.

Funding

This paper emanates from a project funded by the Water Research Commission (WRC), South Africa.

Acknowledgments

The authors would like to thank the commission for funding the project (Grant No. K5/2789//4). Special thanks go to the farmers who spent time with the research team and enumerators who worked hard during the data collection.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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