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Demography and Socio-Economic Aspects on Irrigated Smallholder Agricultural Enterprises and Their Association with the Cultivation of Maize (*Zea mays* L.) as a Selected Field Crop

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Abstract

The purpose of this study is to correlate demography and socio-economic aspects at Irrigated Smallholder Agricultural Enterprises and their association with the Cultivation of Maize in order to determine its positive impacts at irrigated smallholders' agricultural entrepreneurs' household. Chi-square test was used as descriptive analysis method. The Fischer Exact tests were employed to test demography (gender, age, education, and income) in winter and summer production season of irrigated smallholder agricultural enterprises and their association with the cultivation of selected field crop (*i.e.* maize). The results show that gender results were not being statistically significant, as measured by the Phi measure of effect size, $\varphi = 0.149$, $p = 0.011$, and $\varphi = 0.05$, $p = 0.392$ in summer. As far as age is concern, it appears to be a statistically significant association between cultivating maize and age in winter, $\varphi = 0.046$, $p = 0.730$ in winter and $\varphi = 0.172$, $p = 0.013$. Education winter result not being statistically significant, the effect size showed a weak association, as measured by the Phi measure of effect size, $\varphi = 0.112$, $p = 0.305$ and $\varphi = 0.035$, $p = 0.948$ in summer. Income result not being statistically significant, as measured by the Phi measure of effect size, $\varphi = 0.049$, $p = 0.399$ and $\varphi = 0.081$, $p = 0.166$ in summer. In conclusion, the study shows that the development of best management practices must be based on a comprehensive analysis of the livelihoods and irrigated smallholder agricultural enterprise farming styles of participating irrigated smallholder agricultural entrepreneurs.

Keywords

Maize, Association, Irrigated Smallholder Agricultural Enterprises, Demography, Livelihoods

1. Introduction

Maize is described as a cereal crop from the family Graminea with the botanical name, *Zea mays* L., and is grown and used as staple food. In support of the above, it is also the most important summer crop in terms of the area devoted to the crop and number of growers [1]. Moreover, it is produced throughout the country under diverse environments [2]. Successful maize production depends on applying the correct sustainable practices that will sustain the environment, as well as agricultural production. These sustainable practices include soil tillage system, rainwater harvesting technique and water-use efficiency, integrated pest management and integrated nutrient management. If the production area receives less rainfall than the potential required, irrigation should supplement available moisture. Improving water use efficiency in irrigation farming is more imperative than ever [3].

Higher-yielding maize cultivars are vital to achieve a high yield of maize. This means that the Irrigated Smallholder Agricultural Enterprises led by Women and Youth (ISHAE-WY) must be knowledgeable at both the sophisticated maize production process and practices as well as at engagements with agribusiness that controls the markets. South Africa experienced a decline reaching about 8.2 million metric tons [4]. According to [5], in 2018/2019, the total production of maize amounted to 10.51 million metric tons for human food consumption whereas in 2020/2021, the total production of maize amounted to roughly 15.8 million metric tons. However, from 2000 to 2021, an increase of roughly 96.3 percent can be recognized [5]. According to [5] further indicated that Free State was the province with the highest production in all nine provinces with approximately 44.3 percent of the overall production. The lowest state was Western Cape producing 36 thousand metric tons of maize [5]. According to [6], maize planted at 2.60 million hectares in the 2022/23 season, and this area is slightly below the 2021/22 season of 2.62 million hectares. [3] further indicated that South Africa's maize harvest could amount to 15.00 million tons in the 2022/23 season, marginally down from 15.33 million tons of the 2021/22 season. Since maize is the dominant staple crop in South Africa, it could have substantial positive impacts on the livelihoods and food security of smallholder farmers [7]. The objective of this study was to determine the demography and livelihoods at Irrigated Smallholder Agricultural Enterprises led by women and youth (ISHAE-WY) in association with the cultivation of maize as selected field crop. The information generated from the study is important for guiding future research, ISHAE-WY development and the rehabilitation of maize commodity in Vhembe

District Municipality.

2. Methodology

2.1. Site Description

The research project was conducted at Madimbo Corridor and Upper Mutale Valley smallholder irrigation schemes. Madimbo Corridor is situated at Musina Local Municipality, whereas Upper Mutale Valley is based at Thulamela Local Municipality. All these municipalities are situated in Vhembe District Municipality of Limpopo province in South Africa. The agro-ecological condition at Madimbo Corridor is semi-arid, whereas Upper Mutale Valley is sub-humid. Observations show that conditions are significantly different. This confirms that the variables of smallholder irrigation enterprises are affected by diversity and similarities attributed to different demographic and livelihood needs.

This irrigated smallholder agricultural enterprises obtains bulk water from the Cross dam (Gondoza dam). The Cross dam provides balancing storage and also distribute water to irrigated smallholder agricultural enterprises using different electric pumps which owned by entrepreneurs. On the other side of Nwanedi (Madimbo corridor) which is Gumbu area, they depend on the underground water only because there is no river next to the production area. The irrigated smallholder agricultural area at Tshiombo (Upper Mutale Valley) obtains its bulk water from Mutale River. The water weir is used for distribute water to irrigated smallholder agricultural enterprises using canal irrigation water at Tshiombo (Upper Mutale Valley).

2.2. Sampling Procedure

Systematic purposive sampling was used to select ISHAE-WY within districts with strong emphasis on women and youth. We used stratified sampling to obtain a representative sample of villages and households for interview [8]. A two-stage random sampling process was conducted using SURVEYSELECT procedure of SAS. The PROC SUREVEYSELECT allows selection of probability-based random sampling where sampling in different categories or class depends on the number of units within that class. It is appropriate for handling selection bias.

2.3. Data Collection

A semi-structured household questionnaire was used to survey with an emphasis on ISHAE-WY. The total number of ISHAE-WY interviewed were two hundred and ninety-four (N = 294) with a response rate of 75 percent. The sample was made up of 71 youths aged 18 - 35 years old (56 females and 15 males) and 223 women of whom 153 were adults (36 - 59 years) and 70 pensioners (≥60 years old).

2.4. Data Analysis

The Statistical Package for the Social Sciences (SPSS) Version 22 was used to

analyse quantitative data. Descriptive statistics included frequency tables and measures of central tendency. Inferential statistics were in the form of chi-square analyses, which assessed the association between major demographic and socio-economic variables (gender, age, education, and income) and cultivation of maize. Fischer Exact tests were interpreted in cases where the assumptions for chi-square analysis had been violated. A Bonferroni adjustment was made to prevent a type I error; therefore, significance was considered when $p < 0.013$.

3. Results and Discussion

It should be noted that the Bonferroni correction was made due to multiple comparisons with the same dependent variable (cultivating maize); this correction decreases the possibility of making a type I error. Therefore, the significant value of 0.05 was adjusted to 0.013 (0.05/4). This level of significance was too steep for the effects of the demographic traits to be significant.

3.1. The Production Potential of Maize Crop by ISHAE-WY

Maize is regarded as the staple food in Madimbo corridor and Upper Mutale valley irrigation schemes. The average area of maize production was found to be 0.75 ha per farmer. The production potential was found to be about 800 kg per ha. This shows that the commodity seems to be more for household food security than market oriented. The average price earned for the production was R3 200.00 in an informal market priced at R4.00 per kilogram. The formal market potential for ISHAE-WY tended to decline due to a lower price offer of R2.88 per kilogram, which then would offer a lower income of R2304.00.

3.2. The Association between Cultivating Maize and Gender

A chi-square test was conducted for association between cultivating maize and gender in winter and summer (**Table 1**). The results for the winter season indicated that not all the expected cell frequencies were greater than five to comply with the chi-square test. The assumption for the test was violated and the Fischer Exact test conducted. After a Bonferroni correction, the Fischer Exact test showed that there was no statistically significant association between cultivating maize and gender, $p = 0.022$. It was determined that that 40.0% males cultivated maize compared to 15.1% females. In line with the result not being statistically significant, the effect size showed a weak association [9], as measured by the Phi measure of effect size, $\varphi = 0.149$, $p = 0.011$. Similarly, for the summer season, the assumption was violated for chi-square test. The Fischer Exact test showed that there was no statistically significant association between cultivating maize and gender, $p = 0.156$. It was determined that 86.7% males cultivated maize compared to 66.7% females. In line with the result not being statistically significant, the effect size showed a weak association [9], as measured by the Phi measure of effect size, $\varphi = 0.094$, $p = 0.107$.

The chi-square tests generated provided insights into different socio-economic

and biophysical features of ISHAE-WY. [10] showed that there are different roles played by gender in ISHAE-WY. Their findings were corroborated [11] stating that the primary pathway through which gender systems affect growth are by influencing the productivity and efficiency of the economy. Gender plays an important role in development and would therefore influence the profitability of ISHAE-WY. This participant includes those females who are divorced, single or widowed.

Table 1. Association between gender of ISHAE-WY and seasonal cultivation of maize crop in Vhembe District Municipality of Limpopo Province, South Africa.

Gender	Variable	Winter		Summer	
		No	Yes	No	Yes
Male	Count	9		2	13
	Expected Count	12.6	2.4	4.8	10.2
	% within gender of respondent	60.0%	20.0%	13.3%	86.75%
	% within season's crop: maize	3.5%	12.5%	2.1%	6.5%
	% of total	3.1%	2.0%	7%	4.4%
Female	Count	237	42	92	186
	Expected Count	233.4	45.6	90.2	188.8
	% within gender of respondent	84.9%	15.1%	33.3%	66.7%
	% within season's crop: maize	96.3%	87.5%	97.9%	93.9%
	% of total	80.6%	14.3%	31.6%	63.3%
Total	Count	246	48	95	199
	Expected Count	246.0	48.0	95.0	199.0
	% within gender of respondent	83.7%	16.3%	32.3%	67.7%
	% within season's crop: maize	100.0%	100.0%	100.0%	100.0%
	% of total	83.7%	16.3%	32.3%	67.7%
		χ^2 (2) = 0.628, p = 0.730		Not Significant	

The female inclusion could be that most men work far away from their homes and women are the ones left at home to take care of the children and farm. The involving of women's participation in the smallholder irrigation farming practices can reduce the men's burden of being the only source of income in the rural household. This also can alleviate poverty and grow the local economy of Vhembe District.

3.3. The Association between Cultivating Maize and Age

A chi-square test was conducted for association between cultivating maize and age (Table 2). In winter, a chi-square test for association was conducted between

cultivating maize and age. All the expected cell frequencies were greater than five, complying with the assumption of the chi-test.

Table 2. Association between the age of ISHAES W-Y and seasonal cultivation of maize crop in Vhembe District Municipality of Limpopo Province, South Africa.

Age (Years)	Variable	Winter		Summer	
		No	Yes	No	Yes
18 - 35	Count	59	12	33	38
	Expected Count	59.4	11.6	22.9	48.1
	% within gender of respondent	83.1%	16.9%	46.5%	53.5%
	% within season's crop: maize	24.0%	25.0%	34.7%	19.1%
	% of total	20.1%	4.1%	11.2%	12.9%
36 - 59	Count	128	27	44	111
	Expected Count	129.7	25.3	50.1	104.9
	% within gender of respondent	82.6%	17.4%	28.4%	71.6%
	% within season's crop: maize	52.0%	56.3%	46.3%	55.8%
	% of total	43.5%	9.2%	15.0%	37.8%
>60	Count	59	9	18	50
	Expected Count	59.9	11.1	22.0	46.0
	% within gender of respondent	86.8%	13.2%	26.5%	73.5%
	% within season's crop: maize	24.0%	18.8%	18.9%	25.1%
	% of total	20.1%	3.1%	6.1%	17.9%
Total	Count	246	48	95	199
	Expected Count	246.0	48.0	95.0	199.0
	% within gender of respondent	83.7%	16.3%	32.3%	67.7%
	% within season's crop: maize	100.0%	100.0%	100.0%	100.0%
	% of total	83.7%	16.3%	32.3%	67.7%
		χ^2 (2) = 0.628, p = 0.730		χ^2 (2) = 8.668, p = 0.013	

The results indicated that there was no statistically significant association between cultivating maize and age, χ^2 = 0.628, p = 0.730. It was determined that 16.9% of 18 - 35-year participants cultivated maize, compared to 17.4% and 13.2% of 36 - 59 year participants and >60 year participants respectively. In line with the result not being statistically significant, the effect size showed a weak association [9], as measured by the Phi measure of effect size, φ = 0.046, p = 0.730. Therefore, in summer, a chi-square test for association was conducted between cultivating maize and age.

Similarly, after a Bonferroni adjustment, there was no statistically significant association between cultivating maize and age, $\chi^2 = 8.668$, p = 0.013. It was determined that 53.5% of 18 - 35-year participants cultivated maize compared to 71.6% of 36 - 59-year participants and 73.5% of >60 year participants. In line with the result not being statistically significant, the effect size showed a weak association [9], as measured by the Phi measure of effect size, $\varphi = 0.172$, p = 0.013.

The age of an individual is one of the most important factors that determine the way he or she thinks and behaves [12]. In support of the same narrative, [13]] indicated that age was found to be an important factor in diverse agricultural enterprises. It was also stated that most socio-economic studies have shown age to be inversely related to performance. The types of decisions made by elderly people and their behaviour tend to be different from their younger counterparts, e.g. they are not willing to be trained as they prefer and stick to their older production practices and not interested in new technologies which were developed to increase the yield. The age of ISHAE-WY has a strong effect on the family's agricultural productivity and profitability, and this could be a result of the influence of age on such variables as education and farming experience.

The involvement of pensioners (above 60 years of age) might indicate that they are still willing to work hard and provide for their families while they are old, even though they might not be able to work for longer hours. [14] as cited by [15] confirm that negative correlation (Pearson r = −0.272; p = 0.037) was found between age and the level of education, indicating that older farmers tended to have lower levels of education. Age has a negative impact on the achievement of sustainable agriculture for smallholder farmers [16].

ISHAE-WY is observed to be operating less productively due to their age, in comparison to youthful age, which seems to be more productive. Most of the youth in the area may not be interested in farming work, having left the area in search of higher paying employment [17] for white-collar jobs, thereby creating a gap.

3.4. The Association between Cultivating Maize and Education

A chi-square test was conducted for association between cultivating maize and household head education, both in winter and in summer (**Table 3**). In winter, a chi-square test for association was conducted between cultivating maize and household head education. All the expected cell frequencies were greater than five and did not violate the chi-test assumptions. The results showed that there was no statistically significant association between cultivating maize and household head education, $\chi^2 = 3.622$, p = 0.305. It was determined that 13.1% of participants with household head having no/primary education cultivated maize, while 14.7% of participants with household head having secondary education cultivated maize, and 27.3% and 16.0% of participants with household heads with tertiary education and ABET respectively cultivated maize. In line with the result not being statistically significant, the effect size showed a weak association

[9], as measured by the Phi measure of effect size, $\varphi = 0.112$, p = 0.305. Similarly, for the summer season there was no statistically significant association between cultivating maize and household head education, $\chi^2 = 0.364$, p = 0.948.

Table 3. Association between the education of ISHAE-WY and seasonal cultivation of maize crop in Vhembe District Municipality.

Education	Variable	Winter		Summer	
		No	Yes	No	Yes
Primary	Count	53	8	19	42
	Expected Count	51.1	9.9	19.9	41.1
	% within gender of respondent	86.9%	13.1%	31.1%	68.9%
	% within season's crop: maize	21.7%	17.0%	20.0%	21.4%
	% of total	18.2%	2.7%	6.5%	14.4%
Secondary	Count	99	17	40	76
	Expected Count	97.3	18,7	37.9	78.1
	% within gender of respondent	85.3%	14.7%	34.5%	65.5%
	% within season's crop: maize	40.6%	36.2%	42.1%	38.8%
	% of total	34.0%	5.8%	13.7%	26.1%
Tertiary	Count	24	9	11	22
	Expected Count	27.7	5.3	10.8	22.2
	% within gender of respondent	72.7%	27.3%	33.3%	66.7%
	% within season's crop: maize	9.8%	19.1%	11.6%	11.2%
	% of total	8.2%	3.1%	3.8%	7.6%
ABET	Count	68	13	25	56
	Expected Count	67.9	13.1	26.4	54.6
	% within gender of respondent	80.4%	16.0%	30.9%	69.1%
	% within season's crop: maize	27.9%	27.7%	26.3%	28.6%
	% of total	23.4%	4.5%	8.6%	19.2%
Total	Count	244	47	95	196
	Expected Count	244.0	47.0	95.0	196.0
	% within gender of respondent	83.8%	16.2%	32.6%	67.4%
	% within season's crop: maize	100.0%	100.0%	100.0%	100.0%
	% of total	83.8%	16.2%	32.6%	67.4%
		χ^2 (3) = 3.622, p = 0.305		χ^2 (3) = 0.364, p = 0.948	

It was determined that 68.9% of participants with household heads having no/primary education, while 65.5% of participants with household heads having secondary education and 66.7% and 69.1% of participants with household heads with tertiary education and ABET respectively. In line with the result not being statistically significant, the effect size showed a weak association [9], as measured by the Phi measure of effect size, $\varphi = 0.035$, $p = 0.948$. A review of literature shows that education is a vital force to reckon with in effective farming household performance and could inform on how best a new technology is adopted [13]. According to [18], education enables farmers to appreciate the advantages of new technologies. In this study, there were 68.9% of ISHAE-WY that had no education or primary level.

Low levels of farmers' education were reported in several studies as a limiting factor, resulting in inability to interpret market information to be used in production planning and marketing in South Africa [19]. Better education may, therefore, be associated with improved adaptive capacity to adverse effects of climate change and variability. A farmer's level of education has a direct impact on his/her ability to properly manage a given irrigation technology, but lack of formal training in agriculture for most farmers could pose a limitation to their productivity.

3.5. The Association between Cultivating Maize and Income

A chi-square test was conducted for association between cultivating maize and monthly income in winter and in summer (**Table 4**).

In winter, a chi-square test was conducted for association between cultivating maize and monthly income. All the expected cell frequencies were greater than five and did not violate the chi-test assumptions. The results indicated that there was no statistically significant association between cultivating maize and monthly income, $\chi^2 = 0.711$, $p = 0.399$. It was determined that 17.3% of participants earning <R5000 a month cultivated maize, compared to 13.0% of those earning >R5000 a month.

Table 4. Association between monthly income of ISHAE-WY and seasonal cultivation of maize crop in Vhembe District Municipality.

Income	Variable	Winter		Summer	
		No	Yes	No	Yes
<R5000	Count	186	39	68	157
	Expected Count	188.3	36.7	72.7	152.3
	% within gender of respondent	82.7%	17.3%	30.2%	69.8%
	% within season's crop: maize	75.6%	81.3%	71.6%	78.9%
	% of total	63.3%	13.3%	23.1%	53.4%

Continued

>R5000	Count	60	9	27	42
	Expected Count	57.7	11.3	22.3	46.7
	% within gender of respondent	87.0%	13.0%	39.1%	60.9%
	% within season's crop: maize	24.4%	18.8%	28.4%	21.1%
	% of total	20.4%	3.1%	9.2%	14.3%
Total	Count	246	48	95	199
	Expected Count	246.0	48.0	95.0	199.0
	% within gender of respondent	83.7%	16.7%	32.3%	67.7%
	% within season's crop: maize	100.0%	100.0%	100.0%	100.0%
	% of total	83.7%	16.3%	32.3%	67.7%
		χ^2 (1) = 0.711, p = 0.399		χ^2 (1) = 1.916, p = 0.166	

In line with the result not being statistically significant, the effect size showed a weak association [9], as measured by the Phi measure of effect size, $\varphi = 0.049$, p = 0.399. Similarly, in summer there was no statistically significant association between cultivating maize and monthly income, $\chi^2 = 1.916$, p = 0.166. It was determined that 69.8% of participants earning <R5000 a month cultivated maize, compared to 60.9% of those earning >R5000 a month. In line with the result not being statistically significant, the effect size showed a weak association [9], as measured by the Phi measure of effect size, $\varphi = 0.081$, p = 0.166.

The results seem to corroborate the trend that supports the commodity as a food security aligned crop. Family enterprises that earn less than R5000 had higher participation at 17.3% as compared to 13%. The exceptional role played by smallholder farmers in developing Africa's agriculture, brings about high economic interest and, indeed, raises additional incomes at the farm or farmer level, all things remaining equal [20]. This could be because farmers who use ISHAE-WY can intensify and diversify their agricultural activities, which increases their production. In South Africa, the potential grain yields that can be obtained under irrigation maize farming could range from 7 - 12 tons per ha [21]. Therefore, youths' increased access to formal education will likely make these communities more productive, and more amenable to accept, initiate, and manage development projects as opposed to the less economically active groups [22]. According to [23], household income is also one of the determinants of the amount of credit that can be borrowed by the farmers. Farmers with higher incomes are likely to embrace and will be interested in adapting by changing practices and modern methods such as irrigation to cope with the changing climate [24].

4. Conclusion

The results of the study indicated that gender, age, education, and income did

not statistically influence the production of maize in the Madimbo Corridor in Musina Local Municipality and Mutale Valley in Thulamela Local Municipality. The study revealed that the ISHAE-WY are characterised by small land areas under maize cultivation. In return, youth farmers should help transfer technology and information to older farmers. Market channels and access should be promoted for ISHAE-WY to enable them to earn income through formal markets. There is a need to identify crops that are higher yielding, but less demanding as regards nutrient requirements [25].

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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