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Correlation of demographic factors with cultivation of sweet potatoes (*ipomoea batatas l.)* at irrigated smallholder agricultural enterprises in vhembe district, RSA

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Abstract
The study takes place at upper Mutale valley and Madimbo corridor Irrigated Smallholder Agricultural production area. The purpose of the study was to Outline Perspective of Irrigated Smallholder Agricultural Enterprises in Vhembe District through Correlation for Demography and Livelihoods in Association with the Cultivation of Sweet Potatoes as Selected Field Crop. Chi-square test was used as descriptive analysis method through application of Fischer Exact test. 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. Sweet potatoes). The A Correlation for Demography and Livelihoods in Association with the Cultivation of Sweet Potatoes as Selected Field Crop were determined and associated. The results show that, gender is statistically significant, the effect size showed a weak association (Cohen, 1988), [6] as measured by the Phi measure of effect size, $\varphi = 0.173$, $p = 0.003$ in winter and $\varphi = 0.095$, $p = 0.103$ in summer. In Age, the result not being statistically significant, the effect size showed a weak association, as measured by the Phi measure of effect size, $\varphi = 0.032$, $p = 0.863$ in winter, while $\varphi = 0.047$, $p = 0.727$ in summer. As far as Education is concern, the result not being statistically significant, the effect size showed a weak association, as measured by the Phi measure of effect size, $\varphi = 0.127$, $p = 0.197$ in winter production season and $\varphi = 0.091$, $p = 0.492$ in summer. In income, the result not being statistically significant, the effect size showed a weak association, as measured by the Phi measure of effect size, $\varphi = 0.012$, $p = 0.841$ in winter and $\varphi = 0.017$, $p = 0.774$. In conclusion, the study has an impacts of the demographic and livelihoods in correlation with cultivation of sweet potato as a selected field crop. It should be noted that a Bonferroni correction was made due to multiple comparisons with the same dependent variable (cultivating Sweet potato), 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 significance.

Keywords: Demography, fischer exact test, madimbo corridor, upper mutale valley, sweet potato

Introduction

Sweet potato (*Ipomea batata L.*) is a vibrant traditional crop that is cultivated usually by small-scale farmers, primarily for family consumption. It is customarily viewed as a crop for the rural poor as it is typically grown and consumed by resource-poor families, and especially by women. Sweet potato is a crop that has a wide ecological adaptation, drought tolerance and short maturity period of three to five months (Agili, *et al.*, 2012). [2] In the semi-arid agro-ecological zone, this crop depends mostly on irrigation, and it gives satisfactory yields under adverse climatic and soil conditions, as well as under low or non-use of external inputs (Githunguri and Migwa, 2004; Carey *et al.*, 1999; Ndolo *et. al.*, 2001; Kung'u, 1999). [11, 5, 28, 15] As a crop suitable for food security, it can be harvested in phases depending on the needs of the household. The crop offers a flexible source of food and income to rural families who are mostly susceptible to crop failure, and subsequently unstable cash income. It is also an exceptional source of vitamin A, especially the orange-fleshed varieties (Ndolo *et al.*, 2001). [28] However, Stathers *et. al.*, (2005) [30] indicated that most varieties in sub-Saharan Africa are white-fleshed, low yielding and lacking beta-carotene, the precursor of vitamin A. Sweet potato is cultivated throughout tropical and warm temperature regions, wherever there is sufficient water to support growth. The major production areas of sweet potato in South Africa are Limpopo (Hoedspruit, Marble Hall, Burgersfort, Levubu), Mpumalanga (Nelspruit), KwaZulu-Natal and Western Cape (DAFF, 2011). The South African sweet potato production statistics (National Department of Agriculture, 2006) indicate that the industry is comparatively small.

The average annual production was recorded as 51 000–56 000 tons in 2005. The value and average price of sweet potato sold on the fresh produce market for 2005 was 26 938 tons, averaging a value of R 30 076 072—which calculates to a price of R 11 271 per ton. It has been reported that the informal sweet potato sector in South Africa produces large quantities and is marketed informally (Domola, 2003). [9] It was projected that the total land under cultivation in this sector could be 2 000–3 000 ha, with an average yield of 5–10 tons per ha. The average yield within the commercial sector was 40 tons per ha, with land parcels of about 30 ha Laurie, (2004). [16] In comparison with current production, according to Jansen (2022), [13] Sweet potato volumes are usually lower than usual on the fresh produce markets of South Africa. The available volumes on the market had more than halved compared to a years ago while prices rose by 87%. Jansen (2022), [13] further indicated that Johannesburg market agent are currently supplied by a single producer from the northern parts of Limpopo. Popular South African sweet potatoes cultivar sells for between R120 to R150 for a 15kg bag. This shows that an average price is estimated to be R8040 to R10050 per ton.

Though rural households and farmers did not cultivate the crop on large pieces of land, they produced it on any piece of land available in the home garden. This is done for own consumption and to generate income (Domola, 2003). [9] The study conducted by Laurie *et. al.*, (2017) [17] showed that (a) the informal marketing and sales are very irregular, (b) the size of storage was limiting and (c) it is dependent on the place of sale and type of customers. On average, farmers harvested the crop for home consumption with excess sold to the local market. Central to the cultivation of sweet potato by rural households for food security and income is the demography of the farmers producing the crop. It is evident that irrigated smallholder agricultural enterprises women and youth (ISHAE-WY) in rural areas should not be neglected lest their social and economic conditions worsen. Socio-economic factors play a critical role in determining the levels of production undertaken and the sort of crops planted. von Braun and Mirzabaev, (2015) [31] indicated that the production levels are not the only areas affected, but also the way business enterprises are managed, which puts the socio-economic characteristics of the smallholder farmers and entrepreneurs into focus. Previous studies (Mwaniki, 2006; Abdulai *et al.*, 2013; Asante *et al.*, 2013; Onumah *et al.*, 2013) [25, 1, 3, 29] have resolved that if assistance is to be extended to crop producers, their demography is worth investigating to fully comprehend their needs.

The relationship between demography and socio-economic factors will be described in this study to produce appropriate policy information for agricultural stakeholders and the government. The main objective of this study was, therefore, to assess the demography of women and youth agricultural enterprises and the association with the cultivation of sweet potato under smallholder irrigation schemes.

Methodology

1. Site description

The study was conducted at Madimbo Corridor and Upper Mutale Valley smallholder irrigation schemes where the agro-ecological situations are significantly different. The conditions at Upper Mutale Valley are sub-humid and Madimbo Corridor smallholder irrigation scheme is semi-arid. This confirms that the variables of smallholder irrigation schemes are affected by diversity and similarities attributed to different livelihood needs.

The Madimbo Corridor irrigated smallholder agricultural area is situated north-east of the Soutpansberg Mountains. It is located between 22°26'45.34"S latitude and 30°31'18.47"E longitude. Upper Mutale Valley area is located north of Thohoyandou in the Vhembe District of Limpopo. This irrigated smallholder agricultural area lies between 22°47'53.36"S latitude and 30°28'13.21"E longitude.

2. Sampling procedure

Stratified random sampling was used to obtain a representative sample of villages and households for interview (Leedy *et. al,* 2005), [19] with the target population being ISHAE-WY. A two-stage random sampling process was conducted using SURVEYSELECT procedure of SAS. The PROC SUREVEYSELECT allowed for probability-based random sampling where sampling in a category or class depended on the number of units within that class. The sampling was regarded as appropriate for handling selection bias.

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 per cent. The sample was made up of 71 youths aged 18 to 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).

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 variables (gender, age, education, and income) and vegetable/field crop production, water resources and governance. 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 $p < 0.013$.

Results and discussion

It should be noted that the Bonferroni correction was made due to multiple comparisons with the same dependent variable (cultivating sweet potato); 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 significance.

1. The production potential of sweet potato crop by ISHAE-WY

The average area of production under irrigation was 0.53 ha per farmer. The production potential was 2.5 tons per ha, with an average income earned of R10 000 per production in an informal market, priced at R4.00 per kilogram. The potential for ISHAE-WY in the formal market would be projected at R16 800, with an improved price of R6.72 per kilogram.

2. Association between gender and cultivation of sweet potato crop in winter and summer

A chi-square test was conducted for association between cultivating sweet potato and gender in winter and summer is shown in Table 1. Not all the expected cell frequencies were greater than five; therefore, the assumption was violated and the Fischer Exact test conducted. The Fischer Exact test showed that there was a statistically significant association between cultivating sweet potato and gender, $p = 0.009$. It was determined that 46.7% males cultivated sweet potato compared to 16.5% females. Although statistically significant, the effect size showed a weak association (Cohen, 1988), as measured by the Phi measure of effect size, $\varphi = 0.173$, $p = 0.003$.

Table 1: Association between gender and cultivation of sweet potato crop in winter and summer

Gender	Variable	Winter		Summer	
		No	Yes	No	Yes
MALE	Count	8	7	10	5
	Expected count	12.3	2.7	12.3	2.7
	% within gender of the respondent	53.3%	46.7%	66.7%	33.3%
	% within season's crop: sweet potato	3.3%	13.2%	4.1%	9.6%
	% of total	2.7%	2.4%	3.4%	1.7%
FEMALE	Count	233	46	232	47
	Expected count	228.7	50.3	229.7	49.3
	% within gender of the respondent	83.5%	16.5%	83.2%	16.8%
	% within season's crop: sweet potato	96.7%	86.8%	95.9%	90.4%
	% of total	79.3%	15.6%	78.9%	16.0%
TOTAL	Count	241	53	242	52
	Expected count	241.0	53.0	242.0	52.0
	% within gender of the respondent	82.0%	18.0%	82.3%	17.7%
	% within season's crop: sweet potato	100.0%	100.0%	100.0%	100.0%
	% of total	82.0%	18.0%	82.3%	17.7%

Similarly, in summer, not all the expected cell frequencies were greater than five; therefore, the assumption was violated, and the Fischer Exact test conducted. The Fischer Exact test showed that there was no statistically significant association between cultivating sweet potato and gender, p = 0.104. It was determined that 33.3% males cultivated sweet potato compared to 16.8% females. In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1988), as measured by the Phi measure of effect size, φ = 0.095, p = 0.103. Literature indicates that in most cases, females tend to be side-lined in terms of land ownership due to cultural norms, though they usually provide most of the farm labour (Deribe, 2008). [8] The prominence of the climate scourge to ISHAE-WY makes it a necessary to establish the differences in the roles played by males and females in farm households. These gender differences are likely to influence their capacity to adapt to climate change, as well as their choices of climate change adaptation strategies (IFPRI, 2009). The involvement of women's participation in the smallholder irrigation farming practices can reduce the men's burden of being the sole source of income in the rural household. This also can alleviate poverty and grow the local economy of Vhembe District.

3. Association between age and cultivation of sweet potato

A chi-square test was conducted for association between age of ISHAE-WY and cultivating sweet potato in winter and summer is shown in Table 2. A chi-square test was conducted for association between cultivating sweet potato and age in winter. All the expected cell frequencies were greater than five; therefore, the assumption was not violated. There was no statistically significant association between cultivating sweet potato and age, $\chi 2 = 0.295$, p = 0.863. It was determined that 19.7% of 18–35-year participants cultivated sweet potato compared to 18,1% and 16.2% of 36–59 participants and >60-year participants respectively. In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1988), as measured by the Phi measure of effect size, φ = 0.032, p = 0.863. Similarly, in summer, all the expected cell frequencies were greater than five; therefore, the assumption was not violated. There was no statistically significant association between cultivating sweet potato and age, $\chi 2 = 0.637$, p = 0.727. It was determined that 15.5% of 18–35-year participants cultivated sweet potato compared to 19.4% of 36–59-year participants and 16.2% of >60 year participants. In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1988), as measured by the Phi measure of effect size, φ = 0.047, p = 0.727.

Table 2: Association between age and cultivation of sweet potato crop in winter and summer

Age (years)	Variable	Winter		Summer	
		No	Yes	No	Yes
18–35	Count	57	14	60	11
	Expected count	58.2	12.8	58.4	12.6
	% within gender of the respondent	80.3%	19.7%	84.5%	15.5%
	% within season's crop: sweet potato	23.7%	26.4%	24.8%	21.2%
	% of total	19.4%	4.8%	20.4%	3.7%
36–59	Count	127	28	125	30
	Expected count	127.1	27.9	127.6	27.4
	% within gender of the respondent	81.9%	18.1%	80.6%	19.4%
	% within season's crop: sweet potato	52.7%	52.8%	51.7%	57.7%
	% of total	43.2%	9.5%	42.5%	10.2%
>60	Count	57	11	57	11
	Expected count	55.7	12.3	56.0	12.0
	% within gender of the respondent	83.8%	16.2%	83.8%	16.2%
	% within season's crop: sweet potato	23.7%	20.8%	23.6%	21.2%
	% of total	19.4%	3.7%	19.4%	3.7%

Total	Count	241	53	242	52
	Expected count	241.0	53.0	242.0	52.0
	% within gender of the respondent	82.0%	18.0%	82.3%	17.7%
	% within season's crop: sweet potato	100.0%	100.0%	100.0%	100.0%
	% of total	82.0%	18.0%	82.3%	17.7%
		$\chi2(2) = 0,295$, p = 0.863.		$\chi2(2) = 0,637$, p = 0.727.	

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. Having this senior age group amongst household heads brings the advantages of experience and well-developed networks in the community. Its drawback is the inability of older people to adopt and take up new technologies and skills quickly, compared to those in a younger age group (Ncube, 2014). [27] Ncube, (2014) [27] further indicated that farmers within the ages of 30–34 years are likely to understand the issues involved in farming well, and therefore are armed with necessary information regarding climate change adaptation strategies that can be well achieved and adhered to. Farm productivity has been shown to deteriorate with the farmer's age, especially among the smallholders who largely rely on their own physical labour to execute many farming responsibilities (Uddin, *et. al.,* 2014). [32]

4. Association between education and cultivation of sweet potato crop in winter and summer

A chi-square test was conducted for association between level of education of ISHAE-WY and cultivating sweet potato in winter and summer is shown in Table 7.3. According to work done by Ledwaba, (2013), [18] better qualified individuals seem to be recognising farming as an alternative occupation. In support of the above, Mupaso, (2014) [24] indicated that plot holders with better qualifications have now started to see farming as a substitute for other income generation incurred from off-farm employment. The advantage with higher level of education was that it tends to have a strong influence on the extent to which a farmer was able to access new information and technology. That was not only due to the ability of the farmer to access written information, but also through increased ability to search for information using modern information technologies.

Table 3: Association between education and cultivation of sweet potato crop in winter and summer

Education	Variable	Winter		Summer	
		No	Yes	No	Yes
Primary	Count	53	8	52	9
	Expected count	50.3	10.7	50.5	10.5
	% within gender of the respondent	86.9%	13.1%	85.2%	14.8%
	% within season's crop: sweet potato	22.1%	15.7%	21.6%	18.0%
	% of total	18.2%	2.7%	17.9%	3.1%
Secondary	Count	96	20	94	22
	Expected count	95.7	20.3	96.1	19.9
	% within gender of the respondent	82.8%	17.2%	81.0%	19.0%
	% within season's crop: sweet potato	40.0%	39.2%	39.0%	44.0%
	% of total	33.0%	6.9%	32.3%	7.6%
Tertiary	Count	23	10	25	8
	Expected count	27.2	5.8	27.3	5.7
	% within gender of the respondent	69.7%	30.3%	75.8%	24.2%
	% Within season's crop: sweet potato	9.6%	19.6%	10.4%	16.0%
	% of total	7.9%	3.4%	8.6%	2.7%
Abet	Count	68	13	70	11
	Expected count	66.8	14.2	67.1	13.9
	% within gender of the respondent	84.0%	16.0%	86.4%	13.6%
	% within season's crop: sweet potato	28.3%	25.5%	29.0%	22.0%
	% of total	23.4%	4.5%	24.1%	3.8%
Total	Count	240	51	241	50
	Expected count	240.0	51.0	241.0	50.0
	% within gender of the respondent	82.5%	17.5%	82.8%	17.2%
	% within season crop: sweet potato	100.0%	100.0%	100.0%	100.0%
	% of total	82.5%	17.5%	82.8%	17.2%
		$\chi2(3) = 4,677$, p = 0.197.		$\chi2(3) = 2,406$, p = 0.492	

Corroborating the above, low adoption among older South-Kivu farmers could be associated with their predominantly low education level. Katungi and Akankwasa, (2010) [14] found that educated and younger Ugandan farmers adopt more new innovations than less educated and older farmers (Mugumaarhahama *et. al.,* 2021). [23] 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. This factor makes it easy for other stakeholders to effect capacity building programmes for the irrigators, without worrying about issues of illiteracy (Ndlovu, *et.al.,* 2015). Supplementary to the above, education plays a key role in the household's decision to adopt technology; it creates awareness and encourages innovation and invention (Mengistie and Kidane, 2016). [22]

A chi-square test was conducted for association between cultivating sweet potato and household head education in winter and summer (Table 3).

In winter, all the expected cell frequencies were greater than five; therefore, the assumption was not violated. There was no statistically significant association between cultivating sweet potato and household head education, $\chi2 = 4.677$, $p = 0.197$. It was determined that 13.1% of participants with household head having no/primary education cultivated sweet potato, while 17.2% of participants with household head having secondary education cultivated sweet potato, and 30.3% and 16.0% of participants with household head having tertiary education and ABET respectively cultivated sweet potato. In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1988), as measured by the Phi measure of effect size, $\varphi = 0.127$, $p = 0.197$. In summer, all the expected cell frequencies were greater than five; therefore, the assumption was not violated. There was no statistically significant association between cultivating sweet potato and household head education, $\chi2 = 2.406$, $p = 0.492$. It was determined that 14.8% of participants with household head having no/primary education cultivated sweet potato, while 19.0% of participants with household head having secondary education cultivated sweet potato, and 24.2% and 13.6% of participants with household heads having tertiary education and ABET respectively cultivated sweet potato. In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1988), as measured by the Phi measure of effect size, $\varphi = 0.091$, $p = 0.492$.

5. Association between level of income and cultivation of sweet potato crop in winter

A chi-square test was conducted for association between cultivating sweet potato and monthly income in winter and summer (Table 4). According to Mango *et.al., (*2018), [20] the adoption of small-scale irrigation farming was found to have a significant positive impact (at a 5% level) on agricultural income. This could be because farmers who use small-scale irrigation farming can intensify and diversify their agricultural activities, which increases their production. Sweet potato farming has a good prospect for increasing farmer income (Chasanah, *et al.,* 2018). [4] Results of the study by Mavhungu *et.al.,* (2022) [21] also showed better income for ISHAE-WY at informal markets, with sweet potato fetching an average of R10 000, compared to dry beans earning R9 000 and maize fetching R3 200 per unit of production. ISHAE-WY households—if they can afford technologies and production inputs—would likely become successful farming entrepreneurs. However, access to markets has been found to be the major constraint on income enhancement for farmers (FAO, 2000).

Table 4: Association between level of income and cultivation of sweet potato crop in winter

Income	Variable	Winter		Summer	
		No	Yes	No	Yes
< R5 000	Count	185	40	186	39
	Expected count	184.4	40.6	185.2	39.8
	% within gender of the respondent	82.2%	17.8%	82.7%	17.3%
	% within season's crop: sweet potato	76.8%	75.5%	76.9%	75.0%
	% of total	62.9%	13.6%	63.3%	13.3%
>R5 000	Count	56	13	56	13
	Expected count	56.6	12.4	56.8	12.2
	% within gender of the respondent	81.2%	18.8%	81.2%	18.8%
	% within season's crop: sweet potato	23.2%	24.5%	23.1%	25.0%
	% of total	19.0%	4.4%	19.0%	4.4%
TOTAL	Count	241	53	242	52
	Expected count	241.0	53.0	242.0	52.0
	% within gender of the respondent	82.0%	18.0%	82.3%	17.7%
	% within season's crop: sweet potato	100.0%	100.0%	100.0%	100.0%
	% of total	82.0%	18.0%	82.3%	17.7%
		$\chi2(1) = 0{,}040$, $p = 0.841$		$\chi2(1) = 0{,}082$, $p = 0.774$.	

In winter, all the expected cell frequencies were greater than five; therefore, the assumption was not violated. There was no statistically significant association between cultivating sweet potato and monthly income, $\chi2(1) = 0{,}040$, $p = 0.841$. It was determined that 17.8% of participants earning < R5 000 a month cultivated sweet potato, compared to 18.8% of those earning > R5 000 a month. In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1988), as measured by the Phi measure of effect size, $\varphi = 0.012$, $p = 0.841$. In summer, all the expected cell frequencies were greater than five; therefore, the assumption was not violated. There was no statistically significant association between cultivating sweet potato and monthly income, $\chi2(1) = 0{,}082$, $p = 0.774$. It was determined that 17.3% of participants earning < R5 000 a month cultivated sweet potato, compared to 18.8% of those earning > R5 000 a month. In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1988), as measured by the Phi measure of effect size, $\varphi = 0.017$, $p = 0.774$.

Conclusion and Recommendations

a. Conclusions

The results of the study reflected some overbearing conclusions about the demographic profile of the ISHAE-WY and their association with the production of sweet potato. The study indicated that gender had an influence on its production. However, age, education and income did not statistically influence the production of sweet potato in the Madimbo Corridor and Mutale Valley. The study revealed that the ISHAE-WY are characterised by small land areas under sweet potato cultivation with potential for improved incomes. Market channels and access should be promoted for ISHAE-WY to enable throughput of sweet potato, not only to informal but also fresh produce and retail markets.

b. Recommendations

It is suggested that empowerment programs for women, extension practitioners, and literacy support through training input assistance be available and implemented for the improvement of Sweet potato production in Vhembe Irrigation Schemes.

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