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Demographic Factors and Their Association with Cultivation of Dry Beans *(Phaseolus Vulgaris)* in Smallholder Irrigation Schemes at Vhembe District Municipality, Limpopo Province of South Africa

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Abstract

The study was conducted at upper Mutale valley and Madimbo corridor irrigated smallholder agricultural enterprise. The purpose of the study was to investigate a demographic impact on the cultivation of dry beans *(Phaseolus vulgaris)* in irrigated smallholder agricultural enterprise. The questionnaire was developed to collect both qualitative and quantitative data. A semi-structured questionnaire was used to collect primary data at these two smallholder irrigation schemes, and administered on face-to-face interviews which embrace both open- and close-ended questions. A representative sample was based on the number of plot holders as per irrigated smallholder agricultural enterprise led by women and youth (ISHAE-WY). At least 294 women and youth plot holders were sampled for interviews and prompt responses on the investigate a demographic impact on the cultivation of dry Beans *(Phaseolus vulgaris)* in smallholder irrigation schemes. Chi-square test was used as descriptive analysis method through application of Fischer Exact test. The study showed weak association between gender ($\varphi = 0.097$, $p = 0.096$), age ($\varphi = 0.152$, $p = 0.033$), education ($\varphi = 0.182$, $p = 0.022$), and income ($\varphi = 0.081$, $p = 0.163$) with the planting of dry beans in ISHAE-WY. In conclusion, trends based on participation to plant dry beans shows the potential for youth to middle aged, <60 years ISHAE-WY with no primary education and obtaining less than R5 000 through dry beans production. The study also suggests empowerment programs for women and youth through literacy support and training in dry bean production practices at ISHAE-WY.

Keywords: Irrigated Smallholder Agricultural Enterprise, madimbo corridor, smallholder irrigation schemes, upper mutale valley

1. Introduction

For many decades, Irrigated Smallholder Agricultural Enterprise led by women and Youth (ISHAE-WY) have been considered to have the potential to generate economic development of the poor and under-developed rural areas (WRC, 2009). Pittock, *et al.,* (2017) further indicated that most ISHAE-WY produce traditional food crops for the local market, compared to growing improved varieties of vegetable and field crops. The dry bean was identified as one of the most important field crops in Vhembe district on account of its high protein content and dietary benefits. South Africa produces only 75 % of the dry beans consumed in the country, with 25% being imported (DAFF, 2010). The average yield increased from the 0.6 tons per ha obtained in the early seventies to approximately 1.2 tons per ha in the eighties (DAFF, 2010).

At a commercial level, farm gate value for good grades of dry beans is between R12 000 and R14 000 per ton if sold to merchants when cleaned, packed and branded. Farmers can usually get on average between 1.8 tons per ha and 2.2 tons per ha of saleable seed with good dryland production practices (Grain SA, (2019). The economic implication is that farmers can achieve a gross income of about R26 000 per hectare, which compares very well with the income from other dryland crop production options (Grain SA, 2019). A continuous effort is being made to obtain higher production yield in irrigated smallholder agricultural production areas to increase profitability and to meet the ever-increasing demand for food. On average the ISHAE-WY produce dry beans on 1.61 ha and produce about 1.2 tons per ha; they fetch a lower price of R9 000 at the informal markets (about R7.50 per

kilogram). The value could increase to R14 400 at the formal market due to a good price of about R12.00 per kilogram. In 2019/2020, dry beans production in South Africa amounted to 73 thousand metric tons. The province Free State was the major producer, with 32.4 thousand metric tons, roughly 44 percent of the total production. Limpopo and North West followed with 16.8 thousand metric tons and 9.1 thousand metric tons, respectively. Moreover, Northern, Eastern, and Western Cape were the lowest contributors to the production (Statista, 2020). In June 2023, the retail price of dry bean range at R38.86 per kilogram on average. This shows that dry bean is R38 860 per ton (Selina Wamuchi Agriculture, 2023).

It has, however, become increasingly difficult for the ISHAE-WY in this production area to provide enough dry beans within production villages. Socio-economic factors continue to play a critical role in determining the levels of production undertaken and the type of crops planted. This was corroborated by Von Braun, *et al.,* (2015) who stated that the production levels are not the only areas affected, but also the way business enterprises are managed—which brought the socio-economic characteristics of ISHAE-WY into focus. There are several farmers demographic impact on the cultivation of dry beans *(Phaseolus vulgaris)* in irrigated smallholder agricultural enterprise.

These include gender, age, education, and level of income. According to Nakaz, *et al.,* (2017), dry beans can be clearly identified as a women's crop by looking at the proportions of men and women participation intensities of its production. In their study, Nakaz, *et al.,* (2017). further showed that women have significant participation in bean production activities of planting, weeding, harvesting, transporting from the garden, threshing, winnowing, sorting and post-harvest handling as compared to men. UN, (2015), shows that investing in the quality of education and ensuring a sustainable source of funding are also essential to improved levels of crop production. The relationship between ISHAE-WY demography and the participation in the production of dry beans will be assessed in this study, to produce appropriate policy information for agricultural stakeholders and the government.

2. Methodology

2.1 Site Description

The study was conducted at Upper Mutale Valley and Madimbo Corridor 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. The 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.

2.2 Sampling Procedure

Stratified random sampling was used to obtain a representative sample of villages and households Leedy and Ormrod, (2005). 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.

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 per cent. The sample comprised 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).

2.4 Data Analysis

The Statistical Package for the Social Sciences (SPSS) Version 22 was used to analyze 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 $p < 0.013$.

3. Results and Discussion

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

3.1 The Production Potential of Dry Bean Crop by Smallholder Agricultural Women and Youth Enterprises.

The average area of production under irrigation was 1.61 ha per farmer. The production potential was 1.2 ton per ha. The average income earned was R9 000 at an informal market, priced at R7.50 per kilogram. The potential for ISHAE-WY in the formal market would be projected at R14 000, with an improved price of R12 per kilogram.

3.2 Association Between Gender and Cultivation of Dry Beans in Winter and Summer

A chi-square test was conducted for association between cultivating dry beans and gender in winter and summer is shown in Table 1. Fischer Exact test was conducted when cell frequencies were found to be less than five. The Fischer Exact test showed that there was no statistically significant association between cultivating beans and gender, $p = 0.156$. It was determined that 13.3% males cultivated beans compared to 34.1% 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, $\varphi = 0.097$, $p = 0.096$. Similarly, in summer, the Fischer Exact test also showed that there was no statistically significant association between cultivating beans and gender, $p = 0.100$. It was determined that no males cultivated beans compared to 4.7% 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, $\varphi = 0.05$, $p = 0.392$.

Literature indicates that in most cases females tend to be side-lined in terms of land ownership due to cultural norms, though they are usually the ones who provide most of the farm labour (Deribe, 2008). The prominence of the climate scourge to ISHAE-WY makes it 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 only source of income in the rural household. This also can alleviate poverty and grow the local economy of Vhembe District.

Table 1. Association between gender and cultivation of dry beans in winter and summer

GENDER	VARIABLE	WINTER		SUMMER	
		NO	YES	NO	YES
MALE	Count	13	2	15	0
	Expected count	10.1	4.9	14.3	7
	% within gender of the respondent	86.7%	13.3%	100.0%	0.0%%
	% within season's crop: dry beans	6.6%	2.1%	5.3%	0.0%
	% of total	4.4%	7%	5.1%	0.0%
FEMALE	Count	184	95	266	13
	Expected count	186.9	92.1	266.7	12.3
	% within gender of the respondent	65.9%	34.1%	95.3%	4.7%
	% within season's crop: dry beans	93.4%	97.9%	94.7%	100.0%
	% of total	62.6%	32.3%	90.5%	4.4%
TOTAL	Count	197	97	261	13

Expected count	197.0	97.0	281.0	13.0
% within gender of the respondent	67.0%	33.0%	95.6%	4.4%
% within season's crop: dry beans	100.0%	100.0%	100.0%	100.0%
% of total	67.0%	33.0%	95.6%	4.4%

3.3 Association Between Age and Cultivation of Dry Beans Crop in Winter and Summer

A chi-square test for association between cultivating dry beans and age in winter and summer is indicated in Table 2. In conducting the chi-test, all the expected cell frequencies were greater than five, which complied with the assumption for the test. However, since multiple (n=4) analyses using the same dependent variable were conducted, a Bonferroni correction was made to eliminate the chance of a type I error, resulting in an altered significant value of 0,013 (0,05/4). After a Bonferroni adjustment, there was no statistically significant association between cultivating beans and age, $\chi 2 = 6.826$, $p = 0.033$. It was determined that 21.1% of 18–35-year participants cultivated beans compared to 38.7% and 32.4% of 36–59 participants and >60 year participants respectively.

Table 2. Association between age of the respondent and cultivation of dry beans in winter and summer

AGE (YEARS)	VARIABLE	WINTER		SUMMER	
		NO	YES	NO	YES
18–35	Count	56	15	67	4
	Expected count	47.6	23.4	67.9	3.1
	% within gender of the respondent	78.9%	21.1%	94.4%	5.6%
	% within season's crop: dry beans	28.4%	15.5%	23.8%	30.8%
	% of total	19.0%	5.1%	22.8%	1.4%
36–59	Count	95	60	149	6
	Expected count	103.9	51.1	148.1	6.9
	% within gender of the respondent	61.3%	38.7%	96.1%	3.9%
	% within season's crop: dry beans	48.2%	61.9%	53.0%	46.2%
	% of total	32.3%	20,4%	50.7%	2.0%
>60	Count	46	22	65	3
	Expected count	45.6	22.4	65.0	3.0
	% within gender of the respondent	67.6%	32.4%	95.6%	4.4%
	% within season crop: dry beans	23.4%	22.7%	23.1%	23.1%
	% of total	15.6%	7.6%	22.1%	1.0%
TOTAL	Count	197	97	281	13
	Expected count	197.0	97.0	181.0	13.0
	% within gender of the respondent	67.0%	33.0%	95.6%	4.4%
	% within season's crop: dry beans	100.0%	100.0%	100.0%	100.0%
	% of total	67.0%	33.0%	95.6%	4.4%

In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1998), as measured by the Phi measure of effect size, $\varphi = 0.152$, $p = 0.033$. Since this difference is not statistically significant, it is likely to be due only to chance, and not an actual difference between age.

For the summer season, the rows in Table 2 indicate that less than 80% of the cells are greater than five. Therefore, in summer production, chi-square test of association was not interpreted for these variables. However, Table 2 does show that 5.6% of 18–35-year participants cultivated dry beans compared to 3.9% of 36–59-year participants and 4.4% of >60-year participants. The significance of age on the cultivation of crops has been corroborated by (Nesamvuni, *et al*., 2014) who documented that head of household age has a strong effect on the family's agricultural productivity; this could be a result of the influence of age on such variables as education and farming experience. In agreement of the above, 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). As stated by Mphinyane and Terblanche, (2005), a highly significant correlation exists between different age categories and farming experience ($r = 0.450$; $p = 0.001$), and this means that older farmers are more experienced.

3.4 Association Between Education and Cultivation of Dry Beans in Winter and Summer

A chi-square test for association between cultivating dry beans and household head education in winter and summer is shown in Table 3. In conducting the test, it was evident that all the expected cell frequencies were greater than five complying with the assumptions of the test. After a Bonferroni adjustment, there was no statistically significant association between cultivating beans and household head education, $\chi 2 = 9{,}608$, $p = 0.022$. It was determined that 42.6% of participants with household head had no/primary education, while 37.9% of participants with household head having secondary education, and 27,3% and 21,0% of participants with household heads having tertiary education and ABET respectively. In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1998), as measured by the Phi measure of effect size, $\varphi = 0.182$, $p = 0.022$. According to Ledwaba, (2013), the levels of education may 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.

Table 3. Association between education and cultivation of dry beans crop in winter and summer

EDUCATION	VARIABLE	WINTER		SUMMER	
		NO	YES	NO	YES
PRIMARY	Count	35	26	59	2
	Expected count	40.9	20.1	58.3	2.7
	% within gender of the respondent	57.4%	42.6%	96.7%	3.3%
	% within season's crop: dry beans	17.9%	27.1%	21.2%	15.4%
	% of total	12.0%	8.9%	20.3%	7%
SECONDARY	Count	72	44	108	8
	Expected count	77.7	38.3	110.8	5.2
	% within gender of the respondent	62.1%	37.9%	93.1%	6.9%
	% within season's crop: dry beans	36.9%	45.8%	38.8%	61.5%
	% of total	24.7%	15.1%	37.1%	2.7%
TERTIARY	Count	24	9	33	0
	Expected count	22.1	10.9	31.5	1.5
	% within gender of the respondent	72.7%	27.3%	100.0%	0.0%
	% within season's crop: dry beans	12.3%	9.4%	11.9%	0.0%
	% of total	8.2%	3.1%	11.3%	0.0%
ABET	Count	64	17	78	3
	Expected count	54.3	26.7	77.4	3.6
	% within gender of the respondent	79.0%	21.0%	96.3%	3.7%
	% within season's crop: dry beans	32.8%	17.7%	28.1%	23.1%
	% of total	22.0%	5.8%	26.8%	1.0%
TOTAL	Count	195	96	278	13
	Expected count	195.0	96.0	278.0	13.0
	% within gender of the respondent	67.0%	33.0%	95.5%	4,5%
	% within season's crop: dry beans	100.0%	100.0%	100.0%	100.0%
	% of total	67.0%	33.0%	95.5%	4.5%

Also, level of education has a strong influence on the extent to which a farmer can access new information and technology, not only through improved literacy that enables the farmers to access written information, but also through increased ability to search for information using modern information technologies. Urassa, (2015, corroborates the same narrative that education levels can influence individuals' or households' choice of a livelihood strategy. Mutambara and Munodawafa, (2014), as quoted by Moyo*, et al.,* (2017) note that low levels of education limit access to information and understanding of commercial farming concepts, which are both critical to sustaining high production levels.

For the summer season, the results of a chi-square test of association showed that less than 80% of the cells were greater than five. Therefore, the chi-square test was not interpreted for these variables. Table 3 does, however, show that 3.3% of participants with household head had no/primary education, while 6.9% of participants with household head had secondary education, no participants with household heads had tertiary education and 3.7% participants with household head had ABET. The level of education determines the level of assimilation of technical skills required to maintain the system. Moreover, these levels can also determine the ability to practice productive farming Chidavaenzi, *et al.,* (2021). According to Diale, (2011), farmers with more years of schooling in the Sekhukhune District of Limpopo had more use of hybrid seed technology, and this resulted in increased crop yield. This affirmed the findings by Ekoja, (2004) that the rate of adoption of new technology is positively related to the level of education. Nesamvuni, *et al.,* (2014) affirmed that educated farmers were able to read and understand the contents of the print media that is rich in technical information for the agricultural sector; hence, they used hybrid seed technology more than their less schooled counterparts.

3.5 Association Between Level of Income and Cultivation of Dry Beans in Winter

A chi-square test for association between cultivating dry beans and income in winter and summer is shown in Table 4. In the winter season the test showed that all the expected cell frequencies were greater than five; therefore, the assumption of the test was not violated. There was no statistically significant association between cultivating dry beans and monthly income, $\chi 2 = 1{,}945$, $p = 0.163$. It was determined that 35.1% of participants earning < R5 000 a month cultivated dry beans, compared to 26.1% of those earning > R5 000 a month. In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1998), as measured by the Phi measure of effect size, $\varphi = 0.081$, $p = 0.163$. While 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 dry beans and monthly income, $p = 0.312$. It was determined that 5.3% of participants with a monthly income < R5 000 cultivated beans compared to 1.4% of participants earning > R5 000 a month.

Table 4. Association between level of income per month of the respondent and cultivation of dry beans in winter

INCOME	VARIABLE	WINTER		SUMMER	
		NO	YES	NO	YES
< R5 000	Count	146	79	213	12
	Expected count	150.8	74.2	215.1	9.9
	% within gender of the respondent	64.9%	35.1%	94.7%	5.3%
	% within season's crop: dry beans	74.1%	84.1%	75.8%	92.3%
	% of total	49.7%	26.9%	72.4%	4.1%
>R5 000	Count	51	18	68	1
	Expected count	46.2	22.8	65.9	3.1
	% within gender of the respondent	73.9%	26.1%	98.6%	1.4%
	% within season's crop: dry beans	25.9%	18.6%	24.2%	7.7%
	% of total	17.3%	6.1%	23.1%	3%
TOTAL	Count	197	97	281	13
	Expected count	197.0	97.0	281.0	13.0
	% within gender of the respondent	67.0%	33.0%	95.6%	4.4%
	% within season's crop: dry beans	100.0%	100.0%	100.0%	100.0%
	% of total	67.0%	33.0%	95.6%	4.4%

In line with the result not being statistically significant, the effect size showed a weak association (Cohen, 1998), as measured by the Phi measure of effect size, $\varphi = 0.08$, $p = 0.170$. As affirmed by Steiner and Solem, (1988), a

successful farmer is someone likely to have access to adequate financial services and competitive advantage. Household income is a strong determinant of the access and use of agricultural resources (Tshikolomo, *et al*., 2012) and subsequently of agricultural productivity (Nesamvuni, *et al.,* (2014). This could be because farmers who use small-scale irrigation farming can intensify and diversify their agricultural activities, which increases their production. Smallholder agricultural enterprise households would afford technologies and production inputs and would likely become successful farming entrepreneurs—if they make profit.

4. Conclusions

The results of the study reflect some compelling conclusions about the demographic profile of the ISHAE-WY and their association with the production of dry beans. The study showed that gender, age, education, and income did not statistically influence the production of dry beans in the Madimbo Corridor in Musina and Mutale Valley in Thulamela. The study disclosed that the ISHAE-WY are characterised by small land areas under dry bean cultivation. Policy efforts to promote youth should be enhanced—the participation of the age groups was 21.1% of 18–35-year participants compared to 38.7% and 32.4% of 36–59 years and >60-year participants respectively. Farmer field schools and other partnership models should be promoted by the government for the transfer of skills from experienced farmers to youth. In return, youth farmers should help transfer technology and information to older farmers. The increased level (42.6%) of ISHAE-WY with no primary education emphasizes the need for enhanced skills training on-farm to complement the farmer's experience with the cultivation of dry beans. It was determined that 35.1% of participants earning < R5 000 a month cultivate dry beans, compared to 26.1% of those earning > R5 000 a month. Market channels and access should be promoted for ISHAE-WYs to enable them to earn their income through formal markets.

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