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Exploration of Sweet Potato Cultivar Markets Availability in North West Province, South Africa

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Abstract**—**Sweet potato products are necessary for the provision of essential nutrients in every household, regardless of their poverty status. Their consumption appears to be highly influenced by socio-economic factors, such as malnutrition, food insecurity and unemployment. Therefore, market availability is crucial for these cultivars to resolve some of the socio-economic factors. The aim of the study was to investigate market availability of sweet potato cultivars in the North West Province. In this study, both qualitative and quantitative research methodologies were used. Qualitative methodology was used to explain the quantitative outcomes of the variables. On the other hand, quantitative results were used to test the hypothesis. The study used SPSS software to analyse the data. Cross-tabulation and Chi-square statistics were used to obtain the descriptive and inferential analyses, respectively. The study found that the Blesbok cultivar is dominating the markets of the North West Province, with the Monate cultivar dominating in the Bojanala Platinum (75%) and Dr Ruth Segomotsi Mompati (25%) districts. It is also found that a unit increase in the supply of sweet potato cultivars in both local and district municipal markets is accompanied by a reduced demand of 28% and 33% at district and local markets, respectively. All these results were found to be significant at $p<0.05$. The results further revealed that in four out of nine local municipality markets, the Blesbok cultivar seems to be solely available in those four local municipal markets of North West Province. It can be concluded that Blesbok, relative to other cultivars, is the most commercialised sweet potato variety and that consumers across this Province are highly aware of it. For other cultivars to assume market prominence in this Province, a well-designed marketing campaign for creating awareness may be required. This campaign may be based on nutritional advantages of different cultivars, of which Blesbok is relatively inferior, compared to orange-fleshed sweet potato varieties.

Keywords**—**Cultivar, malnutrition, markets, sweet potato.

I. Introduction

SWEET potato (*Ipomoea batatas*) is a root crop native to the tropics and subtropical regions in the world [1]. It is an herbaceous plant with trailing stems, dicotyledonous and belongs to the *Convolvulaceae* or morning glory family [2]. This crop is popular amongst farmers, especially those with limited resources because of its high yield, wide adaptability, early maturity, resistance to diseases and pests, drought tolerance, good cooking quality and high nutritional content [1]-[3]. Thus, smallholder farmers in the poverty-stricken areas of African countries (in particular South Africa) use the products of this crop to generate income for their livelihood and enterprises. Although their markets appear to be regarded as informal markets, smallholder farmers may be profitable if they have access to the formal markets. According to [4] formal markets are where the producers buy their agricultural inputs and sell their products, and where consumers use their income from the sale of crops. In addition, [5] refer to the agricultural market as the exchange of factors of production and output of agricultural products. The question remains whether these formal markets are available to smallholder farmers for utilisation. This question cannot be adequately answered without investigating the access to market or market availability to smallholder farmers. According to [6], market access, or availability, is one of the most critical factors that influence smallholder farmers' potential for success. Increased market participation entails the transition from subsistence farming to a market engagement mode, whereby frequent use of markets is made for the purpose of exchanging products and services [5]. Reference [7] has also concluded that the transition of the small-scale livestock sector towards commercial production would ultimately be determined by its access to markets. Market access can be considered to be the reason why those farmers who produce surpluses remain trapped in the poverty cycle [8]. Interacting with agricultural markets is thus an important aspect of the livelihood strategies of many rural households, rich and poor alike [4]. Reference [8] reported that understanding the factors influencing market access will improve the knowledge of those involved in rural development in general, and smallholder management in particular. Studies by [8]-[10] have found that lack of credit, low demand and variability of income streams, high cost of infrastructure (public transport) and services (water, electricity, and telephone), poor access to business support centres, poor access to training, lack of storage spaces/permanent stalls, lack of transport facilities, and inadequate business space are all constraints against smallholder farmers being linked to markets. Some of the contributory factors that lead to lack of market access by smallholder farmers include the inaccessible marketing facilities and a lack of information about the marketing channels available [9]. According to this author, marketing facilities for crops are inefficient [9]. In addition [11] highlighted the point that South Africa's national food market is characterised by dualism, with a very well developed,

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highly sophisticated food marketing system on one hand, and a highly traditional and less sophisticated, un-organised informal food marketing system on the one hand. The highly sophisticated food marketing system is dominated by a small number of monopolistic retail groups who distribute food through a variety of supermarket franchise located in the major cities and towns of South Africa [11]. These authors presented the converse of the formal food market system as the informal food markets, comprising general dealers, cafes, spaza shops, street vendors, hawkers, tuck shops and street corner stalls in areas such as townships and former homelands, where supermarket retail outlets are absent or have been absent. However, linking smallholder farmers to the formal markets appeared to be quite challenging and informal markets appear to host the marketing needs of these smallholder farmers. These challenges seem to limit the growth and economic viability of the smallholder farmers in South Africa. This happens despite the evidence that shows that linking smallholder farmers to lucrative markets may enable them to access improved inputs, finance, advice and market information. Reference [12] also reported that strong links to markets for poor rural producers are essential for increasing agricultural production, generating economic growth in rural areas, and reducing hunger and poverty. Improving these links creates a virtuous circle by boosting productivity, increasing incomes and strengthening food security. Accordingly, the aim of this study was to investigate market availability for sweet potato cultivars in the North West Province of South Africa, with the objective to identify the markets for the sweet potato varieties in this province.

II. Methodology

The study was conducted in the North West Province of the Republic of South Africa. This province occupies 104,882 km^2 (40,495 sq mi) and it is found at 1 805 (5 922 ft) elevation. It has an estimated population of 3 597 600, with A population density of 33/km^2 (87/sq mi). The province has four district municipalities, with Mafikeng being the capital city. It has nineteen local municipalities. This province has black South Africans as the majority (89.8%) population, followed by white South Africans (7.3%), with coloured and Indian South Africans constituting 2% and 0.6%, respectively.

The study used both qualitative and quantitative research approaches. The qualitative research approach entailed the use of observational techniques, such as participatory rural appraisal (PRA) activities (focus sessions, meetings and workshops). The objective of using a PRA method was to endeavour to conceptualise the project based on a well-grounded observation so as to facilitate the development of clearly defined implementation strategies, and was aimed at establishing the project protocols, project institutional memory, identification of appropriate project teams and stake-holders. This processes yielded the project work break-down structure (WBS). In other words, the participatory rural appraisal (PRA) was essential during the implementation phase. During the participatory sessions, each stake-holder was consulted separately. In such consultations, participants were encouraged to participate freely. This process was mainly aimed at harnessing the understanding and the cooperation of the main stake-holders.

The quantitative research approach used face-to-face interviews, aided by a structured, closed-ended questionnaire. A quantitative method was used to quantify the variables and the factors under consideration. The latter used the questionnaire as a measurement instrument. The questionnaire was developed through rigorous processes where panels of critical experts were involved in critiquing its first and second draft questionnaires. The resultant critiques were aimed at enhancing the precision, alignment and accuracy of the questionnaire instrument to measure the set objectives, as outlined in the study parameters. In addition, the scales and scope of the survey questionnaire were also interrogated to suit the level of the clients. This was done in order to ensure that any expert or researcher who might want to repeat this exercise would find similar results, thus making the investigation verifiable, repeatable and justifiable. Upon the evaluation of the questionnaire instruments, the panellists were satisfied with the questionnaires.

The questionnaire was subsequently used to assess the potential enterprises. These approaches were used to complement each other. This was done in order to solicit accurate information and also to quantify the variables under consideration. A desktop analysis was used to delineate the objectives of the project, while the qualitative method was used to source relevant information and inform the eventual conceptualisation of an appropriate project context. Both the desktop analysis and qualitative research methodologies gave rise to a well-designed study.

The participatory rural appraisal (PRA) followed from the desktop analysis. This method entailed the use of a series of meetings, onsite inspections and workshops with key informants and stakeholders. The respondent populations comprised sales consultants, shelf advisors and hawkers. A specific sampling frame was drawn by designing a roster during the sampling processes. A non-probability sampling method was preferred, owing to the nature (categorical) of the data collected. A purposive sampling procedure where respondents were interviewed (n=98) was used.

The data collected was analysed using the IBM SPSS Exact Tests software [13]. Descriptive and inferential analyses were conducted. During the analysis, a non-parametric test, such as Unordered R x C Contingency Tables with Pearson Chi-Square test and a symmetrical measures test, were used. According to [14], analysis of the data should be well planned in order to provide the relevant outcome. In order to conform to these directives, the choice of the analyses used in this research followed the guidelines mentioned below:

A. Model Specification

Chi-square is a statistical test commonly used to compare a set of observed frequencies with a set of theoretical frequencies [14]. It was calculated as mentioned below:

$$\chi^2 = \sum \frac{(o_i - E_i)^2}{E_i} \quad (1)$$

where: o_i= observed counts for sweet potato cultivars,
E_i= expected counts for sweet potato cultivars.

Kendall's tau b (τ_b) is a refinement of gamma that considers tied pairs [15]. A tied pair occurs when subjects have the same value on the X variable, on the Y variable, or on both. For a given sample size, there are $\boldsymbol{n(n-1)/2}$ pairs of observation. After concordant pairs are removed, the remainders are tied. Tau b does not have a PRE interpretation but does provide a range of -1.0 to +1.0 for square tables. It may be calculated as:

$$\tau_b = \sqrt{\left(\frac{n(n-1)}{2} - T_x\right)\left(\frac{n(n-1)}{2} - T_y\right)} \quad (2)$$

III. Results and Discussion

This section presents both a descriptive and inferential analysis of the study. In the descriptive analysis, the cultivars were presented according to municipalities. The inferential analysis was presented according to local and district municipalities. This was preferred to ensure the logical presentation of the results.

A. Descriptive and Inferential Analysis at the District Municipalities

Table I presents the case processing summary for the analysis undertaken. According to the results of the case processing summary, it is clear that there is no missing data for the respondents.

TABLE I
Case Processing Summary for the Sweet Potato Cultivars and Municipalities

	Cases					
	Valid		Missing		Total	
	N	%	N	%	N	%
Cultivar * District municipality	98	100.0%	0	0.0%	98	100.0%
Cultivar * Local municipality	98	100.0%	0	0.0%	98	100.0%

The results in Table II and Fig. 1 show the frequencies (counts) and proportions regarding the sweet potato cultivars and geographical location under consideration. In Table II, the counts and expected counts were also presented. According to the results, it appears that among the cultivars, Blesbok holds the market with a share of 85.7%, followed by Monate (8.16%), Impilo (4.08%), Ndou (1.02%) and Bosbok (1.02%). While Blesbok dominates the markets of North West Province, it appears that it is also prominent in Bojanala Platinum District (29.8%) and Dr Kenneth Kaunda (28.6%). In the orange-fleshed sweet potato varieties, it is clear that Monate is the prominent cultivar in the Bojanala Platinum (75%) and Dr Ruth Segomotsi Mompati (25%) districts.

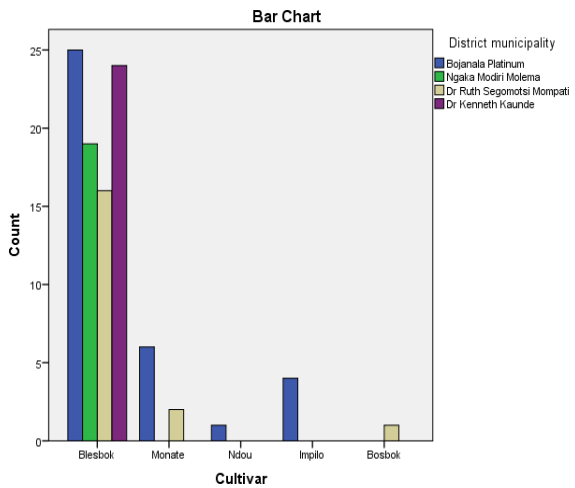

Fig. 1 Bar chart for the sweet potato cultivars in district municipalities

Note that in the cross tabulation table, the expected count of the number of cultivars in the district municipalities and the observed or actual count are presented in Table II. It is clear that the observed counts and expected once do not follow certain pattern across cultivars under investigation.

TABLE II
Sweet Potato Cultivars in District Municipalities

Cultivar		District Municipality			
		Bojanala Platinum	Ngaka Modiri Molema	Dr Ruth Segomotsi Mompati	Dr Kenneth Kaunda
Blesbok	Count	25	19	16	24
	Expected Count	30.9	16.3	16.3	20.6
	Row (%)	29.8%	22.6%	19.0%	28.6%
Monate	Count	6	0	2	0
	Expected Count	2.9	1.6	1.6	2.0
	Row (%)	75.0%	0.0%	25.0%	0.0%
Ndou	Count	1	0	0	0
	Expected Count	.4	.2	.2	.2
	Row (%)	100.0%	0.0%	0.0%	0.0%
Impilo	Count	4	0	0	0
	Expected Count	1.5	.8	.8	1.0
	Row (%)	100.0%	0.0%	0.0%	0.0%
Bosbok	Count	0	0	1	0
	Expected Count	.4	.2	.2	.2
	Row (%)	0.0%	0.0%	100.0%	0.0%
Total	Count	36	19	19	24
	Expected Count	36.0	19.0	19.0	24.0
	Row (%)	36.7%	19.4%	19.4%	24.5%

The result of the Chi-Square test analysis is presented in Tables III and IV. The Chi-Square test table is used to determine whether there is a statistically significant relationship between two dichotomous or nominal variables.

According to the results in Table III, cultivars and district municipalities are significantly different at 95% confident interval (Chi-square = 21.74, df=12, N=98, p<.005). Blesbok is more likely than expected under the null hypothesis to be

available in the markets than orange-fleshed sweet potato varieties.

TABLE III
CHI-SQUARE TESTS FOR THE SWEET POTATO CULTIVARS AND MUNICIPALITIES

	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.739[a]	12	.041
Likelihood Ratio	25.044	12	.015
Linear-by-Linear Association	5.942	1	.015
N of Valid Cases	98		

a. 16 cells (80.0%) have expected count less than 5. The minimum expected count is 0.19.

TABLE IV
SWEET POTATO CULTIVARS IN DISTRICT MUNICIPALITIES

Cultivar	District Municipality			
	Bojanala Platinum	Ngaka Modiri Molema	Dr Ruth Segomotsi Mompati	Dr Kenneth Kaunda
Blesbok	25	19	16	24
Monate	6	0	2	0
Ndou	1	0	0	0
Impilo	4	0	0	0
Bosbok	0	0	1	0
Total	36	19	19	24
Chi-Square			P-value	
21.739			<.005	

TABLE V
DIRECTIONAL MEASURES SWEET POTATO CULTIVARS AND MUNICIPALITIES

			Value
Nominal by Interval	Eta	Cultivar Dependent	.327
		District municipality Dependent	.340

The Directional Measure table provides measures of the strength of the relationship or effect size [16]. These authors highlighted the point that the association between variables is weak, if the value of the statistic will be close to zero. In Table V, it was found that Eta for the cultivars was 0.327, and for district municipalities it was 0.340, indicating that cultivars and municipalities have a share of common variance of 33% and 34%, respectively.

TABLE VI
SYMMETRIC MEASURES FOR THE SWEET POTATO CULTIVARS AND MUNICIPALITIES

	Value	**Asymp. Std. Error[a]**	**Approx. T[b]**	**Approx. Sig.**
Ordinal by Ordinal	-0.283	0.072	-3.210	0.001
Measure of Agreement	-0.133	0.039	-3.351	0.001
N of Valid Cases	98			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis

The symmetric measures recorded in Table VI show that Kendall's tau-b and kappa are -0.283 and -0.133, respectively. Kendall's tau-b analysis indicated a significant negative association between cultivars and municipalities (98) = -0.283, $p<0.05$. This suggests that a unit increase in the supply of sweet potato cultivars (regardless of the type) will lead to a decrease in their demand in the districts municipal markets of 28.3%. The results show that Kappa is -0.133, indicating that the reliability of the findings is 13.3% and therefore it is quite low at -0.133<0.70.

B. Descriptive and Inferential Analysis at the Local Municipalities

The frequencies and proportions of the sweet potato cultivars and geographical location under consideration are presented in Table VII and Fig. 2. In Table VII, the counts and expected counts of cultivars were presented with regard to local municipalities. According to the results, and also as indicated above in the district analysis, Blesbok occupies the market among the cultivars, with a share of 85.7%, followed by Monate (8.16%), Impilo (4.08%), Ndou (1.02%) and Bosbok (1.02%). Furthermore, the results show that the Blesbok cultivar is found in all local municipalities; Monate was found in Madibeng and Lekwa-Teemane; Ndou and Impilo were found only in Madibeng; and lastly, Bosbok was found only in Naledi. With regard to top local municipalities, it appears that Madibeng is a leading local municipality market, with 23.5% market share, followed by Matlosane[1] (17.3%), Mafikeng[1] (13.3%), Rustenburg[1] (13.3%), Lekwa-Teemane (8.2%), Naledi (7.1%), Tlokwe (7.1%), Ramatshere Moiloa (6.1%) and Greater Taung (4%).

TABLE VII
SWEET POTATO CULTIVARS IN THE LOCAL MUNICIPALITIES OF NORTH WEST PROVINCE

Local Municipalities		Cultivar				
		Blesbok	Monate	Ndou	Impilo	Bosbok
Madibeng	Count	12	6	1	4	0
	Expected Count	19.7	1.9	.2	.9	.2
	%	52.2%	26.1%	4.3%	17.4%	0.0%
Rustenburg	Count	13	0	0	0	0
	Expected Count	11.1	1.1	.1	.5	.1
	%	100.0%	0.0%	0.0%	0.0%	0.0%
Ramatshere Moiloa	Count	6	0	0	0	0
	Expected Count	5.1	.5	.1	.2	.1
	%	100.0%	0.0%	0.0%	0.0%	0.0%
Mafikeng	Count	13	0	0	0	0
	Expected Count	11.1	1.1	.1	.5	.1
	%	100.0%	0.0%	0.0%	0.0%	0.0%
Naledi	Count	6	0	0	0	1
	Expected Count	6.0	.6	.1	.3	.1
	%	85.7%	0.0%	0.0%	0.0%	14.3%
Lekwa-Teemane	Count	6	2	0	0	0
	Expected Count	6.9	.7	.1	.3	.1
	%	75.0%	25.0%	0.0%	0.0%	0.0%
Greater Taung	Count	4	0	0	0	0
	Expected Count	3.4	.3	.0	.2	.0
	%	100.0%	0.0%	0.0%	0.0%	0.0%
Tlokwe	Count	7	0	0	0	0
	Expected Count	6.0	.6	.1	.3	.1
	%	100.0%	0.0%	0.0%	0.0%	0.0%
Matlosana	Count	17	0	0	0	0
	Expected Count	14.6	1.4	.2	.7	.2
	%	100.0%	0.0%	0.0%	0.0%	0.0%
Total	Count	84	8	1	4	1
	Expected Count	84.0	8.0	1.0	4.0	1.0
	%	85.7%	8.2%	1.0%	4.1%	1.0%

[1] These municipalities have the Blesbok cultivar only.

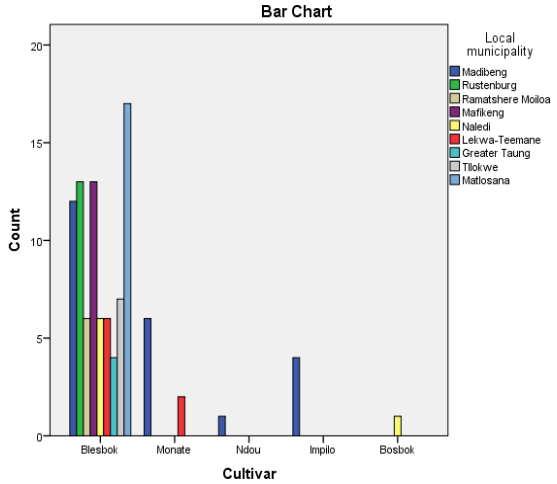

Fig. 2 Bar chart for the sweet potato cultivars in local municipalities

Tables VIII and IX present the results of the Chi-square test analysis. The results shows that the local municipalities and cultivars are statistically significant at 95% confident interval (Chi – square = 51.158, df=32, N=98, P<0.005).

TABLE VIII
CHI-SQUARE TESTS FOR THE CULTIVARS AND LOCAL MUNICIPALITIES

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	51.158[a]	32	.017
Likelihood Ratio	43.172	32	.090
Linear-by-Linear Association	8.263	1	.004
N of Valid Cases	98		

a. 37 cells (82.2%) have expected count less than 5. The minimum expected count is .04

TABLE IX
SWEET POTATO CULTIVARS IN LOCAL MUNICIPALITIES

Cultivar		Local municipality								
		MD	RS	RM	MF	NL	LT	GT	TE	MT
	N									
Blesbok	84	12	13	6	13	6	6	4	7	17
Monate	8	6	0	0	0	0	2	0	0	0
Ndou	1	1	0	0	0	0	0	0	0	0
Impilo	4	4	0	0	0	0	0	0	0	0
Bosbok	1	0	0	0	0	1	0	0	0	0
Total	98	23	13	6	13	7	8	4	7	17
Chi-Square						P-Value				
51.158						<0.005				

Keys: Madibeng=MD, Rustenburg=RS, Ramitshere Moiloa=RM, Mafikeng=MF, Naledi=NL, Lekwa-Teemane=LT, Greater Taung=GT, Tlokwe=TE, Matlosana=MT

Table X shows the results of strength or weakness of the relationship between local municipalities and cultivars. The Eta for cultivars was found to be 0.482 and for the local municipalities it was 0.367, indicating a moderate association between these two variables.

TABLE X
DIRECTIONAL MEASURES FOR THE CULTIVAR AND LOCAL MUNICIPALITIES

			Value
Nominal by Interval	Eta	Cultivar Dependent	.482
		Local municipality Dependent	.367

Table XI presents the results of Symmetric Measures for the local municipalities and cultivars. According to the results, Kendall's tau-b analysis shows a significant negative relationship between local municipalities and cultivars (98) = 0.328, p<0.05. This result show that a unit increase in the supply of sweet potato cultivars will lead to a decrease in its demand at the local municipality markets. The Kappa results show that the reliability of the findings is 11%, which is low at -0.11<0.70.

TABLE XI
SYMMETRIC MEASURES FOR THE CULTIVAR AND LOCAL MUNICIPALITIES

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx . Sig.
Ordinal by Ordinal	Kendall's tau-b	-.328	.073	-3.504	.000
Measure of Agreement	Kappa	-.110	.038	-4.082	.000
N of Valid Cases		98			

a. Not assuming the null hypothesis.
b. Using the asymptotic standard error assuming the null hypothesis.

IV. SUMMARY AND CONCLUSIONS

The aim of the study was to investigate market availability for sweet potato cultivars in the North West Province, and a Chi-square statistic was used. The study concluded that the Blesbok cultivar dominates the markets of the North West Province. It appears from the findings that it is highly prominent in Bojanala Platinum District (29.8%) and Dr Kenneth Kaunda (28.6%). Among the orange-fleshed sweet potato varieties, it appears that Monate is the most prominent cultivar in Bojanala Platinum (75%) and Dr Ruth Segomotsi Mompati (25%) districts.

Kendall's tau-b analysis indicated a significant negative association between cultivars and district municipal markets at a value of (98) = -0.283, p<0.05. This suggests that a unit increase in the supply of sweet potato cultivars (regardless of the type) will lead to a decrease in their demand in the district municipal markets of 28.3%. Similarly, the study found that the Kendall's tau-b analysis for the local markets was also significantly negative at a value of (98) = -0.328, p<0.05. This indicates that a unit increase in the supply of sweet potato cultivars (regardless of the type) will lead to a decrease in their demand in the local municipal markets of 33%. In view of the above findings, the supply of these cultivars appears to be more highly affected in the local municipality (33%) than in the district municipality markets (28%). This suggests that at the district level, the sweet potato market availability is likely to be better compared to that of local municipal markets, at 5%. In addition, the study reveals the market share of the top local municipal sweet potato cultivar. The study indicates that Madibeng is the leading local municipality market, with 23.5% market share, followed by Matlosane (17.3%), Mafikeng (13.3%), Rustenburg 13.3%, Lekwa-Teemane

(8.2%), Naledi (7.1%), Tlokwe (7.1%), Ramatshere Moiloa (6.1%) and Greater Taung (4%). The results further revealed that in four out of nine local municipality markets, the Blesbok cultivar is the only cultivar available in those four local municipal markets. It can be concluded that Blesbok, relative to other cultivars, is the most commercialised sweet potato variety and that consumers across the North West Province are highly aware of it. For other cultivars to assume market prominence in this province, a well-designed marketing campaign for creating awareness may be required. This campaign may be based on the nutritional advantages of different cultivars, of which Blesbok is relatively inferior, compared to orange-fleshed sweet potato varieties.

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