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ASSESSMENT OF HUMAN CAPITAL STATUS IN UNIVERSITIES OFFERING AGRICULTURE IN LIMPOPO PROVINCE, SOUTH AFRICA

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ABSTRACT

This assesses the disparities of human capital in agricultural departments at the universities in Limpopo Province, South Africa. From the two universities in the study area, a sample of 110 lecturers and researchers was selected for this study. Descriptive and inferential statistics were used to analyze the data. The study findings showed that married individuals were more productive in terms of research outputs than single or unmarried individuals. Also, students' throughput in either group and merged data sets by gender revealed that there was no significant difference in research output and students' throughput in both universities. On subjecting the data to principal component analysis, five components (challenges) were identified - resources and infrastructure, financial, personal, research productivity and confidential and marital issues. The paper indicates that collaboration among married and other staff members is necessary to boost the research capacity of younger researchers. Enhanced funding for research and infrastructure should be made a priority by the university management, government, and private stakeholders to improve their offerings and reputations.

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INTRODUCTION

Agriculture in Africa is one of the sectors with considerable potential for growth, diversification, and the generation of income and jobs (Magadani, 2014). For decades, human capital in (African agricultural universities and colleges have been decreasing, reducing their ability to meet the needs of the sector, especially smallholder farmers (Magadani, 2014; Zinnah *et al.*, 2001). In today's global economy, any nation that ignores or fails to generate well-educated people will find it extremely difficult to capitalize on innovations such as biotechnology and mechanization, as well as incorporate and use science as a growth tool (Ojijo *et al.*, 2016). While academic staff recruiting and retention continue to be a significant issue, (Makondo, 2014), across several African countries, the situation appears to be particularly severe. As African university leaders realize the crushing impact of staff shortages on higher education institutions' goals, they caution that unless anything is done soon, the problem will intensify. Not only would the African academy lose its ability to provide enough personnel to fulfil countries' human resource needs, but it would also lose its ability to maintain and protect the region's intellectual life (Tettey, 2010). As the National Research Foundation (2017) stated, demand for agricultural research will continue to rise as the world's population grows, and climate change presents farmers with a set of new challenges. For farmers to ensure food security more research must continue to be developed to improve

crops and produce healthier animals while working towards attaining sustainable development of the country's environment. From the foregoing, it is, therefore, imperative to assess human capacity in universities offering agriculture in the study area to understand the critical areas of need in terms of competencies and skills in agricultural training and research.

Literature Review

Human capacity is defined in line with capacity building/development's definitions, which by Horton *et al.* (2004) is human resource development (knowledge, skills, individual and group attitudes) to develop and manage specific areas of society. As the term indicates, a broad range of interventions and efforts contributes to the development, strengthening, and enhancement of efficiency at the individual, organizational, and societal levels (Maïga and Kazianga, 2016).

Agriculture is recognized as the backbone and a very important sector of the South African economy because it provides food and employment to the majority of people in the country, particularly in rural areas, and it is capable of alleviating poverty and food insecurity in the country as a whole (DAFF, 2008; Rangoato, 2018). According to Shaheen *et al.* (2013), any nation's development is dependent on its educational system and teachers are expected to be the nation's building block and the role of teachers in a country's progress, prosperity, and development cannot be undermined.

The promotion and acceleration of development by disciplined, academically sound, and professionally qualified academicians aids a society's stability. Organizational success depends on the effectiveness of the performances of the individuals who constitute the human capital (Saetang *et al.*, 2010). According to Lynam and Mukhwana (2020), another primary function in the development of the AET institutional framework was the provision of public goods, particularly research and its complement, agricultural extension services. Competent and knowledgeable academics are an integral part and important strength of any AET system. Teaching is a fundamental profession, and teachers have a significant impact on their student's academic, personal, and social growth, as well as the development of the entire country (Saetang *et al.*, 2010; Shaheen *et al.*, 2013).

However, according to Higher Education South Africa (HESA) (2014), in many countries including South Africa, research institutions and higher education in agriculture so far are struggling to respond to meet public needs. With sufficient investment and funding, the institutes will be capable of dealing with problems such as inadequate infrastructure, equipment, inadequate administrative facilities, unfavorable labour conditions, a high turnover rate, and a shortage of well-qualified teaching staff (Maïga, 2013; Higher Education South Africa (HESA), 2014). Because of these constraints, institutions cannot update course curricula, restructure teaching practices, and modernize teaching resources. This is a huge impediment to developing the knowledge, skills, and behaviors that are desperately needed in the agricultural sector. As a result, graduates have little incentive to pursue a career in agriculture or agricultural education (Maïga and Kazianga, 2016). For instance, investment in skills and education enabled structural transformation in Asia (Losch, 2016); this kind of transformation is even needed urgently in Sub-Saharan Africa (SSA). Farmers with stronger foundational skills such as analyzing, interpretation, observations, etc. are much more successful at adopting high-productivity technologies (Stads and Beintema, 2017). There is a pressing need to invest in higher agricultural education transformation to deliver the quantity and graduate efficiency and skills needed to achieve the African Union's Agenda 2063. Agenda 2063 envisions the continent's human capital being built to its full potential, as well as modern and sustainable agriculture centred on science, technology, creativity, and indigenous knowledge (Minde *et al.*, 2015).

Objectives of the study

The aim of the study was to assess human capacity in agriculture at home-based universities in Limpopo Province, South Africa.

Specifically, the study sought to:

- Identify and describe the different categories of agricultural professionals in these universities
- Assess disparities between gender, marital status, research output, and throughput capacity in agriculture of these institutions
- Identify the challenges faced in bridging disparities between gender, marital status and research output, throughput capacity in agriculture of these institutions.

MATERIAL AND METHODS

Study area

The study was conducted in Limpopo Province, South Africa's northernmost province, sharing international boundaries with Botswana, Zimbabwe, and Mozambique. Limpopo province has two universities, which are the university of Limpopo and Venda.

Sampling method

The participants in the universities were chosen using a purposive sampling method because the study focused on higher education institutions in the province that offer agriculture. This study mainly focused on agricultural professionals (lecturers and researchers). The sample size of this study was 110 participants, which was the total academic staff in both universities, however, only 70 questionnaires were fully answered and used for data analysis. To gather qualitative and quantitative data, a semi-structured questionnaire was used as part of the primary data collection process. The questionnaires were distributed to lecturers and researchers as well as the Head of Departments/Human Resource personnel under the agricultural departments/schools since they may have valuable information regarding the capacity of lectures.

Analytical procedures

In addressing the study objectives, descriptive statistics, chi-square statistics and principal component analysis were employed. Descriptive statistics were used to Identify and describe the different categories of agricultural professionals in these universities and the socio-economic characteristics of the respondents.

The Chi-square test is a statistical analysis technique used to evaluate group disparities when the dependent and independent variables are evaluated at the nominal level (categorical variables).) (McHugh 2013). The benchmark for throughput and research output was 8 years, as National Research Foundation uses this benchmark to rate researchers (Morell, 2015) and as for the throughput, the 8 years was used because of the maximum number of years it takes a supervisor to graduate one PhD candidate studying full time. The Chi-Square was used to analyze and validate the research hypothesis for the reasons mentioned above.

The general formula for Chi-Square statistic;

$$\sum \chi^2 = \frac{(O-E)}{E}$$

Where:

O = Observed (the actual count of cases in each cell of the table)

E = Expected value

X^2 = The Chi-square value

Chi-square is sensitive to the distribution within the cells. This was addressed by combining categories if necessary to produce a smaller table). Also using the likelihood ratio is an alternative to assess any association between the variables, whenever the cells display an expected count of less than five (McHugh, 2013).

Principal component analysis (PCA) is a statistical analysis technique that extracts crucial information from a data table, represents it as a collection of new variables called principal components, and displays the pattern of similarity of the observations. As long as data satisfies the five assumptions for using PCA (no significant outliers in the data, data is suitable for reduction, sampling adequacy, linear relationship between variables and multiple continuous variables) (Abdi and Williams, 2010).

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

The study revealed that 57.1% and 62.9% of respondents were male in UL and Univen respectively with 42.9% and 37.1% of respondents in the study areas being female. The study found that the average age of respondents in UL and Univen were 39.34 and 42.49 respectively, with an age range of 27-64 years in UL and 27-57 years in Univen. The study further indicated that in UL and Univen interviewed respondents ranged from 3-15 and 3-20 years of being in the institutions respectively.

UL had the largest proportion of married respondents at 66%, followed by Univen at 63%. According to the report, most staff in UL earned between R26 000 and R35 999 (34.3%) compared to their counterparts in Univen, where many respondents earned between R46 000 and R55 999. The majority of respondents in both study areas were involved in research in one way or another, respondents participating in lecturing and research were found to be 68.6% and 62.9%, respectively, at UL and Univen. Univen had the highest number of respondents with the highest qualification of PhD with 62.9%, whereas, UL had 51.4% of respondents with PhD qualifications (Table 1 & 2).

Table 1. Summary statistics of selected socioeconomic characteristics (Continuous variables).

	University of Limpopo(n=35)			University of Venda(n=35)		
Statistics	Age of Respondents	Number of years in the Institution	Respondents Household Size	Age of Respondents	Number of years in the Institution	Respondents Household Size
Mean	39.34	7.60	3.09	42.49	7.54	4.09
Std. Deviation	8.721	3.457	1.560	9.144	3.837	2.442
Variance	76.055	11.953	2.434	83.610	14.726	5.963
Min	27	3	1	27	3	0
Max	64	15	8	57	20	9

Source: Authors' computation from survey data.

Table 2. Descriptive statistics of other socioeconomic variables.

Variables	Description of variables	UL: % of Staff (N=35) in the department	Univen: % of Staff (N=35) in the department
Field study	Agri. Economics	5.7%	20%
	Animal Production/Sciences	14.3%	14.3%
	Plant Science	40%	8.6%
	Soil Sciences	28.6%	11.4%
	Others	11.4%	45.7%
Highest Qualification	PhD	51.4%	62.9%
	Masters	48.6%	37.1%
Academic Load	Lecturing	14.3%	14.3%
	Research	5.7%	5.7%
	Lecturing & Research (1 &2)	68.6%	62.9%
	All of the above	11.4%	17.1%
Income per month	<R25 999	0%	0%
	R26 000-35 999	34.3%	20%
	R36 000-45 999,	11.4%	25.7%
	R46 000-55 999	25.7%	37.1%
	>R56 000	28.6%	17.1%
Gender	Male	57.1%%	62.9%%
	Females	42.9%	37.%
Marital Status	Married	66%	63%
	Unmarried	34%	37%

Source: Authors' computation from survey data.

Assessment of human capacity at Universities of Limpopo and Venda in the field of agriculture

The results indicate no significant relationship between gender, the number of undergraduates, the number of MSc and the number of PhD students who graduated/supervised in both universities. The results showed that in both universities male respondents had a larger share of students who graduated/supervised as compared to their female counterparts. However, Univen had 28.6% and 22.9% of respondents supervising 6-10 and >11 undergraduate students respectively as compared to UL which has 20% of respondents supervising both 6-10 and >11 students in the last 8 years.

Univen had a higher percentage of male respondents graduating 1-5 (28.6%) and >6 (17.1%) MSc students when comparing it to UL which has 20.0% and 11.4% of MSc students respectively.

Univen's male respondents contributed an overall 40% of PhD graduates, from the overall, 31.4% of the male respondents accounted for 1-5 PhD students who

graduated and 8.6% accounted for >6 PhD students who graduated. Compared to Univen, the UL male respondents' overall percentage was 25.8%, with 22.9% of the respondents graduating 1-5 PhD students and 2.9% graduating >6 PhD students. However, UL has a higher share percentage of female respondents (17.1%) graduating 1-5 PhD students as compared to Univen with 11.4% PhD students. These may be due to on average most respondents having been there for 7 years or less and the low number of PhD staff with regards to UL.

Taking into consideration, that PhD requires 4-5 years of study. Assuming all other factors held constant on average a respondent should be able to graduate two students after 8 years (Table 3).

Table 3. Distribution of students who graduated by gender.

Uni.			No. Under-grads Supervised				No. MSc. Grads			No. PhD Graduated		
			No St.	1-5 St.	6-10 St.	>11 St.	No St.	1-5 St.	> 6 St.	No St.	1-5 St.	>6 St.
UL	Male	Cnt.	3	3	7	7	9	7	4	11	8	1
		EP	3.4	2.9	6.9	6.9	9.1	7.4	3.4	11.4	8.0	.6
		% Cnt.	8.6%	8.6%	20.0%	20.0%	25.7%	20.0%	11.4%	31.4%	22.9%	2.9%
	Female	Cnt.	3	2	5	5	7	6	2	9	6	0
		EP	2.6	2.1	5.1	5.1	6.9	5.6	2.6	8.6	6.0	.4
		% Cnt.	8.6%	5.7%	14.3%	14.3%	20.0%	17.1%	5.7%	25.7%	17.1%	0.0%
Univen	Male	Cnt.	1	3	10	8	6	10	6	8	11	3
		EP	2.5	3.8	8.2	7.5	7.5	8.8	5.7	10.1	9.4	2.5
		% Cnt.	2.9%	8.6%	28.6%	22.9%	17.1%	28.6%	17.1%	22.9%	31.4%	8.6%
	Female	Cnt.	3	3	3	4	6	4	3	8	4	1
		EP	1.5	2.2	4.8	4.5	4.5	5.2	3.3	5.9	5.6	1.5
		% Cnt.	8.6%	8.6%	8.6%	11.4%	17.1%	11.4%	8.6%	22.9%	11.4%	2.9%

	Statistics		
	No. Under-grads Supervised	No. MSc. Grads	No. PhD Graduated
UL	LR = 0.154, DF = 3, p-value=0.985. (4 cells (50.0%) have an expected count of less than 5. The minimum expected count is 2.14.)	LR = 0.291, DF = 2, p-value=0.865. (2 cells (33.3%) have an expected count of less than 5. The minimum expected count is 2.57.)	LR = 1.157, DF = 2, p-value = 0.561. (2 cells (33.3%) have an expected count of less than 5. The minimum expected count is .43.)
Univen	LR= 4.042, DF = 3, p-value = 0.257. (6 cells (75.0%) have an expected count of less than 5. The minimum expected count is 1.49)	LR= 1.335, DF = 2, p-value=0.513. (2 cells (33.3%) have an expected count of less than 5. The minimum expected count is 3.34)	LR= 2.103, DF=2, p-value=0.349. (2 cells (33.3%) have an expected count of less than 5. The minimum expected count is 1.49.)

Hedjazi and Behravan (2011) and Iqbal *et al.* (2018) highlighted that, male faculty members published more often than female faculty members. Thus, in the study, there is no difference in research output due to gender. Table 4 indicated respondents from Univen have a high share of several publications in accredited journals (54.3%) as compared to UL with an overall share of 40% of respondents publishing in accredited journals. However, UL has a larger share of female respondents (34.3%) publishing in accredited journals as related to Univen respondents (28.6%). From these results, there were no disparities displayed between gender and the number of commissioned research by the respondents in both universities. Table 5, indicated that there are differences between marital status and the number of undergraduate, and number of MSc and PhD students who graduated/supervised. Students supervised 34.3% of married respondents in UL supervised >11 undergraduate students to 31.4% of Univen's respondents with the same number of undergraduate students.

Table 4. Gender distribution of respondents by number of publications.

University			No. of Publications in accredited Journals			No. of Commissioned Research		
			No Papers	1-5 Papers	>6 Papers	No Papers	1-5 Papers	>6 Papers
UL	Male	Cnt.	6	12	8	8	12	0
		EP.	5.1	12.0	8.0	8.0	11.4	.6
		% Cnt.	17.1%	34.3%	22.9%	22.9%	34.3%	0.0%
	Female	Cnt.	3	9	6	6	8	1
		EP.	3.9	9.0	6.0	6.0	8.6	.4
		% Cnt.	8.6%	25.7%	17.1%	17.1%	22.9%	2.9%
Univen	Male	Cnt.	3	12	5	5	11	6
		EP.	3.8	12.6	5.7	5.7	10.7	5.7
		% Cnt.	8.6%	34.3%	14.3%	14.3%	31.4%	17.1%
	Female	Cnt.	3	8	4	4	6	3
		EP.	2.2	7.4	3.3	3.3	6.3	3.3
		% Cnt.	8.6%	22.9%	11.4%	11.4%	17.1%	8.6%

	Statistics	
	No. of Publications in accredited Journals	No. of Commissioned Research
UL	LR= .934, DF=2, p-value=.627. (3 cells (50.0%) have an expected count of less than 5. The minimum expected count is 2.14.)	LR= 1.762, DF = 2, p-value=.414. (2 cells (33.3%) have an expected count of less than 5. The minimum expected count is .43.)
Univen	LR= 1.407, DF=2, p-value=.495. (3 cells (50.0%) have an expected count of less than 5. The minimum expected count is 2.23.)	LR= .283, DF = 2, p-value=.868. (2 cells (33.3%) have an expected count of less than 5. The minimum expected count is 3.34.)

Source: Authors' computation from survey data.

This p-value highlights that there are differences between marital status and the number of masters' students who graduated by a certain respondent/individual in UL, however, in Univen there are no disparities between the above-mentioned variables. In UL this may be the case since 2.9% of the unmarried respondents account for 1-5 MSc students who graduated concerning Univen with 17.1% and 2.9% of the unmarried respondents graduating 1-5 and >6 MSc students respectively in the past eight years. Furthermore, the results indicated that there are no disparities between marital status and the number of PhD students who graduated from Univen.

Table 5. Number of undergraduate, MSc and PhD students supervised and graduated by marital status.

University			No. Under-grads Supervised				No. MSc. Grads			No. PhD Graduated		
			No St.	1-5 St.	6-10 St.	>11 St.	No St.	1-5 St.	> 6 St.	No St.	1-5 St.	>6 St.
UL	Married	Cnt	2	2	7	12	5	12	6	9	13	1
		EC	3.9	3.3	7.9	7.9	10.5	8.5	3.9	13.1	9.2	.7
		% Cnt.	5.7 %	5.7 %	20.0 %	34.3 %	14.3 %	34.3 %	17.1 %	25.7 %	37.1 %	2.9 %
	Unmarried	Cnt.	4	3	5	0	11	1	0	11	1	0
		EP	2.1	1.7	4.1	4.1	5.5	4.5	2.1	6.9	4.8	.3
		% Cnt.	11. 4%	8.6 %	14.3 %	0.0%	31.4 %	2.9%	0.0%	31.4 %	2.9%	0.0 %

Univen	Married	Cnt.	1	3	7	11	6	8	8	7	12	3
		EP	2.5	3.8	8.2	7.5	7.5	8.8	5.7	10.1	9.4	2.5
		% Cnt.	2.9 %	8.6 %	20.0 %	31.4 %	17.1 %	22.9 %	22.9 %	20.0 %	34.3 %	8.6 %
	Unmarried	Cnt.	3	3	6	1	6	6	1	9	3	1
		EP	1.5	2.2	4.8	4.5	4.5	5.2	3.3	5.9	5.6	1.5
		% Cnt.	8.6 %	8.6 %	17.1 %	2.9%	17.1 %	17.1 %	2.9%	25.7 %	8.6%	2.9 %

	Statistics		
	No. Under-grads Supervised students	No. MSc graduated students	No. PhD Graduated
UL	Likelihood Ratio = 14.335, DF = 3, p-value = .002. (6 cells (75.0%) have expected count less than 5. The minimum expected count is 1.71.)	UL) Likelihood Ratio = 18.078, DF = 2, p-value = .000. (3 cells (50.0%) have expected count less than 5. The minimum expected count is 2.06.)	UL) Likelihood Ratio = 10.273, DF = 2, p-value = 0.006. (3 cells (50.0%) have expected count less than 5. The minimum expected count is .34.)
Univen	(Univen) Likelihood Ratio = 8.534, DF= 3, p-value = .036. (6 cells (75.0%) have expected count less than 5. The minimum expected count is 1.49.)	(Univen) Likelihood Ratio = 4.144, DF = 2, p-value = .126. (2 cells (33.3%) have expected count less than 5. The minimum expected count is 3.34.)	(Univen) Likelihood Ratio = 4.739, DF = 2, p-value = 0.094. (2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.49.)

Table 6. Number of Publications in accredited Journals and number of Commissioned Research by marital status.

University			No. of Publications in accredited Journals			No. of Commissioned Research		
			No Papers	1-5 Papers	>6 Papers	No Papers	1-5 Papers	>6 Papers
UL	Married	Cnt.	3	15	5	5	17	1
		EP.	5.9	13.8	3.3	9.2	13.1	.7
		% Cnt.	8.6%	42.9%	14.3%	14.3%	48.6%	2.9%
	Unmarried	Cnt.	6	6	0	9	3	0
		EP.	3.1	7.2	1.7	4.8	6.9	.3
		% Cnt.	17.1%	17.1%	0.0%	25.7%	8.6%	0.0%
Univen	Married	Cnt.	2	11	9	2	13	7
		EP.	3.8	12.6	5.7	5.7	10.7	5.7
		% Cnt.	5.7%	31.4%	25.7%	5.7%	37.1%	20.0%
	Unmarried	Cnt.	4	9	0	7	4	2
		EP.	2.2	7.4	3.3	3.3	6.3	3.3
		% Cnt.	11.4%	25.7%	0.0%	20.0%	11.4%	5.7%

	Statistics	
	No. Publications in accredited Journals	No. of Commissioned Research
UL	UL) Likelihood Ratio = 8.419, DF = 2, p-value = .015. (3 cells (50.0%) have an expected count of less than 5. The minimum expected count is 1.71.)	(UL) Likelihood Ratio = 9.846, DF = 2, p-value= 0.007. (3 cells (50.0%) have an expected count of less than 5. The minimum expected count is .34)
Univen	Univen) Likelihood Ratio = 11.016, DF = 2, p-value = .004. (3 cells (50.0%) have an expected count of less than 5. The minimum expected count is 2.23.)	Univen) Likelihood Ratio = 8.560, DF = 2, p-value= 0.014. (2 cells (33.3%) have an expected count of less than 5. The minimum expected count is 3.34.)

Source: Authors' computation from survey data.

Table 6 indicates that marital status affects the number of publications in approved journals in this study; the p-values for both universities are less than 0.05. This suggests that marital status matters when it comes to getting published in a reputable journal. Highlighting that there is a likelihood that a respondent publishes a paper if he or she is married in this study. UL has a higher percent 42.9% of married respondents publishing 1-5 papers, whereas Univen is leading with a share of 25.7% of married respondents publishing >6 papers in the past eight years.

Table 7 highlighted that there are differences between the marital status of a respondent and the number of commissioned research in both universities. Univen had the highest overall respondents with the number of commissioned researches at 57.1%, with 37.1% of the married respondents having 1-5 commissioned research and 20% of respondents having >6 commissioned research papers in the past eight years. These results support the group which highlighted a significant correlation between marital status and the number of under-grads, MSc and PhD students who graduated/supervised.

Gender, research output and students' throughput rate

As depicted in Tables 5, 6 and 7, there is enough evidence to highlight that there is no significant relationship between gender when it comes to research output and student throughput either due to 20% of cells having an expected count of less than five and the overall likelihood ratio results were greater than >0.05. Which is the standard confidence interval for the chi-square statistic in both University of Limpopo and Venda. Given the small sample size and the fact that two Chi-Square cells contain fewer than five observations, more research with larger sample size is needed to test the hypothesis that there is a relationship between gender, research output, and student throughput. Although according to Anyaogu and Iyabo (2014), gender had a negative but significant correlation to the research output of academic staff. However, this finding disagrees with the study in question results, which revealed that there was no difference in research output because of gender. The study of North *et al.* (2011) found no association between gender and research output at a 5% level of significance. This study concurs with our study findings. According to Lone and Hussain (2017), males have higher average productivity than females in all performance criteria, including research productivity, patent development, funding, and cross-regional and cross-disciplinary cooperation. However, the gap is narrowing over time Ogbogu (2009) concluded that female academics made contributions that are more significant to teaching than research. According to Atanda and Olasupo (2018), the study hypothesis revealed there was no correlation between the male and female research output of academic staff in the University of Ibadan. This implies that male and female academic staff carry out research at the same rate. This disagrees with the findings of Adu *et al.* (2012) who found that male teachers are more productive than female lecturers. In addition, García-Gallego *et al.* (2015) discovered that female professors produce greater teaching outcomes than male colleagues. As stated by Lone and Hussain (2017) that, men are more productive than women in research and remain more productive throughout their careers.

Effect of marital status on research output and student throughput rate

Tables 5, 6 and 7, indicates that there are disparities between the marital status of a respondent, research

output and student throughput. The results indicate that there is a higher possibility of more student supervised/graduated and more papers published in accredited journals if the respondent is married in both universities and the results of the merged data sets indicate that marital status is significant. Olakunle and Olanrewaju (2019) and Williams (2003), they disagree with the results of the study, which highlight that marital status affects the research output of academic staff. Their study highlights that marriage increases domestic workload in women, which in turn are affect research productivity, and lead to low academic ranks, and fewer research funds. Similarly, to our study, Bassey *et al.* (2007) mentioned that the married staff displayed higher research productivity than their unmarried counterparts. The logical reason for this finding was that married academic workers are more settled, which may cause them to focus more on research activities than their single colleagues, whose thoughts and problems of being single prevent them from settling down to produce high-quality research works. However, in contrast to the study in question, Webber *et al.* (2016) studied the effect of marital status on research productivity and found that marital status has no major impact on academic staff's research productivity in institutions. The overall results highlight that married respondents in both universities supervise, graduate, and have more research papers as compared to their unmarried counterparts.

Table 7. Number of undergraduate, MSc and PhD students supervised and graduated, number of publications in accredited Journals and number of commissioned research by marital status.

University			No. Under-grads Supervised				No. MSc. Grads			No. PhD Graduated		
			No St.	1-5 St.	6-10 St.	>11 St.	No St.	1-5 St.	> 6 St.	No St.	1-5 St.	>6 St.
	Married	Cnt	3	5	14	23	11	20	14	16	25	4
		EC	6.4	7.1	16.1	15.4	18.0	17.4	9.6	23.1	18.6	3.2
		%	6.7%	11.1	31.1	51.1	24.4	44.4	31.1	35.6	55.6	8.9
Merged		Cnt		%	%	%	%	%	%	%	%	%
groups	Unmarried	Cnt	7	6	11	1	17	7	1	20	4	1
		EP	3.6	3.9	8.9	8.6	10.0	9.6	5.4	12.9	10.4	1.8
		%	28.0	24.0	44.0	4.0%	68.0	28.0	4.0%	80.0	16.0	4.0
		Cnt	%	%	%		%	%		%	%	%

	Statistics				
	No. Under-grads Supervised	No. Masters Graduated	No. PhD Graduated	No. of Publications in accredited Journals	No. of Commissioned Research
Merged groups	LR = 21.260, DF = 3, p = 0.001. (a. 2 cells (25.0%) have an expected count of less than 5. The minimum expected count is 3.57.)	X^2= 14.262, DF = 2,p = 0.001. (a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.36.)	LR = 13.512, DF = 2, p = 0.002. (2 cells (33.3%) have an expected count of less than 5. The minimum expected count is 1.79.)	X^2 = 14.051, DF = 2, p = 0.001. (a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.00.)	X^2 = 17.101, DF = 2, p = 0.001. (a. 1 cell (16.7%) have an expected count of less than 5. The minimum expected count is 3.57.)

Source: Authors' computation from survey data.

Principal Component Analysis results for the University of Limpopo and Venda

Dobgegah *et al.* (2011) highlighted that the KMO statistic ranges from 0 to 1, with a value of 0 suggesting that the number of partial correlations is high compared to the sum of correlations, indicating that the pattern of correlations has diffused, and therefore factor analysis is unlikely to be acceptable. As highlighted by Dobgegah *et al.* (2011) and Field (2005) that for the sample size to fit the Principal Component Analysis the KMO value should be greater than 0.50.

Moreover, as presented in Table 1, the KMO measure of this study achieved a slightly high value of just 0.516, which is just above the 0.50 margin mentioned above, indicating the sample size's suitability for factor analysis The sphericity test by Bartlett was also significant, indicating that the population was not an identity matrix.

Table 8. KMO and Bartlett's test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.516
Bartlett's Test of Sphericity	Approx. Chi-Square	128.503
	Df	66
	Sig.	.000

Source: Authors' computation from survey data.

Table 9. Total variance explained.

PC	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
1	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
2	2.152	17.935	17.935	2.152	17.935	17.935	2.019	16.824	16.824
3	1.767	14.726	32.661	1.767	14.726	32.661	1.790	14.913	31.737
4	1.547	12.889	45.550	1.547	12.889	45.550	1.375	11.455	43.192
5	1.243	10.355	55.905	1.243	10.355	55.905	1.302	10.849	54.041
6	1.032	8.597	64.502	1.032	8.597	64.502	1.255	10.461	64.502
7	.962	8.016	72.518						
8	.903	7.522	80.040						
9	.698	5.818	85.857						
10	.599	4.989	90.846						
11	.422	3.515	94.361						
12	.373	3.105	97.466						

Table 9 together with Figure 1 (Scree plot) illustrates five (5) components with eigenvalues greater than 1.0 and they were extracted using a factor loading of 0.50 as the cut-off point. The explained total variance by each principal component is as follows: Principal component 1 (PC1) accounted for 17.935%, Principal component 2 (PC2), explained 14.726 %, Principal Component 3 (PC3) accounted for 12.889%, Principal component 4 (PC4) accounted for 10.355%, Principal component 5 (PC5) accounted for 8.597%. The cumulative proportion of the variance acceptable from the extracted components should together explain at least 50% of the variation, and for our study the five (5) extracted components cumulatively explained 64.502% of the variation.

Table 10. Rotated Component Matrix[a].

	Component				
	1	2	3	4	5
Lack of equipment	.849				
Lack of laboratories	.773				
Shortage of land/animals	.674				
Research funding				.739	
Staff shortage		.647			
Academic overload		.604			
Personal health			.884		
Curriculum inefficiency				.820	
Staff collaboration				-.603	
Shortage of office space					-.722
Marriage					.703
Extraction Method: Principal Component Analysis.					
Rotation Method: Varimax with Kaiser Normalization.					
a. Rotation converged in 10 iterations.					

Source: Authors' computation from survey data.

Based on a critical analysis of the inherent relationships among the variables under each component, the following description was deduced to reflect the underlying dimensions of the components. For example, principal component 1 was labelled Resources and Infrastructure Challenges, principal component 2 was called Financial Challenges, principal component 3 housed Personal challenges; principal component 4 was classified as Research Productivity Challenges and component 5 was termed Privacy and Marital Challenges. These names were created using a variety of interacting characteristics and variables with high factor loadings.

Principal Component 1: (Resources and Infrastructure Challenges)

The fourth component has both positive and negative associations with Lack of equipment, Lack of laboratories and Shortage of land/animals, so this component primarily measures the problem of resources and infrastructure challenges in the department/school in these universities. Many respondents especially those who fall under Animal, Plant and Soil sciences expressed the need to increase/have the required resources to produce well-qualified students and increase the level of research output. They outlined that there are limited animals and land to perform their experiments for gathering data and continuing with their research. Thus, they look for external facilities, which in turn exhaust their already limited funding and extend the completion time of the student's research projects and their research, which also affects the research output of the school/department as a whole. According to the findings of Badat (2020), the facilities given to universities since 2008 for academic buildings, student accommodation, and research equipment has been a welcome contribution; however, to enable efficient and long-term planning, there must be reliability, quality, and sustainability of funding based on consistent and transparent requirements.

Principal component 2: (Financial Challenges)

The Second component has both positive associations with Staff shortage and academic overload, so this component primarily measures the problem of financial stability/challenges of the agricultural departments in the universities. Stads and Beintema (2017) identified that the shortage of sufficient research facilities and resources is one of the main reasons for the comparatively low science success of West African agricultural research institutes.

Principal component 3: (Personal challenges)

The third component has both positive and negative associations with personal health, so this component primarily measures the respondent's status problems. This issue does affect academic staff although not

intentionally. Many respondents agreed that issues such as injuries, sickness, diseases, etc. do affect their performance when it comes to research output and student throughput, even though some you can control some are unavoidable and will affect output.

Principal component 4: (Research Productivity Challenges)

The fourth principal component has large positive associations with Research funding, Staff collaboration and Curriculum inefficiency, so this component primarily measures long-term academic throughput and research output challenges. Many respondents highlighted that funding and available qualified personnel is required to ensure an increase in research output and throughput for both academic staff and post-graduate students as well. Some respondents highlighted that supervisor should also apply funding for themselves and the students they supervise because in some cases the lack of funding delays the completion of certain research due to the inability to access the study areas in question.

In the case of staff shortage, they suggested the recruitment of post-grad students to alleviate this challenge, because it may help them in covering some of the expenses of their research projects. However, Freer (2015) and Rivera and Alex (2008) expressed that, the AET structure has been categorized by a lack of cross-system integration in educational institutions and providers including government ministries, NGOs, and the private sector. At the career level, programs have been critiqued for a narrow and production-oriented focus that is misaligned with the current agricultural occupations and overlooks agricultural systems as a part of rural development (Vandenbosch, 2006). While appraisals at the undergraduate level demonstrated heavy theoretical and academic emphasis that are conflicting with employer needs and those of smallholder and entrepreneur needs (Rivera, 2006).

Principal component 5: (Privacy and Marital Challenges)

The fifth principal component has large positive and negative associations with a shortage of office space and marriage problems, so this component primarily highlights the need to find office space. Because sharing of office in some cases leads to staff conflicts due to differences in opinions on the standard of office use because of personal behaviours. This may lead to low performance of an individual in the office and it can affect future research collaborations. Only a few respondents highlighted that marriage does affect work whether directly or indirectly. So, a need for one to have his/her own office is really important, because whether we like it or not these issues are real and do affect certain academic staff.

CONCLUSION AND RECOMMENDATIONS

The aim of the study was to assess human capacity in agricultural departments in two universities in Limpopo Province, South Africa. All the objectives of the study were met and satisfied. The study hypothesised that the there are no disparities between gender, marital status, research output, and throughput capacity in agriculture of these institutions. The hypothesis was rejected, because the findings highlighted that in both grouped and merged results, marital status plays a significant role in determining the research output and student throughput of the academic staff in the study areas. Based on this study, we can conclude that we have identified several challenges that should be addressed, the results indicated challenges faced by academics when it comes to issues relating to research, challenges such as finance, infrastructure, privacy, resources etc., were among many academics come across when conducting and supervising research activities in these two universities. The study focused on only two universities in the country, narrowing down to the school/departments of agriculture in these universities. Furthermore, data collection was restricted to only two public universities' faculty members (lectures and researchers); as a result, to validate and generalize the study findings, the research should be expanded geographically within the same category of education institutions. Based on the findings, the study recommends.

Collaboration among married and other staff members as well as other institutions should be encouraged and promoted as it has the potential to improve the reputation of both an individual and the universities in question. Better infrastructural facilities should be made available by the university, government, and other private stakeholders for better and quality research by both academic staff and students. Each department/school should have a separate unit that only

deals with research to facilitate/accelerate the issue of research output. The school/department of agriculture should be developing a strategy that incentivizes a staff member to obtain a Ph.D. degree and that will grow the school size particularly at senior levels.

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