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The Zimbabwe Journal of Applied Research aims to publish peer reviewed articles that employ Scientific Research Methodologies to generate applied knowledge in the fields of Agriculture, Commerce, Social Sciences and Humanities. The journal seeks to give its wide readership evidence-based knowledge that bridges the gap between theory and practice. It also offers academia and practitioners across disciplines a platform to assess the merit of their research and subsequently make their work known to the journal readership.

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NOTE FROM THE EDITOR

We are delighted to publish the 6th volume of the Zimbabwe Journal of Applied Research. The current issue features contributions mainly focusing on education and rural livelihoods. The papers address different topics which include E- learning, continuous assessment, climate change adaptation technologies and the role of non-timber forest products (NTFPS) in rural livelihoods. The paper by Piet Muparuri and Remigio Chingara evaluates the implementation of Continuous Assessment Learning Activity (CALA) in selected secondary schools in Masvingo District of Zimbabwe. The study reveals challenges which need to be addressed to enhance the success in the implementation of this programme. The authors suggest interesting recommendations that may promote motivation among teachers and school heads in the implementation of CALA. Another research article in education focuses on the factors which impact the use of Information Communication Technologies (ICTs) in e-learning by lecturers at institutions of higher learning.This paper by Mavezera looked at perceptions of the use of ICT, teaching /learning outcomes for lecturers, and impediments to embracing new technologies in university teaching and learning. It brings out interesting reasons for use or none use of ICT and also suggests practical recommendations. The research article by Muvhuringi, Ngwenya and Dube conducted in the Mberengwa District employed mixed methods to assess the impact of climate-smart agriculture (CSA) technologies (hydrogel, pfumvudza, smallholder irrigation) on maize yields, dietary diversity and household incomes. They show the advantages of the technologies and also highlight the major challenges that need to be overcome for the benefits to be realized. The paper makes recommendations on how these hurdles can be overcome. Another paper related to rural livelihoods, in this issue, by Mguni, Gwate & Musavengana evaluated literature on the role that non-timber forest products play in enhancing the rural livelihoods of communities in Southern Africa with a particular focus on the marula tree. The results of the review revealed growth in the utilization and commercialization of the marula tree in Southern Africa offering livelihood options to several families. Research on technologies that can aid product development and improve the shelf life of marula products and eventually marketing has been suggested as a way forward.

Dr Margaret Macherera

(*Chief Editor*)

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AN EVALUATION OF CONTINUOUS ASSESSMENT LEARNING ACTIVITY (CALA) IMPLEMENTATION IN SELECTED SECONDARY SCHOOLS IN MASVINGO DISTRICT, ZIMBABWE

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ABSTRACT

There is a perception that the implementation of the Continuous Assessment Learning Activity (CALA) in secondary schools in Zimbabwe is mired in controversy. Some stakeholders in Education feel that the CALA initiative is the worst nightmare being endured by learners and teachers in schools. However, the Ministry of Primary and Secondary School Education (MoPSE) maintains that CALA is a necessary part of a holistic assessment of learner competence under competence-based curriculum implementation. This study sought to evaluate the implementation of CALA in selected secondary schools in Masvingo District of Zimbabwe. The study employed a quantitative research methodology and adopted a descriptive survey design. Random sampling was used to select a sample of 200 teachers and 20 school heads. A questionnaire with both open-ended and close-ended questions was used to gather data. Findings from this study reveal that the implementation of CALA in the selected schools is being met with a plethora of challenges which need to be addressed if the programme is to be successful. The study recommends that there be some introspection on the way CALA is being implemented in secondary schools to improve it. The extra work resulting from CALA has to be met with corresponding salary adjustments to avoid demotivation and rent-seeking behaviours as is currently the case. Alternatively, the number of teachers in secondary schools should be increased in tandem with the extra work brought in by CALA to avoid overburdening the already burdened teachers.

Keywords: *Continuous Assessment, Continuous Assessment Learning Activity (CALA), Continuous Assessment Implementation, Evaluation, Descriptive*

INTRODUCTION

During the last few years, Primary and Secondary School Education in Zimbabwe has experienced a paradigm shift. This has seen it gravitating towards pragmatism where the issue is not what is true, but what works. The schools' shift to pragmatism is most evident in what has been dubbed Continuous Assessment Learning Activity (CALA).

Such type of education is premised on the idea of innovating new ideas and solving real-world problems affecting the current socio-politico-economic environment. The expectation is that this type of education produces a citizen who is rooted in pragmatic skills for solving problems arising in our environment. The Ministry of Primary and Secondary School Education (MoPSE) through the Zimbabwe Schools Examination Council (ZIMSEC) introduced CALA in 2021 as a candidate assessment procedure that requires students to perform, and demonstrate their knowledge, understanding and proficiency in their learning areas before the main public examinations. CALA is a policy from the government of Zimbabwe's Ministry of Primary and Secondary Education

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(MoPSE) that advocates that coursework performance for basic education learners be captured and included in the final examination of learners. Learners are evaluated based on their performance during a programme (Makamure & Jojo, 2023). This is done to avoid relying solely on tests after the academic term (Juet et.al, 2021). Learners are therefore regularly tested during the course of their schooling duration. During the implementation of CALA, learners are expected to carry out projects and tasks in schools which will constitute 30% of their final examination for each subject. Thus, students will be assessed from both the coursework and the final examination.

However, the implementation of CALA in Zimbabwean schools appears to be mired in controversy. It was introduced rashly in 2021 (Gama, 2022). Some stakeholders in Education seem to think that the CALA initiative is the worst nightmare being endured by learners and teachers in schools (Gama, 2022). However, the MoPSE is of the view that CALA is a necessary part of the holistic assessment of learner competence under competence-based curriculum implementation (MoPSE, 2021). It is against this background that this study sought to evaluate the implementation of CALA in selected secondary schools in the Masvingo District of Zimbabwe.

LITERATURE REVIEW

CALA is any learning activity or assessment that requires learners to perform, and demonstrate their knowledge, understanding and proficiency (MoPSE, 2021). It is also described as a learning process by which learners are assessed based on what they know and try to sharpen them (Firomumwe, 2022). The fundamental role of CALA is hinged on the concept that education must be education with production. It must foster creativity and industrial development through the nesting of new ideas at the secondary and primary levels. Identification of the learners' talents and skills by the teacher helps the learners to develop creativity, innovation and entrepreneurial skills leading to industrial development. CALA is premised on the idea that every child who goes to school must come up with something that is tangible which contributes to the development of the economy (Secretary's Circular No.2 of 2022). That is, education must be geared towards industrial development as well as preparing learners with skills for exiting school and preparing others for academic progression.

The effectiveness of CALA will never be questioned if properly planned. What is needed is vigorous engagement with the implementers (teachers and school heads) as well as provision of resources for workshops and training if this kind of reform is to succeed (Chanda, 2022). There must be adequate time for piloting the intended reform before implementing the intended reform. This implies that there must be wide-ranging engagements of teachers and school heads as the implementers who are crucial in the development, execution, administration, supervision and assessment of CALA. They are also responsible for guarding against any malpractices.

The use of continuous assessment has been embraced worldwide as a basis for determining the progress and achievement of learners holistically and reliably (Gemachu & Teklu, 2020). The justification for continuous assessment is that it allows learners to be assessed in the cognitive, affective and psychomotor areas of learning (Shute & Rahini, 2017). Its purpose should be to develop learners. Continuous assessment has been adopted in many countries across Africa and the rest of the world. For instance, it has been adopted in Tanzania (Byabato & Kisamo, 2014; Mpapalika, 2013), Ethiopia (Abejehu, 2016), Ghana (Akyeampong, 1997; Boachie, 2016), Nigeria (Atsumbe & Emmanuel, 2012) and South Africa (Der-Berg & Shepherd, 2015). It was introduced in Tanzania in 1995 (Firomumwe, 2022). In South Africa, continuous assessment constitutes 25% of the final weight of matriculation results and is a vital part of the assessment of South African learners at that level (Der Berg & Shepherd, 2015). Studies by Browne (2017) in South Africa, Ghana, Malawi, Nigeria and Zambia indicate that teachers in these countries were not keen to use continuous assessment because they lacked the institutional support framework to do so. The study also found that the teachers did not understand its purpose since it was just imposed on them from above. This suggests that the teachers were not involved from its inception even though they are to be the ones to implement it in their schools (Alsubaie, 2016). This confirms the notion that teachers are often

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forgotten stakeholders in educational change (Chanda, 2022).

THEORETICAL FRAMEWORK

The theoretical framework guiding this study is the Process Model which advocates an approach to learning that provides learners with both knowledge and skills (Gama, 2022). This model is a direct response to the product model of instruction which emphasises rote learning and regurgitation of textbook material. The use of the product model makes it challenging to ascertain what the learners will have learnt and how they can use what they have learnt. Teachers who use the process model impart both knowledge and skills. The model pays attention to the benefits of the process of learning rather than the level of achievement. This model relates to CALA in that CALA implementation is meant to equip learners with hands-on experience of the theoretical aspects learned. The teachers can assess the learners' capabilities in applying the aspects of the theory they will have learnt to the real world. This will enable the learners to have a better understanding of what they will have learnt as well as demonstrate their knowledge and ability to give practical applications.

This study therefore sought to evaluate the implementation of CALA in selected secondary schools in Masvingo District of Zimbabwe.

RESEARCH QUESTIONS

The following research questions guided this study:

1) How do teachers and school heads understand CALA?
2) What are the challenges that are associated with implementing CALA in schools?
3) How can the challenges associated with implementing CALA be solved to effectively implement it in schools in Zimbabwe?

SIGNIFICANCE OF THE STUDY

This study provides insights into challenges facing both teachers and school heads as they implement CALA in their schools. It provides possible solutions to these challenges in such a manner that highlights the importance of CALA as an assessment device. The research findings add to the already existing literature on the implementation of CALA in schools the world over.

LIMITATIONS TO THE STUDY

The study is limited to an evaluation of the implementation of CALA in selected secondary schools in the Masvingo District of Zimbabwe using the descriptive method. The descriptive method provides information that indicates norms, not standards, and the investigator learns what is being done and not what could be done or should be done (Anderson, 2012). The researcher using the descriptive survey, determines usual practices, rather than causes, reasons, meanings or possibilities (Kumar, 2008). Given the small population and sample size, the findings of the study might be difficult to generalize with accuracy.

DELIMITATION OF THE STUDY

The researchers delimited the study to an evaluation of the implementation of CALA in selected secondary schools using a sample of 200 teachers and 20 heads of schools from Masvingo District in Masvingo Province of Zimbabwe. Other stakeholders such as parents, pupils, education inspectors and School Development Committee / Association members were not included in this study as they were adjudged to be outside the scope of this particular research.

RESEARCH METHODOLOGY

The quantitative research methodology was employed in this study. This method makes it fairly easy to collate data into a graph, chart or table. It also makes it easy for research to be conducted on a large scale thereby providing more information (Cohen & Manion, 2011). The study made use of the survey design. The study's population comprised all the teachers and school heads from the seventy (70) secondary schools in Masvingo District of Masvingo Province. Random sampling was used to select 20 schools. This technique was used because it permitted every teacher an equal opportunity to participate in the study (Kumar, 2008). From each school, the head and ten (10) teachers were randomly selected. The final sample consisted of 200 teachers and 20 school heads. A questionnaire with both open-ended and close-ended questions was used to gather data. It was chosen because it gives respondents time to

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consider questions (especially so when not face to face) and responses can be highly structured and easily coded (Cohen & Manion, 2011). However, if not administered physically, there is a possibility of a low response rate (Anderson, 2012). Researchers sought prior permission from the Ministry of Primary and Secondary Education officials at the district level and were granted before they proceeded to distribute the questionnaires to the selected schools. Respondents participated voluntarily and they were assured of anonymity and confidentiality.

RESULTS AND DISCUSSION

The study set out to evaluate the implementation of CALA in selected secondary schools in Masvingo District of Zimbabwe. This section is presented in two parts; namely, the presentation of data and the discussion of the presented data.

Presentation of demographic data of the respondents.

Table 1: Distribution by Responses

Category of Responses	Frequency	Percentage (%)
Heads	20	9
Teachers	200	91
Totals	220	100

Table 1 above indicates that there were more teachers than heads in this study. Naturally, there is only one school head and more teachers in a school. That is why teachers constituted 91% of the sample and heads were only 9% of the respondents.

Table 2: Distribution of Respondents by Gender

Category of Responses	Heads		Teachers		Totals	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Male	7	35	36	18	43	19.5
Female	13	65	164	82	177	80.5
Totals	20	100	200	100	220	100

Table 2 above shows that there were more female heads and teachers than their male counterparts (80.5%: female; 19.5%: male). The data in this study confirms observations found that districts with urban areas do have more female teachers and school heads than male ones.

Table 3: Distribution of Respondents by Age

Category of Responses	Heads		Teachers		Totals	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
25 to 30	0	0	20	10	20	9
30 to 40	4	20	80	40	84	38.2
40 to 50	7	35	60	30	67	30.5
50 and above	9	45	40	20	49	22.3
Totals	20	100	200	100	220	100

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Table 3 above shows that the majority of school heads (52.8%) were in the 40 to 50 and 50 and above categories respectively. The majority of teachers (68.7%) lie in the 30 to 50 age range. These results indicate that the majority of respondents were mature.

Table 4: Distribution of Respondents by Educational Qualifications

Category of Responses	**Heads**		**Teachers**		**Totals**	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
C.E/DipEd	0	0	60	30	60	27.3
Bed	7	35	110	55	117	53.2
Med	13	65	30	15	43	19.5
Totals	20	100	200	100	220	100

Table 4 above shows that all the respondents in the study had professional qualifications. 65% of the school heads in this study had Masters degrees whilst the rest (35%) had bachelors degrees. 53.2% of the teacher respondents in this study had bachelors degrees whilst 19.5% had Masters' degrees. Only 27.3% were diploma or certificate of education holders. These results indicate that the majority of respondents in this study were well-qualified in their respective areas of expertise.

Table 5: Distribution of Respondents by Work Experience

Category of Responses	**Heads**		**Teachers**		**Totals**	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
0 to 10	8	40	67	33.5	75	34.1
10 to 15	7	35	113	56.5	120	54.5
15 and above	5	25	20	10	25	11.4
Totals	20	100	200	100	220	100

Table 5 above shows that 60% of the school heads in this study were in the 10 to 15 and 15 to 20 categories. 25% were in the 15 and above category. Only 40 % were in the 0 to 10 category which could imply that these are the recently promoted school heads. 54.5% of the

teachers were in the 10 to 15 category whereas only 11.4% were in the 15 and above category. 34.1% were in the 0 to 10 category. These results indicate that the majority of respondents in this study were well-experienced in their respective areas of expertise.

School heads and teachers' understanding of CALA

Figures 1 to 3 provide information on school heads and teachers' understanding of CALA.

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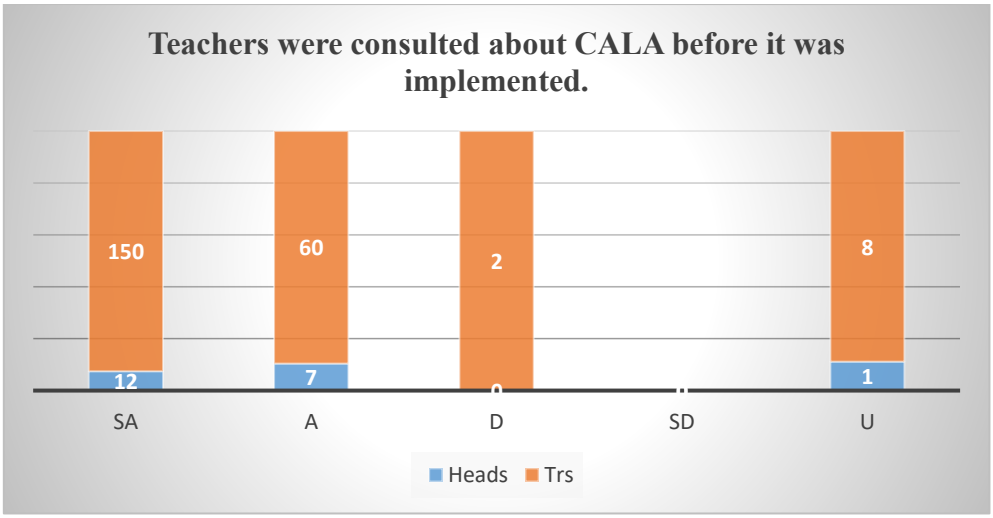

Figure 1: *Responses on teacher consultation about CALA*

Figure 1 above indicates that twelve (12) school heads strongly agreed (SA) that teachers at their schools were not consulted about CALA before it was implemented while seven (7) agreed (A). Only one school head was uncertain (U). One hundred and fifty (150) teachers strongly agreed whilst sixty (60) agreed. Only eight (8) teachers were uncertain. These results indicate that the majority of both school heads and teachers were not consulted before CALA was implemented in their schools.

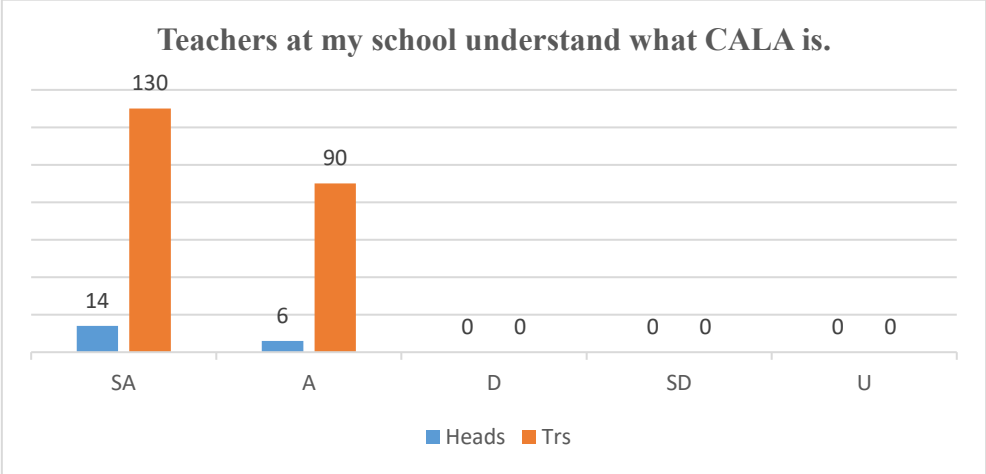

Figure 2: *Responses on teachers' understanding of CALA.*

Figure 2 above indicates that fourteen (14) school heads strongly agreed that teachers at their schools understood what CALA was while six (6) agreed. One hundred and thirty (130) teachers strongly agreed whilst ninety (90) agreed. These results indicate that both school heads and teachers in their unanimity understand what CALA is.

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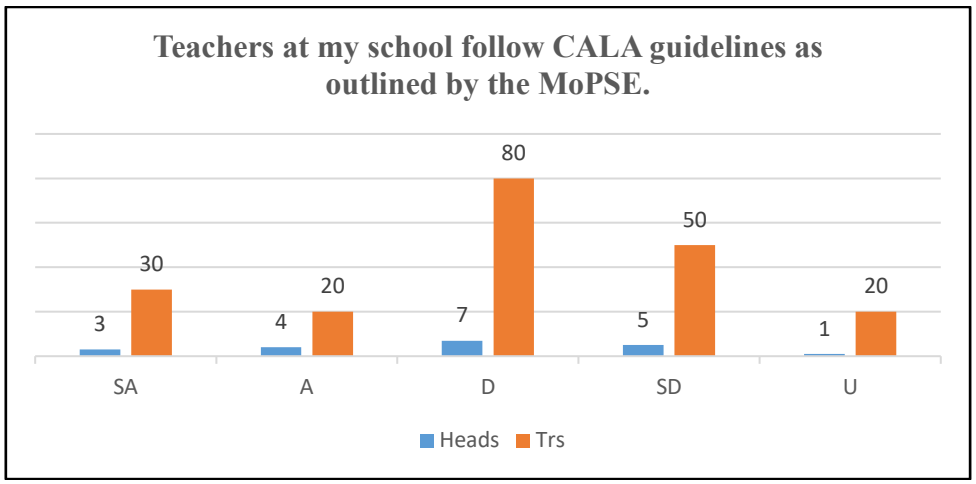

Figure 3: *Adherence to CALA guidelines.*

Figure 3 above indicates that a total of seven (7) school heads out of twenty (20) do agree that teachers at their schools follow CALA guidelines. Twelve (12) out of twenty disagreed (D). Only one (1) was uncertain. Collectively, fifty (50) teachers agreed that they followed CALA guidelines whilst one hundred and thirty (130) disagreed. Only twenty (20) were uncertain. These results indicate that teachers in the schools under study do not follow CALA guidelines as outlined by the MoPSE.

Challenges met when implementing CALA in secondary schools.

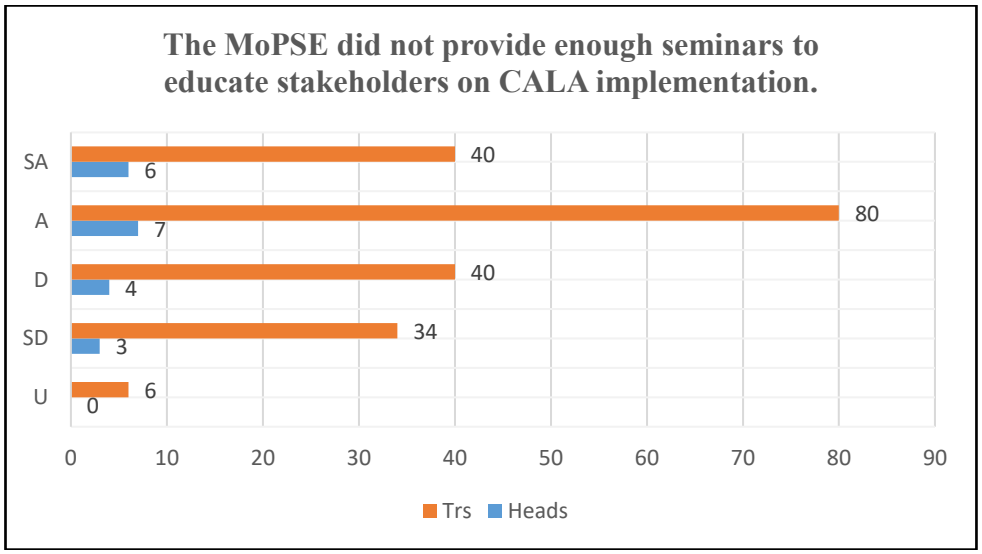

Figure 4: *Provision of adequate seminars to educate stakeholders on CALA implementation*

Figure 4 shows that thirteen (13) school heads out of twenty (20) agreed that the MoPSE did not provide enough seminars to educate stakeholders on CALA implementation. However, seven (7) disagreed. One hundred and twenty (120) teachers did agree that the MoPSE did not provide enough seminars. Seventy-four teachers disagreed and six (6) were uncertain. What these results indicate is that the majority of teachers in the schools under this study were not provided with enough seminars on CALA implementation.

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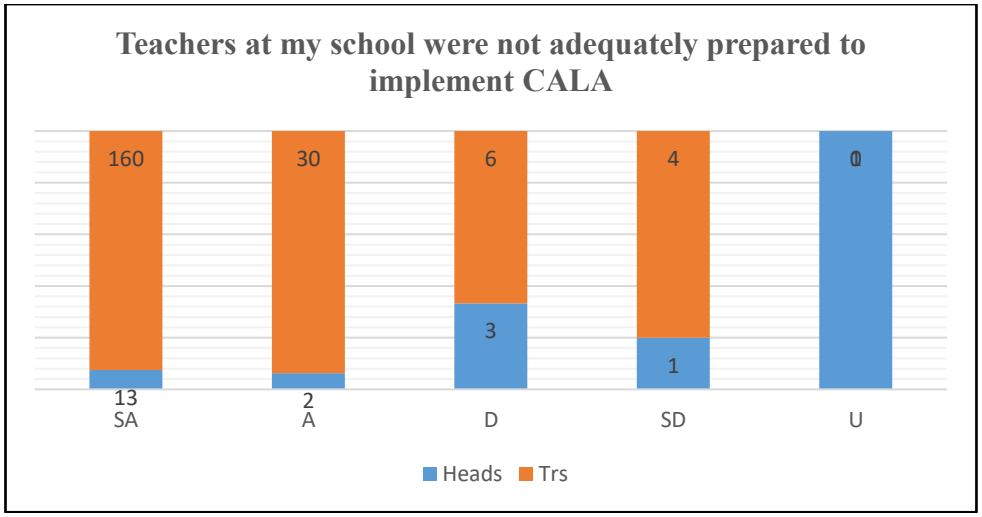

Figure 5: *Teacher preparedness*

Figure 5 shows that fifteen (15) school heads out of twenty (20) agreed that teachers at their schools were not adequately prepared to implement CALA. Only four (4) disagreed. One hundred and ninety (190) teachers agreed that teachers at their schools were not adequately prepared to implement CALA. Ten (10) teachers disagreed. The respondents were unanimous in their agreement that teachers at their schools were not adequately prepared to implement CALA. These results indicate that teachers in schools in this study were not adequately prepared to implement CALA.

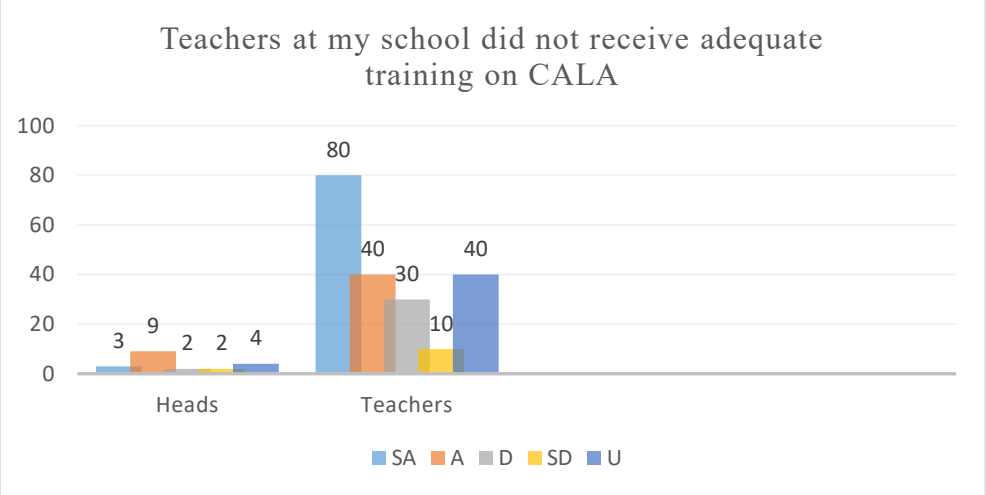

Figure 6: *Adequacy of training*

Figure 6 above shows that twelve (12) school heads out of twenty (20) were in agreement that the MoPSE did not provide adequate training to teachers on CALA. However, four (4) disagreed and four (4) were uncertain. One hundred and twenty (120) teachers did agree that the MoPSE did not provide adequate training. Forty teachers disagreed and forty (40) were uncertain. Those teachers who were uncertain could have been the new teachers who were not sure whether there was training of that sort that ever happened. These results indicate that teachers in the schools in this study did not receive adequate training on CALA.

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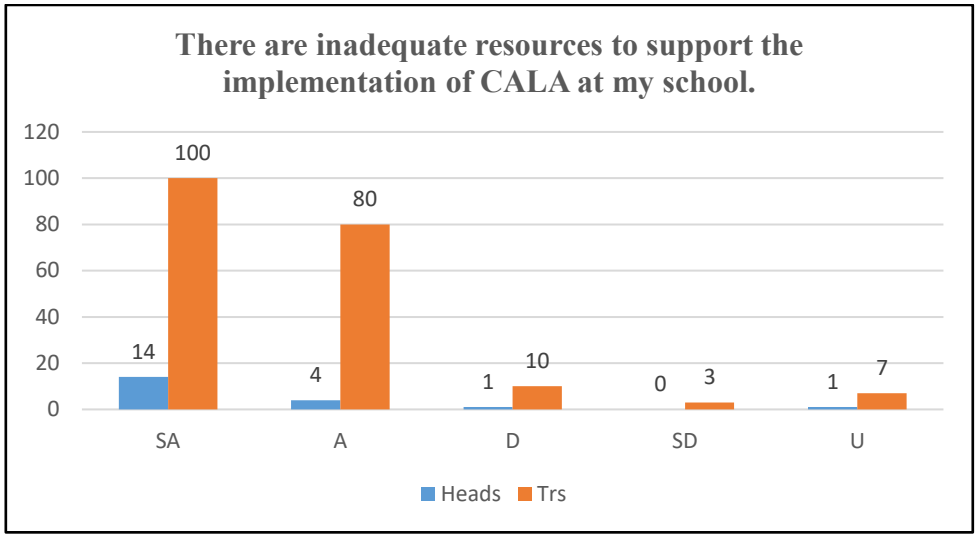

Figure 7: *Adequacy of resources*

Figure 7 shows that eighteen (18) school heads out of twenty (20) agreed that there were inadequate resources to support the implementation of CALA in their schools. One (1) disagreed and one (1) was uncertain. However, one hundred and eighty (180) teachers agreed that there were inadequate resources to support the implementation of CALA in their schools. Thirteen (13) teachers disagreed and seven (7) were uncertain. This indicates that there were indeed inadequate resources to support the implementation of CALA in schools in this study.

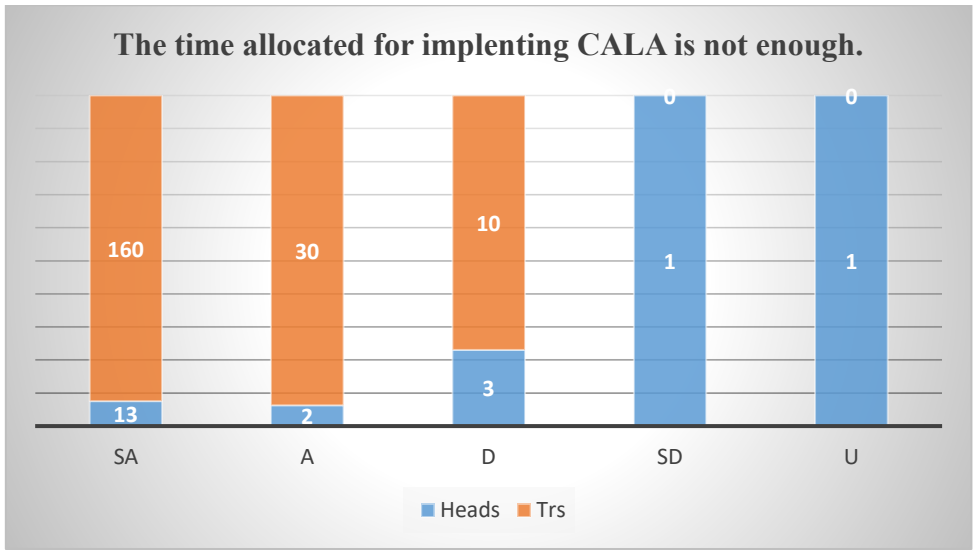

Figure 8: *Adequacy of time*

Figure 8 shows that fifteen (15) school heads out of twenty (20) agreed that the time allocated for implementing CALA in schools was not enough. However, four (4) disagreed and one (1) was uncertain. One hundred and ninety (190) teachers did agree whilst ten (10) disagreed. These results indicate beyond any reasonable doubt that the time allocated for implementing CALA in schools was not enough.

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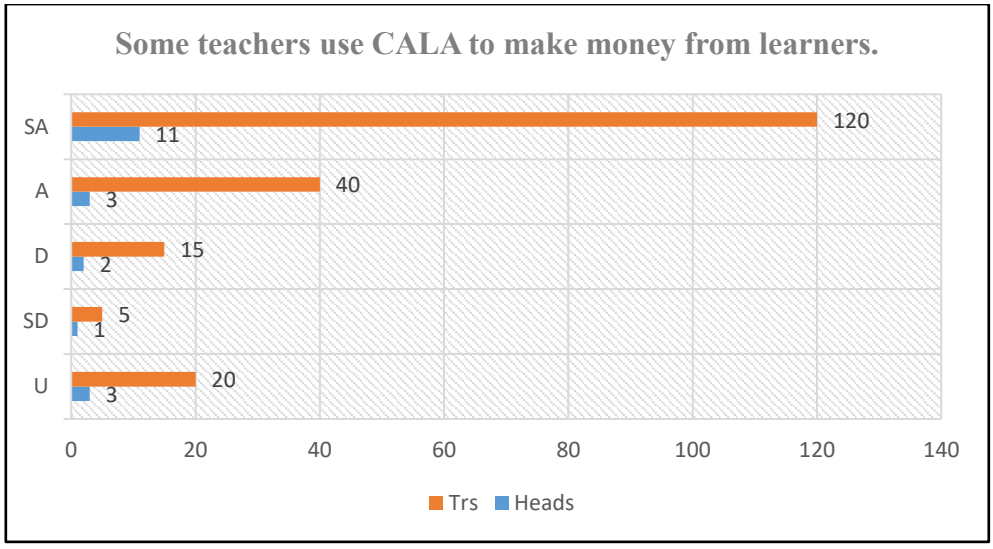

Figure 9: *Rent-seeking behavior*

Figure 9 shows that fourteen (14) school heads out of twenty (20) agreed that some teachers in their schools use CALA to make money from learners. However, three (3) disagreed whilst three (3) were uncertain. One hundred and sixty (160) teachers agreed to the same. Twenty (20) teachers disagreed while twenty (20) were uncertain. These results prove the existence of rent-seeking behaviour in schools when it comes to the implementation of CALA.

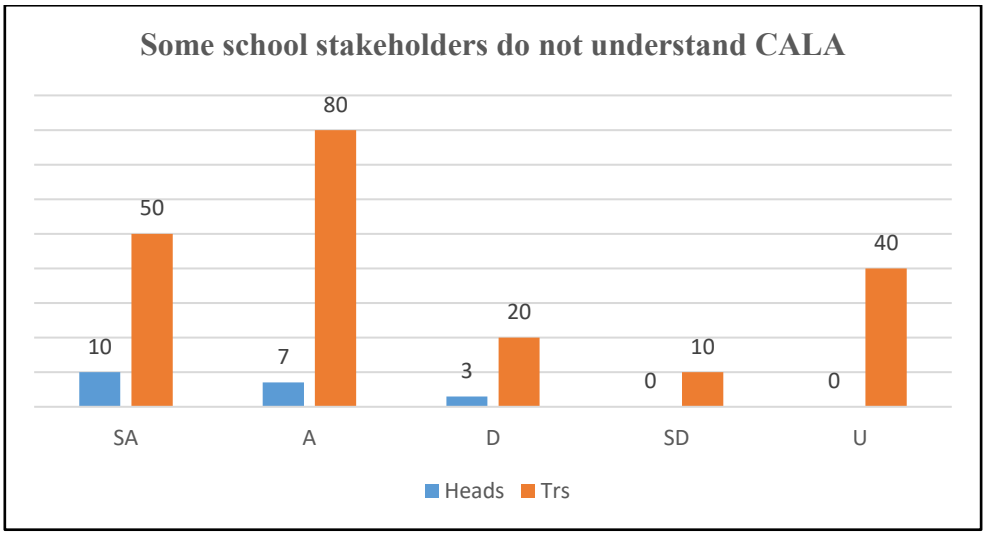

Figure 10: *Stakeholder engagement*

Figure 10 above shows that seventeen (17) school heads out of twenty (20) agreed that some school stakeholders do not understand CALA. However, three (3) disagreed. One hundred and thirty (130) teachers did agree whilst thirty (30) disagreed. Forty (40) were uncertain. The high numbers of those uncertain could have been those of new teachers.

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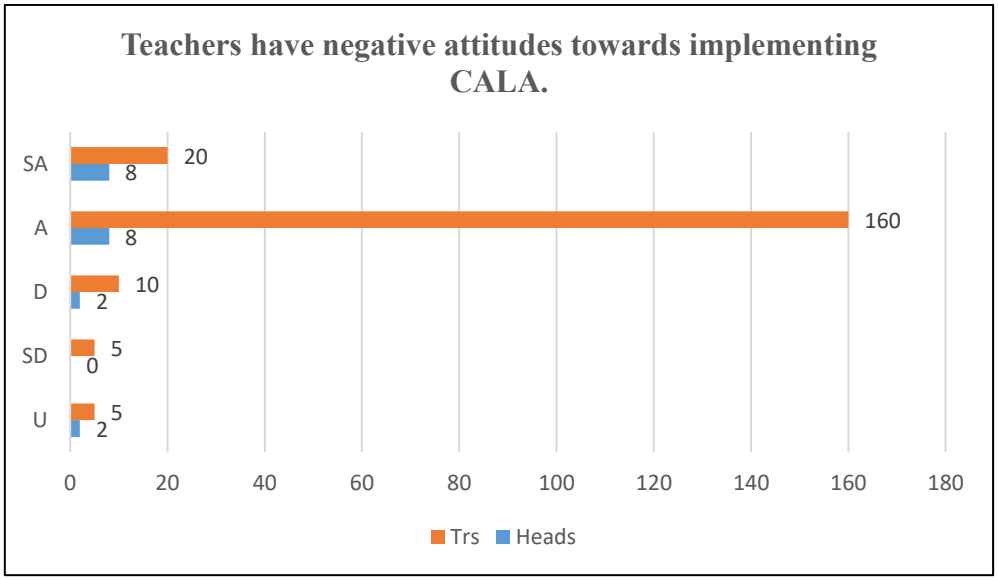

Figure 11: *Attitude towards implementing CALA*

Figure 11 shows that sixteen (16) school heads out of twenty (20) did agree that teachers had a negative attitude towards implementing CALA. However, two (2) disagreed whilst two (2) were uncertain. One hundred and eighty (180) teachers did agree whilst fifteen (15) disagreed and five (5) were uncertain. These results indicate that teachers have a negative attitude towards the implementation of CALA in their schools.

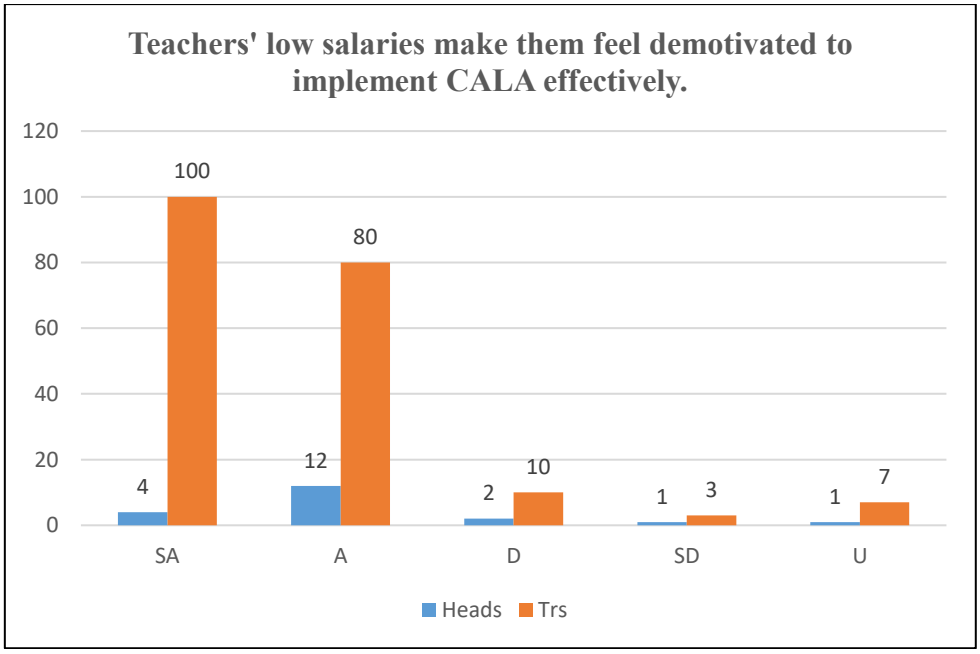

Figure 12: *Teacher demotivation*

Figure 12 shows that sixteen (16) school heads out of twenty (20) agreed that teachers' low salaries demotivated them from implementing CALA effectively. However, three (3) disagreed. One hundred and eighty (180) teachers did agree whilst thirteen (13) disagreed and seven (7) were uncertain. This indicates a high level of demotivation on the part of teachers concerning their salaries.

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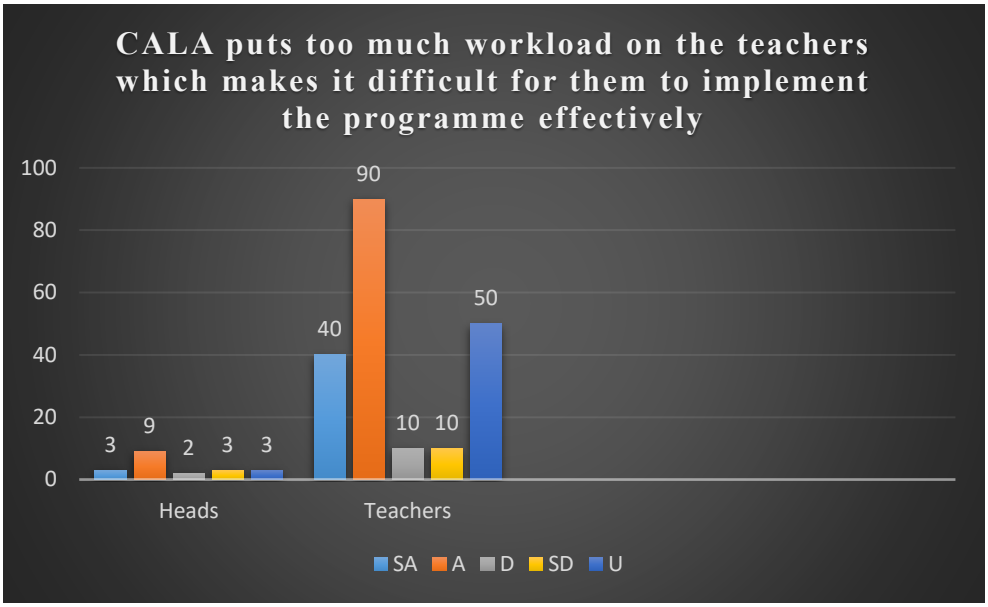

Figure 13: *Teacher workload*

Figure 13 shows that twelve (12) school heads out of twenty (20) agreed that CALA puts too much workload on the teachers which makes it difficult for them to implement the programme effectively. However, five (5) disagreed whilst three (3) were uncertain. One hundred and thirty (130) teachers agreed whilst twenty (20) disagreed and fifty were uncertain. The high numbers of those uncertain could have been those of new teachers. Overall, these results indicate that teachers feel burdened by the CALA workload which is making it difficult for them to implement it effectively.

Solutions to the challenges met when implementing CALA in secondary schools.

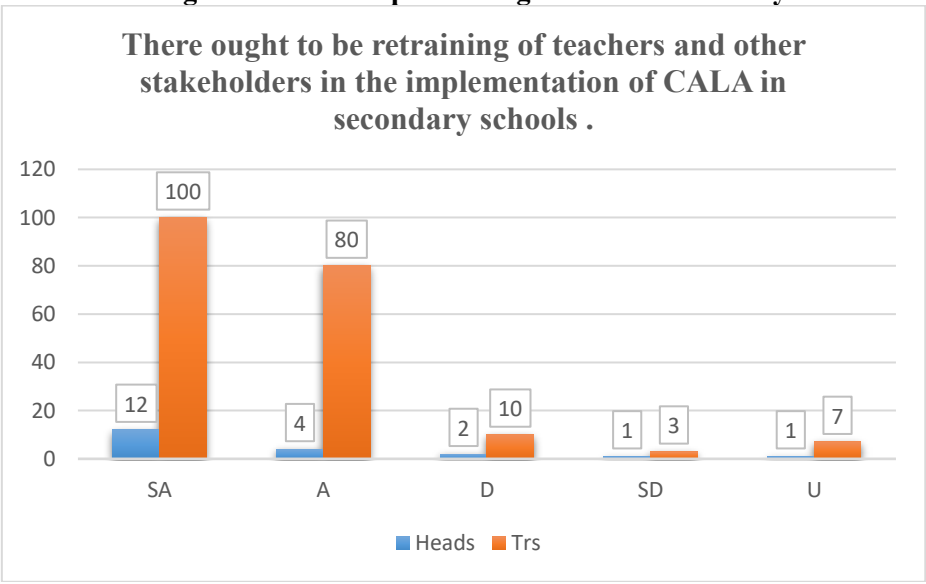

Figure 14: *Teacher retraining*

Figure 14 above shows that sixteen (16) school heads out of twenty (20) agreed that there ought to be retraining of teachers and other stakeholders in the implementation of CALA in secondary schools. However, three (3) disagreed whilst one was uncertain. One hundred and eighty (180) teachers did agree while thirteen (13) disagreed and seven (7) were uncertain. These results indicate the need for the retraining of teachers and other stakeholders in the implementation of CALA in secondary schools.

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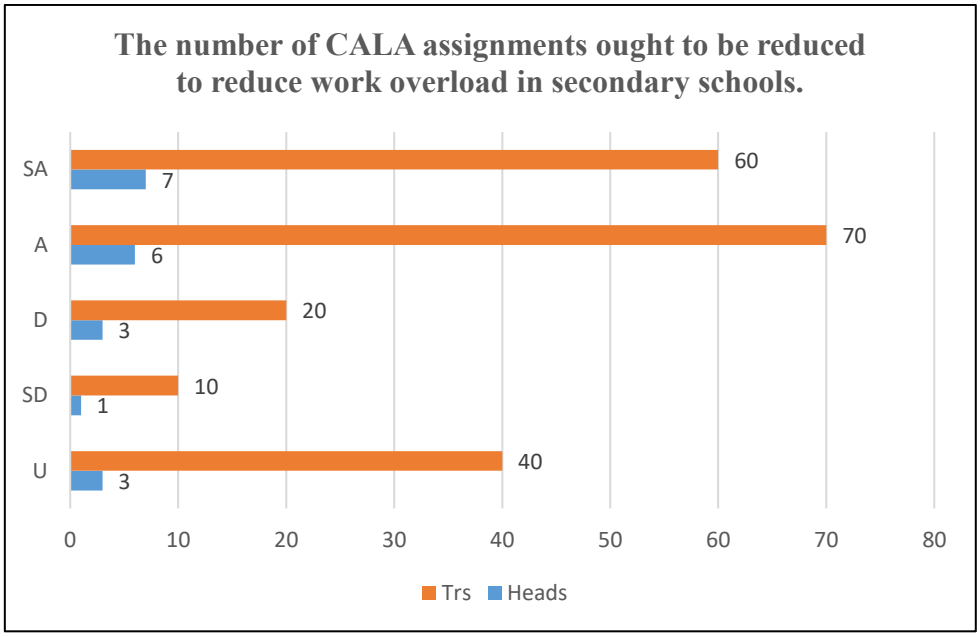

Figure 15: *Reduction of CALA assignments*

Figure 15 above shows that thirteen (13) school heads out of twenty (20) agreed that the number of CALA assignments ought to be reduced to reduce work overload in secondary schools. However, four (4) disagreed while three (3) were uncertain. One hundred and thirty (130) teachers agreed while thirty (30) disagreed and forty (40) were uncertain. The high numbers of those uncertain could have been those of new teachers. These results indicate that the number of CALA assignments in secondary schools ought to be reduced to reduce work overload on both teachers and learners.

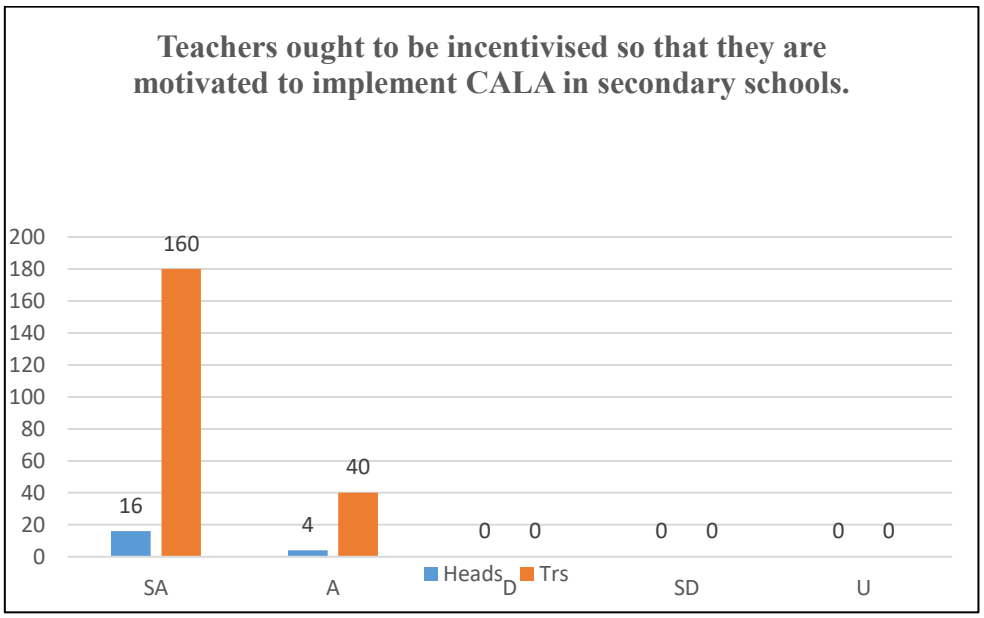

Figure 16: *Teacher incentives*

Figure 16 above shows that all the twenty (20) school heads agreed that teachers ought to be incentivised so that they are motivated to implement CALA in secondary schools. All the two hundred (200) teachers agreed as well.

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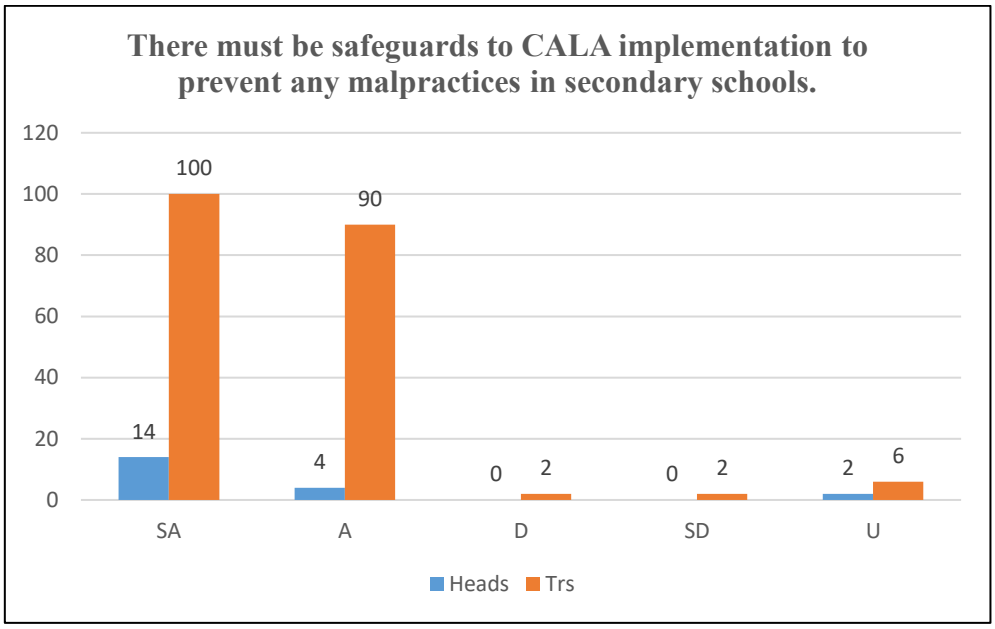

Figure 17: *Safeguards to CALA*

Figure 17 above shows that eighteen (18) school heads out of twenty (20) agreed that there must be safeguards to CALA implementation to prevent any malpractices in secondary schools. Only two (2) were uncertain. One hundred and ninety (190) teachers agreed whilst four (4) disagreed and six (6) were uncertain.

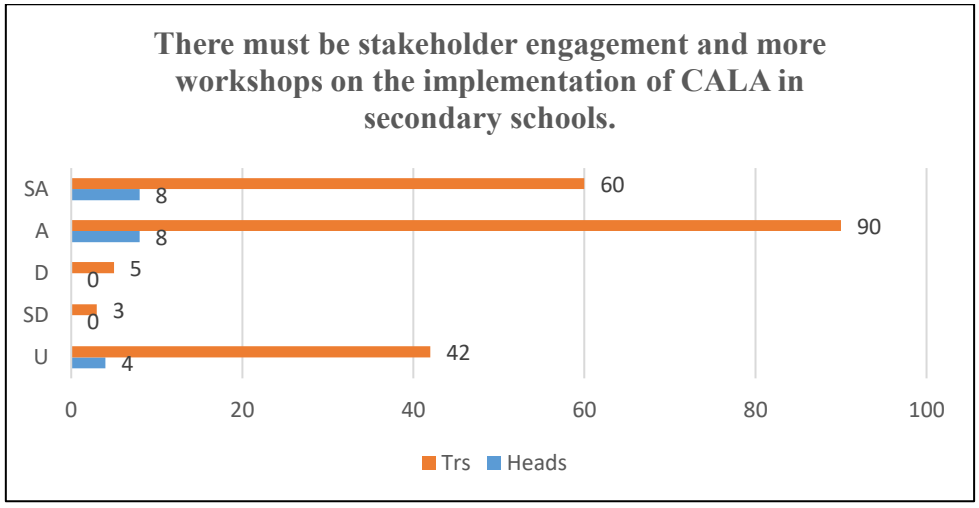

Figure 18: *Stakeholder engagement*

Figure 18 above shows that sixteen (16) school heads out of twenty (20) agreed that there must be stakeholder engagement and more workshops on the implementation of CALA in secondary schools. Only four (4) were uncertain. One hundred and fifty (150) teachers agreed whilst eight (8) disagreed and forty-two (42) were uncertain. The high numbers of those uncertain could have been those of new teachers.

DISCUSSION

Findings from the study indicate that although the majority of both school heads and teachers were not consulted before CALA was implemented in their schools, they understood what it was. This is not surprising because they received three (3) days of training on CALA (Firomumwe, 2022). However, they acknowledged that the training was not enough and this

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had detrimental effects on their capacity to implement it. It was introduced rashly (Gama, 2022). There was no engagement of teachers in the implementation process and no budgetary preparation for its implementation in advance. The MoPSE is said to have simply announced through the media that CALA would be implemented in all schools starting with 2021 candidates. The MoPSE is also said to have commanded provinces around the country to arrange rushed workshops for all exam classes without taking into consideration various factors which affect the implementation of the initiative. It is reported that there was no budget for such workshops and schools were expected to fund teachers' and school heads' attendance at such workshops. Chanda (2022) is of the view that the effectiveness of CALA will never be questioned if properly planned. What is needed is vigorous engagement with the implementers (teachers and school heads) as well as provision of resources for workshops and training if this kind of reform is to succeed (Chanda, 2022). There must be adequate time for piloting the intended reform before it is implemented. This implies that there must be wide-ranging engagements of teachers and school heads as the implementers who are crucial in the development, execution, administration, supervision and assessment of CALA. They are also responsible for guarding against any malpractices.

Teachers are normally left out when decisions on education matters are made concerning their welfare (Ali & Ajibora, 2015). However, the basis of an effective CALA programme is the involvement of teachers as they are the implementers of educational reforms. National Association of School Heads (2021) note that it is essential to engage teachers as they develop CALA instruments, and monitor, supervise and support learners during CALA implementation. School stakeholders have to be involved from the initial stage since they play a significant role in ensuring the availability of relevant and adequate resources needed for effective implementation.

Findings from the study indicate that in as much as teachers in this study professed being knowledgeable about CALA (Figure 2), they did not follow CALA guidelines as outlined by the MoPSE (Figure 3). Gama (2022) found that teachers lacked relevant knowledge for doing CALA coursework activities. In his study, he found that teachers in secondary schools lacked sound knowledge for implementing CALA. This is not surprising because the respondents in this study admitted that they were not provided with enough seminars on CALA implementation (Figure 4) nor did they receive adequate training on the same (Figure 6). Lack of training negatively influences teachers' attitudes towards CALA implementation. Mpapalika (2013) maintains that lack of training lowers their capacity to implement it. The study also found that there were inadequate resources to support the implementation of CALA in schools (Figure 7). Teachers were therefore not adequately prepared to implement it (Figure 5). Although CALA is a significant indicator of learner performance in schools that guides them to make knowledgeable selections of career choices and further studies (Der Berg & Shepherd, 2015), findings indicate that schools were not prepared to administer it. Both teachers and school administrators felt that it was a programme that was imposed on them without proper input from them and other stakeholders.

Findings also indicate that the time allocated for implementing CALA in schools was not enough (Figure 8). The study found the existence of rent-seeking behaviour in schools when it came to the implementation of CALA (Figure 9). Some teachers were doing the CALA activities on behalf of learners in exchange for money. This finding mirrors that of Gama (2022) who also found that teachers allegedly ended up doing the CALA activities for the learners to earn extra money and also because they were not able to guide the learners to do the activities for themselves. This finding is also similar to one carried out in Nigeria by Atsumbe and Emmanuel (2012). Their study revealed that when teachers were not remunerated proportionate to continuous assessment workload, some of them ended up channelling their efforts towards doing the tasks on behalf of the students for a certain fee at the expense of their main mandate. This then defeats the whole purpose of the initiative which is targeted at improving the education system (National Association of School Heads, 2020). Firomumwe (2021) argues that when teachers do assessment tasks for the

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learners, this produces learners lacking practical skills in solving socio-economic problems.

Findings also show that some school stakeholders do not understand CALA (Figure 10). The majority of teachers were found to be having a negative attitude towards the implementation of CALA in their schools (Figure 11). The CALA workload was found to be adding more work to teachers who are already demotivated by their low salaries (Figure 12). Overally, these findings indicate that teachers feel burdened by the CALA workload (Figure 13) which is making it difficult for them to implement it effectively. These findings mirror those by Firomumwe (2022) whose study also found that the majority of teachers in his study showed a negative attitude towards the implementation of CALA. Among the reasons given for the negative attitude was that CALA had brought along with it an increased workload whilst the salaries remained stagnant.

Findings from this study indicate the need for the retraining of teachers and other stakeholders in the implementation of CALA in secondary schools (Figure 14). The number of CALA assignments in secondary schools ought to be reduced to reduce work overload on both teachers and learners (Figure 15). Teachers have to be incentivised so that they are motivated to implement CALA in secondary schools (Figure 16). There must be safeguards to CALA implementation to prevent any malpractices in secondary schools (17). There must be stakeholder engagement and more workshops on the implementation of CALA in secondary schools (Figure 18).

Gama (2022), in his dissertation, resolved that teachers should be retrained in implementing CALA. He also recommended the reduction in the number of CALA assignments that contribute towards learners' coursework to only two to reduce the volume of work for both teachers and learners.

CONCLUSION

Given the observations noted in this study, it suffices to conclude that the implementation of CALA in the selected schools was not being done properly. Whilst its role as an assessment tool is to provide realistic and better options for student learning, this does not appear to be what is happening in secondary schools. Rather, these schools are struggling to implement the programme. They are facing a plethora of challenges.

RECOMMENDATIONS

To ensure success in the implementation of CALA in secondary schools, the MoPSE is encouraged to prioritise planning before it embarks on such an onerous programme. Such planning should encompass how the resources required for such a programme can be harnessed. These could be material, financial and human. In terms of financial resources, these should be for staff developing teachers and school heads as well as conducting adequate seminars on CALA implementation. In the absence of these resources, the programme is certain to be met with difficulties such as the ones articulated in this study. This study therefore recommends that there be continuous engagement of all stakeholders so that there be clarity on the roles they play in the process of implementing CALA. Such engagement should culminate in workshops, seminars and training of the key stakeholders involved with implementation. These should not be events but processes that are ongoing. Additional work brought about by the implementation of CALA in secondary schools has to be met with equal and corresponding salary adjustments to avoid demotivation and rent-seeking behaviours on the part of the implementers. Alternatively, the number of CALA tasks ought to be reduced to avoid overburdening both the implementers and the learners. Better still, the number of teachers should be increased to avoid overburdening the already burdened.

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IMPACT OF CLIMATE-SMART TECHNOLOGIES IN IMPROVING FOOD SECURITY AMONG SMALLHOLDER FARMERS IN ZIMBABWE

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ABSTRACT

The serious potential threat to food security at the global level is climate change and the window for opportunity to avert it is rapidly closing. The research was conducted in the Mberengwa District to assess the impact of climate-smart agriculture (CSA) technologies (hydrogel, pfumvudza, smallholder irrigation) on maize yields, dietary diversity and household incomes. A mixed methods design was employed in which a semi-structured questionnaire, developed on Kobo Collect gathered quantitative data such as demographic characteristics, type of CSA technology, maize yields, food security indicators and household incomes. Focus groups and key informant interviews collected qualitative data to substantiate the quantitative findings. A desk review gathered background information from periodic reports. Data was analysed using Statistical Package for Social Sciences (SPSS). The maize yields differed significantly ($p<0.05$) before and after the use of CSA technology. The acceptable food consumption score ranged from 61.5% to 80% across all the CSA technologies. Based on minimum dietary diversity-women, irrigators had the highest proportion of food-secure households (83.3%), followed by pfumvudza (75%) and hydrogel (67.3%) farmers. Separation of means using Fisher's protected LSD indicated that irrigators earned more per annum and significantly differed ($p<0.05$) with hydrogel and pfumvudza farmers. Farmers using CSA technologies are highly food secure through improved maize yields and dietary diversity. Major challenges hindering adoption were vandalism, high irrigation system establishment costs, maintenance costs, load shedding and high ZESA rates, unavailability of hydrogel locally and extreme labour on pfumvudza. The researcher recommends the installation of solar-powered irrigation systems, decentralizing hydrogel markets and mechanized holing on pfumvudza concept.

Keywords: *Agriculture, Climate change, Pfumvudza, Smallholder irrigation, Hydrogel*

INTRODUCTION

The serious potential threat to food security at the global level is climate change and the window for opportunity to avert it is rapidly closing. This is evidenced by excessive droughts, erratic rains and continued prevalence of malnutrition in which 1 in every 4 people is undernourished (FAO, 2015). Akiyode and Daramola (2011) suggest that climate change is the most severe dilemma facing scientists across the globe. The Intergovernmental Panel on Climate Change (IPCC) reported that climate change effects will continue to impact people in various ways through continued increases in global temperatures (UNFCCC, 2008; IPCC, 2019). Climate action is Goal 13 of the UN Sustainable Development Goals (SDGs) (UN, 2019) which encourages nations to make frantic

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efforts to lessen the impacts of climate change by implementing climate-smart technologies. Potentially irreversible changes in the global ecosystems are highly anticipated because of climate change which has resulted in life-threatening situations for billions of people through increased droughts, heatwaves, and floods (Furtak & Wolinska, 2023).

As climate change affects every nation in the world, developing countries are more vulnerable to climate change because they rely on sectors like agriculture which are climate-sensitive (UN, 2019). The bulk of the developing countries are in Africa with Zimbabwe included. These countries are extremely vulnerable to climate change due to their limited capacity to counter the effects (FAO, 2015). Moreover, these nations already have enormous gaps in technological capacity, human resource availability, and infrastructure development, which restrict their ability to participate in the global economy and leave them permanently vulnerable to stresses associated with both socio-economic conditions and climate change. Climate change is expected to cause this continent to warm up more, receive less rain, and see droughts and floods of greater intensity. People will experience greater water stress and decreased agricultural production which will result in greater food insecurity; and altered disease transmission, leading to the spread and occurrence of diseases like malaria, diarrhea, and dengue (UNFCCC, 2008).

Climate change acts to double existing threats to food security (UN, 2022). WFP (2021) projected that by the year 2050, the threat of hunger is expected to increase by 10 to 20%, and malnutrition for children by 20% higher than in a no-climate-change scenario. Niang *et al.,* (2014) assert that due to climate change's effects on agriculture, there is an increased risk of food shortages, resulting in hunger and poverty in the long run. This goes hand-in-hand with the understanding that two-thirds of Africa's lands consist of arid regions, are subject to frequent droughts and floods, and are considered highly vulnerable to climate change (UN, 2022). The majority of the Zimbabwean populace derive their source of livelihood from agricultural production with 70% of the farmers depending on rain-fed crop production as a source of livelihood (Manatsa *et al.,* 2020). However, farming that relies on rainfed directly confronts hazardous climate change effects. Precipitation patterns are characterized by unpredictable high variability over time. Projections indicate that Southern Africa warms faster compared to other parts of the world (IPCC, 2014). Furthermore, Southern Africa is among the few regions at a global scale that experience extreme arid conditions and consequently persistent droughts.

Hence it is pertinent to implement climate-smart agricultural technologies to mitigate the effect of climate change on agricultural production. The Food and Agriculture Organisation (FAO, 2016) reported that the impacts of climate change on livelihoods had already reached alarming levels with negative effects on millions of smallholder farming communities in sub-Saharan Africa. Lybbert and Sumner (2010) highlighted that the already daunting challenges confronting the agricultural sector are exacerbated by climate change with developing countries having a greater risk. Developing countries derive their source of livelihood mainly from agriculture, which is highly affected by climate change (FAO, 2016; Niang *et al.*, 2014). The situation is further worsened by the fact that such countries are quite warm and lack ideal infrastructural development to sufficiently respond to increased changes in climatic conditions, and inadequate capital investment in adaptation technologies (Lybbert & Sumner, 2010). Zakari *et al.,* (2019) agree that climate change negatively affects household food security, especially in areas where traditional farming methods are prevalent such as sub-Saharan Africa. Due to over-dependence on rainfed agriculture coupled with high frequent and severe droughts, semi-arid areas continue to face agricultural production morass which dwindles household food security and economic prospects for affected countries (Altieri & Nicholls, 2017).

The agriculture industry is vulnerable to climate shocks hence there is a need to identify

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climate-smart technologies[1] which boosts production in the morass of climate change. Henceforth, innovations in agriculture are fundamental in curbing the mess of climate change. The Zimbabwe government in collaboration with development partners such as the International Fund for Agriculture Development and Food and Agriculture Organisation have been promoting climate-smart agriculture technologies which include hydrogel[2], pfumvudza[3] and installation of irrigation[4] systems. Such CSA technologies can be a panacea to the water requirements of plants in periods of adversity. Climate-smart technologies are useful in reducing climate change effects on crops in dryland regions which will benefit the rural people who rely on agriculture as a source of livelihoods. Through climate-smart agriculture technologies, hidden hunger which is prevalent in developing countries can be reduced to the World Health Organisation's recommended threshold of 20%. Little research has been done so far on the impact of climate-smart technologies in Zimbabwe. Therefore, this research sought to assess the impact of climate-smart technologies in improving food security among smallholder farmers through assessment of maize yields, level of adoption of CSA technologies, household incomes and food security indicators such as household dietary diversity Score (HDDS), Food Consumption Score (FCS), Minimum Dietary Diversity for Women (MDDW).

METHODOLOGY

Study site

The research was conducted in the Mberengwa District from the 1st of August 2023 up to the 15th of August 2023. The district is situated in agro-ecological region IV which receives 450-650 mm annual rainfall with an average temperature of 28°C (Manatsa, *et al*., 2020). The rainfall in this region is too low and erratic for the reliable production of even drought-resistant fodder and grain crops.

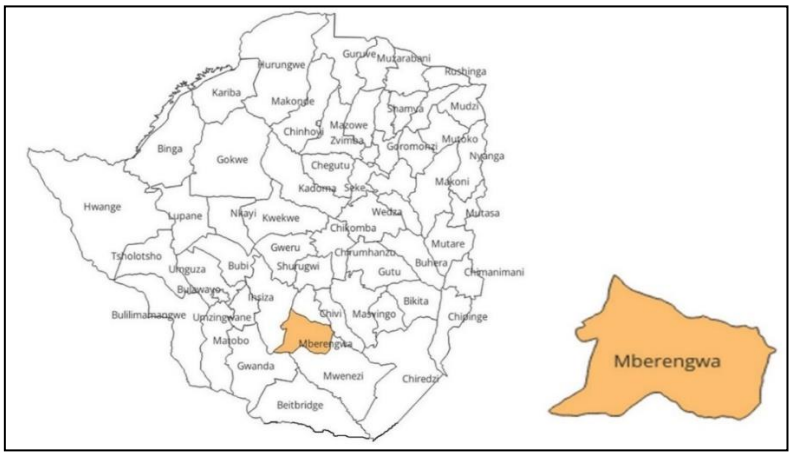

Figure 1. *Map showing the study site, Mberengwa District*

[1]**Climate smart technologies** refer application of scientific knowledge to facilitate adaptation and mitigation to achieve resilience directly or indirectly against climate change impacts globally in the short, medium and long term.

[2]**Hydrogel** is a substance that retains water, stores several times its weight water and considerably delays out planting sites in the soil, saves water, reduces evaporation, saves working time by extending irrigation intervals, protects the environment, by reducing the use of fertilizers since leaching is prevented and strengthens plants and make them more resistant by promoting the growth of new roots and so strengthens the resistance of the plant.

[3]**Pfumvudza** is a conservation agriculture concept that employs potholing as a land preparation method to achieve food security for an average family of six for the entire year.

[4]**Irrigation** is described as the practice of artificially applying water to the land to guarantee double cropping and a consistent water supply in regions with unpredictable rainfall.

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RESEARCH DESIGN

The research applied a mixed methods approach in which both qualitative and quantitative methodologies were triangulated. Qualitative sentiments from focus groups and key informants substantiated the quantitative findings.

POPULATION AND SAMPLING

The study population comprised Mberengwa farmers under CSA technologies. Farmers were selected using a stratified random sampling procedure. Firstly, the smallholder farmers were divided into strata of irrigating farmers, hydrogel farmers and pfumvudza farmers. In each stratum, a systematic random sampling procedure was then applied to select the farmers for household questionnaire administration. Purposive sampling was used for focus groups and key informant interviews.

Sample size calculation

The sample size was obtained using the formula by Singh and Masuku (2014) as shown below:

$n = z^2pq/e^2$

Where:

n = Sample size

z = Standard normal deviate which is set at 1.96 corresponding to a 95% confidence interval

p = Proportion of farmers in Mberengwa (Mataga Cluster)

$q = 1-p$

e = Maximum allowable error set at 0.05

DATA COLLECTION PROCEDURE

Desk review

A desk review was conducted to gather background data on climate-smart technologies. Documents such as periodic reports, manuals, lists of beneficiaries and other evaluations were gathered from Agritex and the Smallholder Irrigation Revitalisation Programme. Desk review serves an important function in the assessment and provides a foundation on which to build subsequent steps in research (USAID, 2014). Desk review activities include searching literature, analyzing secondary data, and building reference lists (Kothari, 2004; USAID, 2014).

Household survey questionnaire

A household questionnaire was developed on Kobo Collect to collect quantitative data such as demographic and social characteristics, type of climate-smart technology used, production and productivity, food security [Minimum Dietary Diversity-Women (MDDW), Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS)], household incomes and challenges faced in implementing climate-smart technologies.

Key informant interviews

Agricultural extension officers were purposefully chosen for key informant interviews since they are responsible for disseminating information to farmers on new technologies. The adoption of new technologies by farmers is facilitated by agriculture extension officers. In this study, three agricultural extension officers were interviewed to gather information which included the adoption of CSA technology, changes due to CSA technology, challenges, and recommendations. Stahl and King (2020) suggest that involving key informants in research increases the credibility of the findings.

Focus group discussions

A total of five (5) focus groups were conducted of which four (4) were conducted at ward level with the Ward Food and Nutrition Security Committee (WFNSC) and one FGD with the District Food and Nutrition Security Committee (DFNSC). A Food and Nutrition Security Committee (FNSC) comprises stakeholders who carry out nutrition-specific and nutrition-sensitive interventions such as village health workers, nutritionists, Agritex extension officers, social services officers, women affairs, grain marketing board, local leadership (traditional leaders, church leaders) and non-governmental organisations.

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DATA ANALYSIS

Data from Kobo collection was exported to Statistical Package for Social Sciences (SPSS) version 21. Frequencies and percentages were generated using SPSS. The FCS was computed in three poor categories (1-21), borderline (21.5-35) and acceptable (≥35.5). The HDDS was computed for each of the survey households as a measure on a scale of 1 to 12 and a high HDDS is an indicator of the variety of foodstuffs (cereals, tubers, vegetables, fruit, meat, eggs, fish, pulses, dairy products, oil, sugar, and condiments) eaten by the members of the household over a 24-hour recall period. Households who met their calorie requirements but consumed non-diversified diets were regarded as food insecure. The HDDS thresholds were computed in three categories which are food insecure (0-2 food groups), mildly food insecure (3-5 food groups) and food secure (6-12 food groups). Cross tabulations and chi-square tests were done to determine the association between the variables such as the climate-smart technology and food consumption score. A paired sample T-test was used to compare the crop production levels before and after the intervention of climate-smart technologies. One way ANOVA was used to compare yields of maize under different climate-smart agriculture technologies. Means were separated using Fisher's protected LSD 1935. The adoption score of climate-smart technologies was calculated by dividing the sum of actual adoption scores by the maximum score possible for each technology (Olivera *et al*., undated). Microsoft excel generated graphical presentations. The qualitative data substantiated the results from the quantitative research findings.

VALIDITY AND RELIABILITY

Multi-tier quality assurance system was adopted, beginning with recruitment of the right enumerators and an effective training process prior to data collection. The second tier is the use of Kobo collect with stringent programming to eradicate human error in data collection and entry. GPS coordinates collection was embedded in the tool to ensure spatial distribution of sampled households. The third quality control tier involved data collection verification processes which included comparison of enumeration completeness, pilot testing of all the data collection tools and uploading data collected every day-end then carry out quick data quality checks. Triangulation also enhanced the trustworthiness and credibility of the findings of this study (Honorene, 2017). Stahl and King (2020) support use of various data sources (triangulation) in promoting validity and credibility of the research findings.

ETHICAL CONSIDERATIONS

The researcher followed the recommended research principles. The research was carried out in accordance with the code of ethics and approval of the research and extension services office (RESO). Before collecting data, the researcher notified the relevant stakeholders on the objectives of the research. Permission was then granted to visit the research site for data collection. At the research site, Agritex extension officers assisted the researcher to approach local leadership for authorization to carry out face-to-face interviews with the sampled households. Before administering the data collection tools, the researcher made it clear to the interviewees that participation is voluntary, and the research is intended for academic purposes. The researcher ensured privacy and confidentiality and that private details such as address, and contact details remained anonymous. After explaining the purpose of the research to the respondents, verbal consent was granted which led the researcher to proceed with the interviews.

RESULTS AND DISCUSSION

This section presents the findings of this research which include demographic and social characteristics, knowledge attitudes and practices on climate-smart technologies by smallholder farmers, food security status of smallholder farmers under each climate-smart technology and household income levels of smallholder farmers under climate-smart technologies.

Demographic and social characteristics

The majority (72.4%) of the respondents were women which indicates that women participate

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more than men in agricultural activities. The United Nations SDGs Pillar 5 together with the Zimbabwe's National Development Strategy call for the full and effective participation of women and equal opportunities (UN, 2022; Maodza, 2012; GoZ, 2020). The research revealed that men dominate (55%) household headship. Most households across the schemes comprised married/cohabiting couples (73%), followed by widowed individuals (14.7%) with the majority (68.3%) having attained at least secondary education. An assessment conducted by the United Nations Educational, Scientific, and Cultural Organization in 2015 indicated that Zimbabwe is ranked in the top ten African countries on adult literacy with a rate of 86,4% (UNESCO, 2015). Muvhuringi and Chigede (2021) suggest that farmers can be easily trained on production skills if they have attained secondary level. Farmers were categorized into three age groups, 35 years and below (youth), 36 to 49 years (middle age) and the greater than 49 years (old age). The greatest proportion (38%) of the respondents were the middle aged. Guo *et al.,* (2015) aver that the middle aged are devoted farmers who will have made well informed decision on what to pursue for their living and have physical strength capable to effectively carry out agricultural production.

Table 1: Percentage distribution of the demographic and socio-characteristics (n=300)

Characteristic	Percentage
Gender of respondent	
Male	72.4
Female	27.6
Sex of household head	
Male	55.0
Female	45.0
Level of education	
None	2.7
Primary	29.0
Secondary	63.0
Tertiary	5.3
Marital status	
Never married	6.0
Married/Cohabiting	73.0
Divorced/Separated	6.3
Widowered	14.7
Age (years)	
≤35	29.0
36-49	38.0
≥50	33.0
Climate smart technology	
Irrigation	33.3
Hydrogel	32.0
Pfumvudza	34.7

Maize yields under various climate-smart agriculture technologies

This study focused on comparison of maize production under three climate-smart agriculture technologies which are irrigation system, hydrogel and pfumvudza. Maize is the only crop which was produced under all the climate-smart technologies being evaluated. Pvumvudza and hydrogel technologies were applied in the dryland farming areas. According to the FNC (2022), maize is the most grown crop in Zimbabwe accounting for 84% of the households in the smallholder farming sector.

Comparison of climate-smart agriculture technologies maize yields

The yield of maize was higher (4179 kg) on irrigating farmers followed by the farmers who applied hydrogel (3961 kg). Pfumvudza technology had an average maize yield of 3743 kg. The averages of maize yield obtained from the three climate-smart technologies assessed are greater than the average national maize harvested (237.5 kg) reported on the 2022 ZIMVAC rural livelihoods assessment survey. Chazovachii (2012) suggests that irrigation systems increase agricultural output for both commercial and subsistence farming. Previous studies (LFSP, 2020; Mujere, 2022; Mavesere & Dzawanda, 2023) support that the pfumvudza approach achieves food security at the household level with minimum investment. A pilot study by the livelihood and food security programme conducted in the 2019/20 season in response to poor rains revealed that farmers who adhered to the recommended pfumvudza protocol achieved an average of 7.8 tonnes of maize per hectare which translates to 33 weeks of household food security. Such performance indicates a greater potential for the pfumvudza concept in improving the food security of the rural populace and the nation at large (LFSP,

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2020). The current research findings also concur with Rubongoya (2019) who noted that climate-smart agriculture technologies have a positive contribution to crop production and productivity. There were no significant differences ($p>0.05$) between the climate-smart technologies used on maize yield. This implies that if the procedures of conducting crop production under each climate-smart technology are followed, all the CSA technologies can achieve better yields.

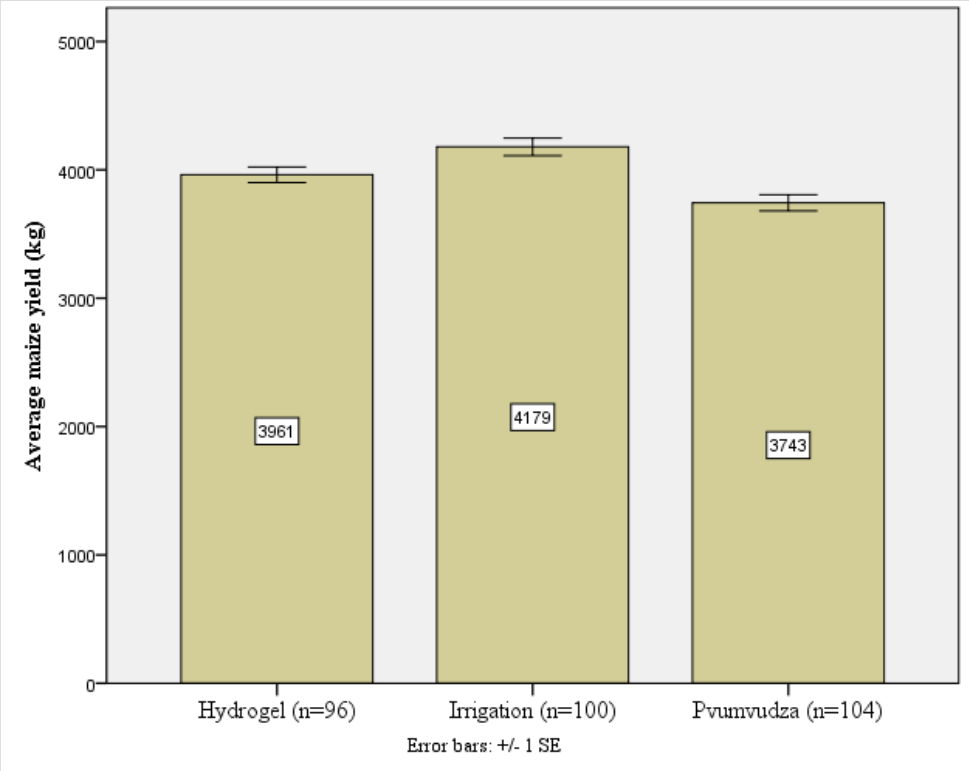

Figure 2. *Comparison of climate-smart agriculture technologies maize yields*

Comparison of maize yields before and after use of climate-smart agriculture technology

Water is fundamental for humans in several ways which include agriculture production among others (Kasdi & Hidayat, 2008). Climate-smart agriculture technologies provide and conserve moisture which ensures adequate water supply for successful crop production. All the farmers who applied climate-smart agriculture technology confirmed that there was an increase in maize yield. A paired sample T test indicated that there was a significant difference ($p<0.05$) between maize yield before the use of technology and maize yield after the use of technology.

Table 2: Maize yields before and after the use of climate-smart agriculture technology (n=300)

Climate-smart technology	Maize yield before use of CSA Technology	Maize yield after the use of CSA Technology
Hydrogel dryland farmers (n=96)	1978.13±45.53[a]	3961.46±60.87[b]
Irrigating farmers (n=100)	1900.50±54.54[a]	4165.00±66.03[b]
Pfumvudza dryland farmers (n=104)	2013.46±40.86[a]	3705.77±60.54[b]

Means in the same row with different superscripts are significantly different. Means are+/- standard deviation

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Adoption of climate-smart technologies

It was noted that farmers adopt technologies through the knowledge which is imparted by local agriculture extension officers. Ouédraogo *et al.,* (2019) found out that the adoption of drought-tolerant crop varieties was highly influenced by the extension services which trained the farmers. Tripathi and Mishra (2017) agree that extension services are a key component of the agricultural sector and through extension services farmers acquire new skills and technologies. The attitude of farmers towards climate-smart agriculture technology is changed by agriculture extension services whilst farmers with access to extension services make better-informed decisions than those who are not (Murage *et al.*, 2015). The current findings indicated that the adoption of hydrogel has been lower than pfumvudza and irrigation systems (Table 3). However, most (36%) female-headed households had adopted hydrogel technology. A local agriculture extension officer asserted that:

> *All the climate-smart agriculture technologies play a fundamental role in improving crop yields in the face of climate change. However, the cost of investment deters farmers from venturing into the establishment of irrigation systems. Alternatives such as hydrogel and pfumvudza are promising to be a solution for rainfed farmers. The adoption of the pfumvudza concept has been remarkably noted. This has been necessitated by the intensive training of good agricultural practices which included the pfumvudza concept and provision of inputs through the presidential input package for a pfumvudza plot. Hydrogel technology has not been widely adopted. The reason is the absence of a local market for hydrogel. Irrigation technology has been adopted through the support which was granted by the Smallholder Irrigation Revitalisation Programme which revitalised schemes such as Biri Extension, Biri Old and Chamakudo.*

It was universal among all the FGDs that irrigation systems, pfumvudza and hydrogel play an important role in improving food security in rural communities. Although the participants in all groups agreed that irrigation was the best in achieving more crop intensity and productivity, there was a general agreement that irrigation systems require huge investment to establish which many rural households cannot afford. However, findings by Mhembwe *et al.,* (2018) indicate that small-scale irrigation schemes are a panacea to food insecurity which most of the rural populace face. Solar-powered irrigation systems have been described as technically viable with a high return on investment. However, high costs of investment deter farmers from adopting it. The FAO (2017) highlighted that solar-powered irrigation system is highly recommended since it has the potential to reduce the emission of greenhouse gases through the replacement of fossil fuels with renewable energy sources (solar energy). To counter the rumbling adverse climate change effects, which are expected to pose 20% crop losses by 2050, conservation agriculture is one of the most promising climate-smart technologies especially for poor-resourced farmers (Mazvimavi, 2011). The Food and Nutrition Security Committees acknowledged that hydrogel and pfumvudza are ideal for rainfed farmers. However, one ward FNSC chairperson avers that.

> *The pfumvudza concept has been associated with the provision of inputs for the pfumvudza plot. While in the short run, it may increase the adoption and use of the concept, there is a danger of farmers abandoning the concept if the input package attached to it is withdrawn. Most of our farmers are too old such that it is a mammoth task for them to dig the pfumvudza holes. Engagement of the Department of Agricultural Engineering Mechanisation Soil and Water Conservation to design holing equipment may sustain the pfumvudza concept which appears to be laborious. Hydrogel has been used for only 2 seasons and it also gave good results. However, hydrogel is unavailable in*

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the local market. Decentralisation of hydrogel markets may increase adoption of hydrogel by rainfed farmers.

Table 3: Adoption Score by Gender of Household Head

	Adoption Score (%)	
Technology Type	**Male**	**Female**
Pfumvudza	52.0	40.0
Irrigation	42.0	38.0
Hydrogel	26.0	36.0

Food consumption score (FCS)

This section focuses on the food consumption score which is the proxy indicator for household food security calculated using 8 food groups. The score is determined based on the frequency of consumption of each food group and protein efficiency ratio. The frequency of consumption of a specific food group is determined on a 7-day recall as the count of days that a specific food group has been consumed by each sampled household.

Each food group score is determined by multiplying the food consumption frequency (number of days consumed by the food group in the past 7 days) and its PER (weight).

Table 4: Food Group and its Protein Efficiency Ratio

Food Group	Weight
Cereals and tubers	2
Pulses and nuts	3
Vegetables	1
Fruits	1
Meat and fish	4
Dairy products	4
Sugar, honey	0.5
Oil, fat, butter	0.5

The World Food Programme (WFP) household FCS thresholds were used in which households are categorised into three FCS groups as indicated below.

Across all the climate-smart technologies, the majority were on acceptable food consumption scores (Figure 3). The irrigators had a proportion of 80% in the acceptable food consumption score. Hydrogel and *pfumvudza* farmers had 66.7% and 61.5% in the acceptable range respectively. The current findings indicate that household caloric availability has improved greatly compared to the ZIMVAC (2022) findings which showed that only 35% of the households were on acceptable food consumption score category (FNC, 2022). A decrease in households in the poor category was also noted. The 2022 rural livelihoods assessment survey indicated that 43% were in the poor category whilst the current research indicated that a proportion ranging from 7.7% to 9.3% were on the poor food consumption score index. The current findings suggest that there is no association ($p>0.05$) between climate-smart technology and the food consumption score index.

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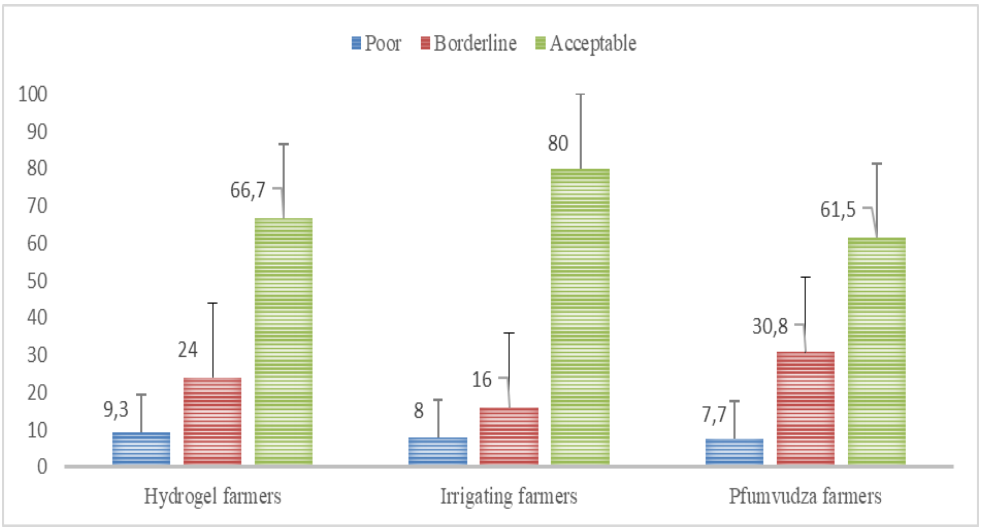

Figure 3: *Percentage distribution of food consumption index by climate-smart agriculture technology*

Household dietary diversity score

Household dietary diversity score is used to determine how many households have access to a variety of foods. A qualitative indicator of food intake, HDDS reflects household access to diverse food groups. It is just a straightforward tally of the food groups that members of a household have eaten within the last 24 hours intended to provide a quick overview of a household's financial capacity to purchase a range of foods. Asking the respondent, a series of yes/no questions yield data for the HDDS indicator. When asking the question, a respondent can be the responsible person for meal preparation or an adult person who was present and had eaten in the household on the previous day. The home is considered as a whole rather than a single member of a household.

The results indicate that irrigators had the highest proportion of food-secure households (94%), followed by hydrogel farmers (89%) and *pfumvudza* farmers (88%). It was interesting to note that severe food insecurity was absent in all households under climate-smart agriculture technologies. The proportion of mildly food insecure households was highest among *pvumvudza* farmers (13%), followed by hydrogel farmers (12%) and irrigators (6%). Irrigating farmers had the lowest proportion of households with mild food insecurity.

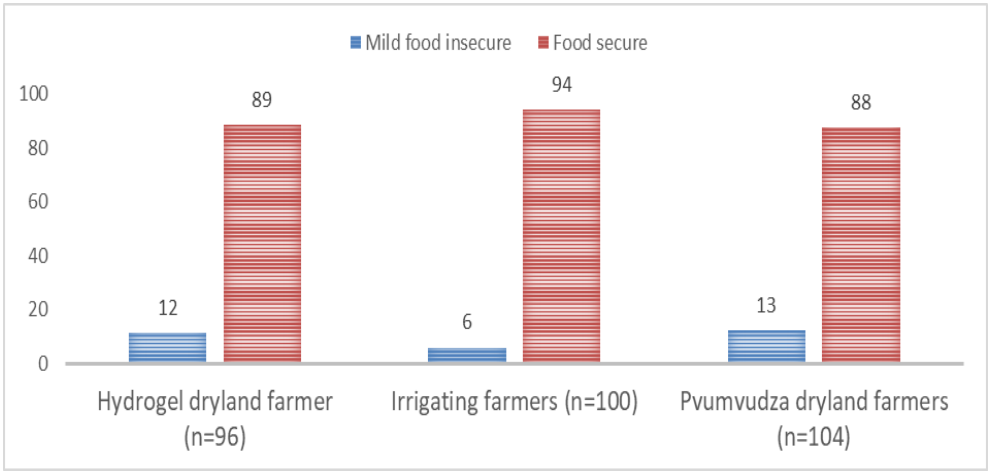

Figure 4: *Percentage distribution of the Household Dietary Diversity Score by climate-smart agriculture technology*

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The results indicate that climate-smart agriculture technologies have the potential to improve food security through improved access to dietary diversity. Additional interventions may be needed to address the food insecurity situation confronted by people who do not have access to irrigation or other resources.

Table 6: The proportion of households consuming specified food groups

Food Group	**% of households consuming specified food group**			
	Irrigators (n=100)	Non-irrigators (hydrogel farmers) (n=96)	Non-irrigators (*pfumvudza* farmers) (n=104)	Average (n=300)
Cereals	100.0	100.0	100.0	100.0
Tubers	40.0	40.6	38.5	39.7
Legumes	60.0	72.9	27.9	53.6
Vegetables	96.0	97.1	95.8	96.3
Fruits	35.0	34.4	20.2	29.9
Meat	63.0	50.0	51.0	54.7
Eggs	48.0	35.4	29.8	37.7
Fish / kapenta	35.4	29.2	20.4	28.3
Milk and dairy products	44.0	34.4	38.5	39.0
Sugar and sugary foods	100.0	91.7	100.0	100.0
Oils and fats	100.0	100.0	100.0	100.0
Condiments	100.0	100.0	100.0	100.0

Table 6 provides the proportion of households consuming specified food groups among irrigators, hydrogel farmers, and *pfumvudza* farmers. All groups generally have improved dietary diversity evidenced by a high proportion of households consuming tubers, legumes, fruits, meat, fish/*kapenta*, milk and dairy products, and oils and fats. The consumption of cereals, vegetables, sugar and sugary foods, and condiments is high across all households.

Minimum dietary diversity score for women aged 15 to 49 years (MDDW)

Results presented in Figure 5 show the classification of the Minimum Dietary Diversity Score for Women (MDDW) by type of climate-smart agriculture technology used, which provides insight into the dietary diversity and food security status of households in the target areas. The households are categorized into two groups based on their MDDW score: food secure (5-10 food groups), and food insecure (less than 5 food groups).

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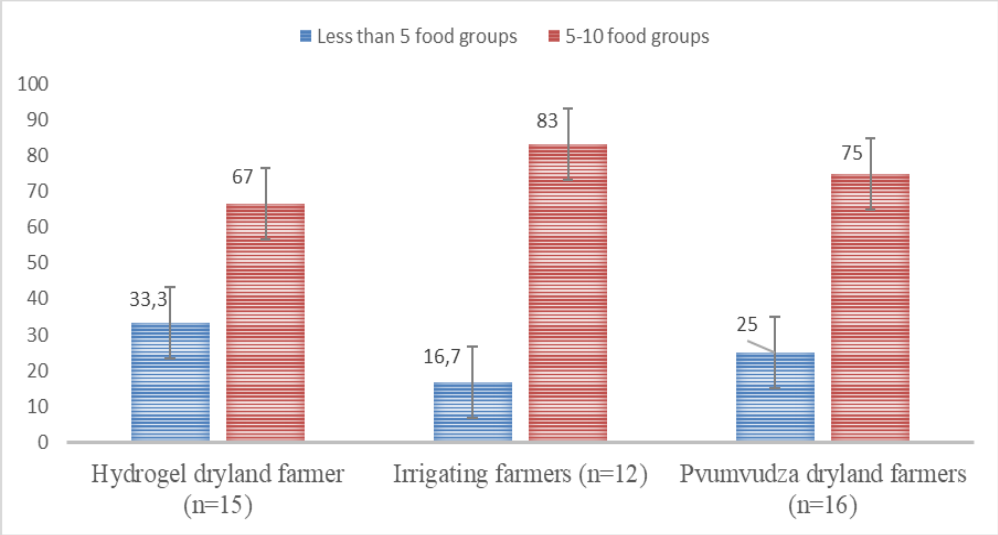

Figure 5: *Classification of MDDW by climate smart technology (n=43*)

The results show that, based on the MDDW, irrigators had the highest proportion of food-secure households (83.3%), followed by *pfumvudza* farmers (75%) and hydrogel farmers (67.3%). Conversely, hydrogel farmers had the highest proportion of food-insecure households (33.3%), followed by *pfumvudza* farmers (25%) and Irrigators (16.7%). The classification of MDDW by type of climate-smart agriculture technology highlights the need to address the food security and dietary diversity challenges faced by households that do not have access to irrigation or other resources. However, besides irrigation development, the MDDW score is influenced by a range of other factors, including household income, education, food availability and accessibility, cultural practices and beliefs, food preferences, and household composition. Understanding these factors can help to identify strategies to improve dietary diversity and promote better nutrition and health. To improve food security and dietary diversity among women in rural communities, it is important to promote climate-smart technologies such as irrigation development, *pfumvudza* concept and hydrogel technology which have proven to increase crop yields, leading to greater access to a variety of foods, and higher dietary diversity. Results indicated that women contributed more than men in household food security hence efforts should be made to empower them to participate in decision-making processes and improve their access to resources and services.

Knowledge, attitudes and practices on CSA technologies

All the interviewees were aware of climate-smart agriculture technologies. Most farmers (59.3%) were familiar with two climate-smart agriculture technologies. A proportion of 39% of farmers were familiar with at least three climate-smart agriculture technologies. On the importance of CSA technologies in reducing the impacts of climate change, 63.3% indicated that CSA technologies are very important and a few 36.7% indicated that CSA technologies are moderately important. All the interviewees were interested in learning more about CSA technologies. Across all the groups, all the respondents confirmed that they made frantic efforts to reduce the effect of climate change and had used at least one CSA technology.

Table 7: Knowledge, Attitudes and Practices on CSA Technologies (n=90)

KAP	KAP sub-categories	Response	Percentage
Knowledge	Aware of CSA technologies	Yes	100.0
	Familiarity with CSA technologies	Familiar with one CSA technology	1.7

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		Familiar with two CSA technologies	59.3
		Familiar with at least three CSA technologies	39.0
		Total	100.0
Attitudes	Level of importance of CSA technologies in minimizing climate change effects	Moderately important	36.7
		Very important	63.3
		Total	100.0
	Interest in learning more about CSA technologies	Yes	100.0
Practices	Making efforts to reduce the effect of climate change	Yes	100.0
	Used at least one CSA technology	Yes	100.0

Challenges faced in implementing CSA technologies

Various scholars agree that climate-smart technologies such as irrigation systems, conservation farming and hydrogel play a pivotal role in improving food and nutrition security in rural communities (Kasdi & Hidayat, 2008; Altieri & Nicholls, 2017; FAO, 2017). However, most irrigation schemes have become non-functional due to a plethora of challenges. Mhembwe *et al.,* (2018) assert that food insecurity has been a problem for smallholder farmers in Zimbabwe mainly due to climate-related droughts and ineffective use of irrigation schemes. Maodza (2012) highlighted that the Guyu-Chelesa irrigation scheme had at some point ceased to function due to vandalism by local people. Moyo *et al.,* (2017) identified hindrances which confront small-scale irrigation schemes in Zimbabwe which include poor institutional arrangements, low technical capacity and exorbitant charges on water authorities leading to low productivity, less capacity to pay bills and operations costs. During FGDs and KIIs it was discovered that irrigating farmers face challenges such as vandalism of irrigation equipment, high costs of establishment, maintenance costs, load shedding and high ZESA rates. Adoption of hydrogel faced challenges of unavailability of hydrogel in the vicinity of the farms and the prices were prohibitive. The *pfumvudza* concept was regarded as too laborious especially when digging the holes for the plot.

Table 8: Summary of challenges hindering implementation of climate-smart technologies

Irrigation	Hydrogel	Pfumvudza
• Vandalism of equipment by local people • High costs of establishment • Maintenance costs • Power cuts • High ZESA rates	• Unavailability of hydrogel on the local market • Prohibitive prices	• Labour-intensive (digging the holes)

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CONCLUSION AND RECOMMENDATIONS

This section gives the conclusion from the findings on the impact of climate-smart technologies on improving food security. Policy recommendations are also presented in this section. The recommendations will advise policymakers on the appropriate route to take to address climate change effects through the use of climate-smart agriculture technologies.

Conclusion

Climate-smart agriculture technologies such as irrigation systems, *pfumvudza* concept and hydrogel significantly increase maize yields. Smallholder farming communities using climate-smart technologies are highly food secure and have improved dietary diversity. Adoption of irrigation systems is compromised by vandalism of irrigation equipment, high costs of establishment, maintenance costs, load shedding and high ZESA rates. Recommendations

The authors recommend the installation of solar-powered irrigation systems to reduce costs such as electricity bills. The supply of hydrogel should be improved through the decentralisation of hydrogel markets. The responsible government ministry should invest in mechanised holing on *pfumvudza* concept to reduce labour. The government should subsidize climate-smart technologies to increase adoption.

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ACADEMIC FUNCTIONING IN THE ADVENT OF E-LEARNING: FACTORS AFFECTING UNIVERSITY LECTURERS' READINESS TO EMBRACE E-LEARNING INSTRUCTIONAL MODELS: A CASE OF ONE STATE UNIVERSITY IN ZIMBABWE.

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ABSTRACT

The study sought to establish the role of university lecturers in the use of information technology in literacy instruction. The study also focused on the factors which significantly impact the use of Information Communication Technologies (ICTs) in e-learning. The variables of interest were age, gender, highest qualification attained, work experience, tenure and employment status. This study was informed by Lev Vygotsky's (1978) Socio-cultural theory also known as social constructivism theory which stresses that learning and development are a social process and learners construct knowledge which is relevant to a particular society within a given culture. A case study research design which allowed for an in-depth study was used in this study. Purposive sampling was employed to come up with a sample of 20 lecturers. Of the 20 lecturers, 10 were females, and the other 10 were males. The studylookedat perceptions of the use of ICT, teaching /learning outcomes for lecturers, and impediments to embracing new technologies in university teaching and learning. Quite significant, therefore, is the fact that the presentation empowers all stakeholders to redirect their efforts to address the use of technology to enhance literacy instruction in institutions of higher education. It was noted that there is less use of ICTs by lecturers in teaching and learning due to various reasons. Variables such as age and gender among others were seen to affect the use of ICTs. The study recommended that the university must come up with a clear policy to monitor lecturers on the use of ICTs in research, lecture preparation, presentation and assessment. Academics wouldalso need to regularly attend refresher workshops and seminars on the use of ICTs in education. Thus, provision of personal computers and laptops among educational stakeholders in their workplaces would result in effective teaching and research through e-learning.

Keywords: *higher education, ICT, literacy instruction, information literacy, e-learning*

INTRODUCTION AND BACKGROUND

Generally speaking, much progress has been made in the expansion of educational technology worldwide, and Zimbabwe is no exception. Currently, an up-to-date classroom is defined by technology and the COVID-19 pandemic has accelerated the usage of technology in teaching and learning. ICT resources have

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been availed to the education sector at an incredible rate. ICTs, according to Dambudzo (2016), are all technologies used to pass information from one person to another. The Government of Zimbabwe adopted an ICT policy in 1995 which was in a way later directed by the Nziramasanga Education Commission Report of 1999 which supported the use of ICT for teaching and learning. The World Economic Forum's Global Information Report, ranked Zimbabwe 105out of 115 economies in 2005-2006, based on a networked readiness index which measures the degree of preparedness of a nation to participate in and benefit from ICT developments (Shafika, 2007). The setup of the East African Submarine Cable System (EASS) which is a submarine optical fibre system running alongside the east coast of Africa substantially benefitted Zimbabwe's internet connectivity. This enormous availability of virtual and networked tools has the net effect of transforming teaching and learning processes in higher education. Vygotsky's 1978 cultural tools may be characterised as the genuine apparatus and image frameworks that allow people in a community to impart, think, take care of issues, and make learning. Vygotsky 1978, based on the assumption that a person's intellectual improvement is influenced by the social apparatus that they are given. In this case, ICTs are the cultural tools for the modern world which are meant to enhance sending and receiving information during teaching and learning. When dealing with cultural tools, a lot is involved that includes embracing modern content formats which are multiple media or hybrid texts (Lemke, 1998), new reader expectations reading nonlinearly, and new activities (Warschauer, 2006). Cultural tools extend traditional literacy experiences with comprehension of information on the Internet; effective use of search engines like Google to locate information; evaluate internet sources; communicate using e-mail, texts, and chats; and use word processing programmes (The International Society for Technology in Education, 2007).

Although different universities convey the obligation for the availability of ICT hardware, this was not the case at the university under study. Notwithstanding the existence of traditional classroom practice, Mavezera (2021) alludes to data published by the Pew Research Center (2011) which concludes that the use of technology in education has reached astounding levels. This was seen in that 89% of four-year public universities provide online guides and courses; 50% of university presidents are expecting that during the next 10 years, most students will have taken courses online; 62% of university presidents are expecting that in 10 years more than half of the textbooks used might be virtual; 57% of university graduates have used a smartphone, laptop or tablet to some degree during class; most institutions do not have clear policies regarding the use of such gadgets; for most institutions it is up to the individual instructors to manage such uses (Taylor, Parker, Lenhart & Patten, 2011: 1-2). All these facts point to a growing trend towards the use of ICTs in literacy instruction which universities can ignore at their peril. ICT acts as an influential change agent in the higher education landscape. Even now, there has emerged a need for academic establishment to warrant that graduates can display appropriate levels of information literacy, 'the capacity to identify an issue and then to identify, locate and evaluate relevant information to engage with it or to solve a problem arising from it' (Oliver, 2000). Integration of ICT in training assists in educating students to participate in the rapid growth process of the 21st Century.

The use of ICT offers powerful learning environments and can transform the learning and teaching process so that students can deal with knowledge in an active, self-directed and constructive way (Volman & Van Eck, 2001; De Corte, et al., 2003). It is also imperative to be aware of the realisation of the social realities and cultural experiences of young people which have become increasingly virtual involving technology, irrespective of career

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paths (Beavis, Dezuanni & O'Mara, 2017; Ra, et al., 2019). In a way, this suggests that these realities and experiences of young people require technologically savvy educators to tap into the opportunities provided by digital media and devices. In essence, digitally connected educational communities have the potential to enhance these prospects as proposed. Vygotsky sought to recognise how human beings could analyse their social surroundings and create unique ideas on social learning (Kurt, 2020). In addition, Vygotsky argued that teachers have the potential to govern many elements in an academic setting, inclusive of tasks, behaviours, and responses. As a result, Vygotsky recommended greater interactive activities to promote cognitive growth along with productive discussions, positive feedback, and collaboration with others, who could be peers or anyone in their social environment.

Literature confirms that many countries the world over, Zimbabwe included, understand the growing need for technology in students' lives. They emphasise the development of technology-integrated curricula that are developmentally appropriate for young people (Plowman, Stevenson, McPake, Stephen & Adey, 2011). As a result, technological improvements have successfully brought educators to come up with new ways to disseminate information. In South Africa, as noted by Mahao and Gennrich (2022) the South African Department of Basic Education (DBE) proposed a formidable declaration reflecting the motive of the Department by asserting that every South African learner in the general and further education and training groups should be ICT capable (that is, use ICTs confidently and creatively) to help develop the skills and knowledge they need to achieve personal goals and to be full participants in the global community by 2013. This indicates that South Africa is a country readying itself and moving in sync with the worldwide trends of embracing ICT and promoting literacy instruction.

Great technological advances have been made to be used in literacy instruction. These information communication technologies (ICTs) consist of amongst others; digital textbooks (E-books), simulation technology, gamification, computerised grading, flipped classrooms, active learning classrooms and Learning Management Systems (LMSs). Classroom technology is assumed to be any digital technology which is available and typically used in classrooms, such as digital texts, videos and games, wikis, blogs, e-books, podcasts, tablets, smartphones, and online resources (Howard, Ma & Yang, 2016). The use of technology in literacy instruction has many benefits as the study sought to unravel. These may include access to instruction to normally deserving clients who are often excluded (for example, those with disabilities), those who have not engaged with technology before due to their backgrounds, preparing students for the future workforce, reducing tuition costs related to traditional methods of instruction and enhance student learning and achievement among others. Research results show that despite the benefits of the Internet, its use in the faculty is still very low. Adika (2003) analysed Internet use among faculty members of universities in Ghana. Research results from Ghana show that despite the benefit of ICT, internet use among faculty members was still very low.

With regards to Zimbabwe, the former and late President R.G. Mugabe's call for the establishment of at least one state university in each of the ten provinces (Herald, 18 April 2012) triggered a surge in student enrolments and in the need to use and expand opportunities provided by ICT facilities. Based on the researcher's experience, some of the lecturers faced problems with the use of new-era technology for literacy coaching. The issues that lecturers faced consisted of a lack of adequate technological skills, time, technical support, and pedagogical understanding in the use of new technology. In addition, the researcher noted that institutional policies regarding the use of new technology and assessments did

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not match the new literacy expectations. These challenges were compounded by a lack of adequate assistance when needed from the few who had an ICT background. This lack of assistance has resulted in what is termed 'technology anxiety' which is one of the factors leading to the non-use of technology by teachers (Adukaite, van Zyl & Cantoni, 2017). Thus, the researcher's own experiences and the situation obtained at the studied university as well as the studies noted above stimulated the researcher to carry out this study.

THEORETICAL FRAMEWORK

This study was informed by Lev Vygotsky's (1978) Socio-cultural theory/ social constructivism theory which stresses that learning and development are a social process and learners construct knowledge which is relevant to a particular society within a given culture. Vygotsky (1978) postulates that social interaction within cultural artefacts forms the most important part of learners' psychological development. Consequently, ICTs have become part of the contemporary society and cultural tools or artefacts of the 21st century. Vygotsky further states that the role of education is to provide children with experiences which are within their zone of proximal development (ZPD), thereby boosting advancement in the student's acquisition of knowledge and development. The ZPD is the gap between the actual development level as determined by independent problem-solving and the level of potential problem-solving as determined through problem-solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978: 86). In this case, university lecturers are the more knowledgeable others who set up tasks using ICTs to assist students in discovery learning and development of higher mental functions. For Vygotsky, the settings in which individuals grow up will influence how they think and what they think about.

Vygotsky's ideas also brought out the importance of scaffolding learners. Here the lecturer is to use all the available ICTs in the students' ZPD. In this study, Vygotsky's theory can best be understood through scaffolding which is meant to support learning and problem-solving among learners. This support may be evident through cues, reminders, encouragement, breaking the problem down into steps and providing examples that allow the students to grow as independent learners. Thus, the lecturer is compelled to use all the available ICTs in the students' ZPD to scaffold them and assist the students to ascend to the next rung of the educational ladder and assist them in learning, research and problem-solving.

REVIEW OF RELATED LITERATURE

The notion of e-learning and challenges faced by lecturers in the use of instructional technology

E-learning is defined as the educational usage of technological devices, tools and the Internet (Adedoyin & Soykan, 2020). In this case, the lecturer teaches the students from a distance and is divorced from the lecture room where the students' educational enterprise is technologically supported. E-learning is also known as electronic learning or online learning because of the methods employed in its delivery. Experts in education and educational technology define e-learning as "the delivery of training and education via networked interactivity and a range of other knowledge collection and distribution technologies" (Fry, 2000). Simply put, it is learning that is supported electronically and commonly uses materials which include websites (for research), educational videos, and e-books. Usually, e-learning is conducted on the Internet, where students can access their learning resources online at any place and time.

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E-learning can offer synchronous e-learning where the interface happens in real-time allowing lecturers and students an online experience and interacting at the same time through live webinars, real-time discussion boards, and instant messaging that support university learning. It allows for instantaneous feedback during the teaching/learning exercise. Through synchronous online learning, groups of students can simultaneously participate in activities in real time, anywhere they are in the world (Hrastinksi, 2008). In contrast with synchronous online learning, asynchronous e-learning methods allow students to study independently at different times and locations, without real-time communication (Bouchrika, 2024). This type of learning approach allows students to have more flexibility in their schedules. Technologies used for asynchronous e-learning methods include email, blogs, e-books, discussion forums, CDs, and DVDs. Asynchronous e-learning allows learners to complete their practical training at their own pace, without real-time interaction with their lecturers or peers. Content is pre-prepared and can be accessed anytime, anywhere, via e-learning platforms.

It becomes a drawback if those involved in the process of teaching and learning are digitally incompetent due to inexperience or insufficient training. The strategy of integrating the use of ICT into teaching and learning is an intricate process that would negatively affect educational practitioners. In concurrence with Bingimals (2009), Nkengbeza, Mbuzi, and Chainda (2022) also note that lack of access, time, training, resistance to change and technical support as barriers to implementation and use of technology by teachers. These issues come in a big way to hinder the successful use of ICTs in teaching and learning processes. In supporting the above claim, Heng and Sol (2020) posits that some distinctive technological issues noted include a lack of knowledge of how to use computer applications, unstable/slow internet connection, archaic communication devices, and incompatible browsers. If lecturers cannot fully access e-learning resources, it will be a challenge to fully realise the benefits of e-learning. Therefore, access to computers, updated software and hardware are key elements to successful adoption and integration of technology. Vygotsky (1896 – 1934) says 'tools' play a significant role in humans' understanding of themselves as well as the world around them. In this regard, academics need e-resources to function well in the implementation of e-learning programmes. Vygotsky further alludes that human beings can only act directly in the physical world with the intercession of tools which are used as aids in problem-solving.

Taban, Abdullah-Al-Mamun and Chekum (2012) note that as Uganda adopts ICT in education, it faces the same challenges as most developing countries where unstable economy, poorly developed ICT infrastructure, high bandwidth costs, unreliable supply of electricity, and general lack of resources among others. These were predominantly found to be the central issues to meet a broad spectrum of needs of the country. Yildirim (2007) also argues that access to technological resources is one of the effective ways to the teachers' pedagogic use of ICT in teaching and learning.

FACTORS INFLUENCING ADOPTION AND ICT USE

The question of ICT competence as wellas factors influencing these competencies is a contested terrain that has roped in issues of age, gender, tenure, work experiences and educational level among others. This section will give a snapshot of some of the controversies or contestations around these factors.

Age

There are contestations regarding ICT competencies and age. This is noted not to be a global trend as observed by Hernes et. al, (2000) in

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Norway where a share of teachers who state that they have a good command of the use of the Internet is negatively correlated with age. About 77% of the teachers who are 25 years or younger stated that they have a good command of the use of the Internet, compared to 25% of teachers who are 56 years older. Also, around 63% of the teachers who are 25 years or younger versus only 32% of the teachers who are 56 years or older have a positive attitude towards the use of the Internet in their teaching.

Prensky (2001) believes that younger teachers are ICT natives who were born in a digital world and since they have been exposed to ICT more than older colleagues, they use ICT tools more confidently (Peerar & Van Petegen, 2010).

Gender

Several studies have reported gender differences and the use of ICT. Males spend more time online and are more likely to go online overnight than females (Jones et al., 2009). Confidence in using virtual platforms and programmes is higher among male participants in surveys of technologies for learning (Huang, Hood & Yool ,2012). Additionally, it was noted that females utilise mainstream information-gathering tools and express higher confidence interacting through email or social media platforms such as WhatsApp, TikTok, and Instagram, just to mention a few. Lower levels of computer use by female lecturers have been reported in studies about lecturers' gender and ICT use (Volman & Van Eck, 2001) due to female teachers' limited technology access, skill and interest. Research studies also revealed that male teachers used more ICT in their teaching and learning processes than their female counterparts (Kay, 2006; Wozney, Venkatesh, & Abrami, 2006). Jamieson-Proctor (2006) conducted a study on teachers' integration of ICT in schools in Queensland State. Results from 929 teachers indicated that female teachers were integrating technology into their teaching less than male teachers.

Educational Level

Individuals with higher levels of education used the Internet more frequently; only 61% of individuals without a high-school diploma used the Internet while 94% of individuals with some college degree and 97% with a college degree or higher were Internet users (Pew Research Center, 2012). According to the National Centre on Adult Literacy Technical Report (2005), one study in Britain established that people with higher educational qualifications have higher ICT skills, but suggests that more educated people tend to work with computers, making it difficult to differentiate whether education or employment has the biggest impact on ICT skill levels (Ali, Haolader & Muhammad, 2013).

Tenure

With regards to tenure, Adika (2003) explored faculty members' use of ICT and their information-seeking behaviours and activities on the Internet in his doctoral study at Angelo State University. The study found differences between tenured and tenure-track faculty members on the perceived value of the Internet to meet their research and classroom information needs. Tenure-track faculty members reported a higher average Internet use per week than tenured faculty members.

Work experience

Some previous studies concluded that more experienced lecturers had used ICT in their teaching and those teachers who used Computer-Assisted Language Learning (CALL) activities had more experience with CALL (Egbert, Paulus & Nakamichi, 2002). Also, Teo (2008) found that the years of computer usage are positively correlated with the level of computer confidence. Studies on teachers' teaching experience and age have reported that teacher ICT use, experience and age are

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inversely associated meaning that more experienced teachers and older teachers tend to use computers less frequently (Van Braak, et al., 2004; Bebell, et.al., 2004). Some studies have attributed this to veterans' limited computer proficiency (Bingimals, 2009) and readiness to use ICT in their classes (Inan & Lowther, 2010). Literature asserts that experienced teachers are less ready to integrate ICT into their teaching as reported by the United States that teachers with less experience in teaching were more likely to integrate computers in their teaching than teachers with more experience in teaching (U.S National Centre for Education Statistics, 2000). The reason for this disparity may be that fresh teachers are more experienced in using the technology (Baek, Jong & Kim, 2008) than their counterparts.

Aljaraide (2009) descriptively examined the usage and related advantages of the Internet to the teaching members at Damascus University. The study found no statistically significant differences due to teaching experience or academic rank. In another meta-analysis and review of 81 research studies by Rosen and Maguire (1990), it emerged that the teachers' teaching experience does not eliminate computer phobias and many experienced teachers display some wariness, discomfort and/or mild anxiety about computers.

BENEFITS OF USING TECHNOLOGY IN E-LEARNING

The innovations that ICT has brought in teaching and learning processes include E-learning, e-communication, quick access to information, online student registration, online advertisement, reduced burden of keeping hard-copy, and networking with resourceful persons, (Ali et al, 2013). Many people recognize ICTs as catalysts for change; change in working conditions, handling and exchanging information, teaching methods, learning approaches, scientific research, and accessing information. Department of Education and Skills (2020) notes that ICT offers the potential to share information across traditional barriers, to give a voice to traditionally unheard peoples, and to provide valuable information that enhances economic, health and educational activities. According to Vygotsky (1978) in Lantolf (2000) the child is completely dependent on other people, usually the parents, who initiate the child's actions by instructing him/her as to what to do, how to do it, as well as what not to do. Parents, as representatives of the culture and the conduit through which the culture passes into the child, actualise these instructions primarily through language. About Vygotsky's claims, lecturers could use ICT to facilitate learning, critical thinking and peer discussions.

Classroom technology is understood to be any digital technology which is available and commonly used in classrooms, such as digital texts, videos and games, wikis, blogs, e-books, podcasts, tablets, smartphones, and online resources (Howard, Ma & Yang, 2016). In using these digital technologies, lecturers adopt strategies which are learner-centric and hence bring about the active participation of students in the learning process. Students get motivated when learning activities are thought-provoking, authentic, multi-sensorial and multi-disciplinary. Vygotsky (1978) advocates that good instruction should proceed ahead of development and should awaken and rouse to life an entire set of functions, which are in the stage of maturation and lie in the ZPD. It is in this way, as he claims, that instruction can play an extremely important role in development. Instructional technology offered by lecturers awakens the students' thinking in the ZPD which subsequently provides learners with new tools for thinking to meet the learning demands of the university education.

Concerning the ZPD, Vygotsky also suggests scaffolding which avers that in a social interaction, a knowledgeable member can create using speech and supportive conditions in which the student (apprentice) can participate in and extend current skills and knowledge to

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a high level of competence. In this regard, the lecturer models the desired learning strategy or task and then gradually shifts responsibility to the students through ICT tools.

ICT is vital in universities and other educational institutions as it enables the carrying out of activities and functions such as record keeping, research work, instructional uses, presentations, financial analysis, examination results management, communication, supervision, teaching/ learning activities, and general institutional management functions. Many researchers (Taban, Abdullah-Al-Mamun & Chekum, 2012) and theorists assert that the use of computers can help students become knowledgeable, reduce the amount of direct instruction given to them, and allow teachers to help those students with particular needs. It can help the teachers enhance their pedagogical practice and equip them with the knowledge and skills to use different computer technologies to access, analyse, interpret process and disseminate information to learners.

RESEARCH OBJECTIVES

The study sought to:

1. Identify factors that influence university lecturers' use of technology for instructional literacy.
2. Examine challenges faced by lecturers in the use of technology.
3. Suggest ways in which lecturers could benefit from the use of technology.

METHODOLOGY

The research study adopted the interpretive paradigm in this qualitative inquiry to understand university lecturers' readiness in the use of e-learning instructional models at one selected university in Zimbabwe. This study used a case study research design which allowed for an in-depth study even though it is criticised for less quantification and representative significance (Henderson, 2016). Out of a total of 168 lecturers from the selected school, a sample of 20 lecturers was used. Of the twenty, ten were females and the other ten were males. In particular, the researcher explored the aforesaid issue through semi-structured interviews with 20 purposively sampled university lecturers using an interview guide. Questionnaires with open-ended questions were also administered to the 20 purposively selected lecturers to produce qualitative data. Purposive sampling, which relies on the researcher's situated knowledge of the field (Barratt, Ferris & Lenton, 2015) was employed to ensure that participants across the schools' six departments who were directly involved in online teaching and learning participated in this study. Purposive sampling is a method of sampling where the researcher deliberately chooses whom to include in the study based on the ability to provide necessary data (Patton, 1990). Of the 20, five were professors, nine were PhD holders and six were Master's degree holders. The age range of the participants was between 25 and 65. Five of the participants were not tenured. In terms of experience, the study targeted participants who had been with the university for at least two years.

The researcher analysed the data thematically as recommended by Glaser and Strauss (2017) and Braun and Clarke (2013). According to Brown, Weilenmann, Mcmillan and Lampinen (2016), research ethics should be grounded in the sensitivities of the research participants and everyday practice as opposed to bureaucratic or legal concerns. Accordingly, the researcher sought informed consent from lecturers through emails, telephone calls and WhatsApp to participate and record interviews. The purpose of the study was explained to them and they were assured that responses obtained could be used only for academic purposes. Accordingly, ethical principles such as anonymity, confidentiality and privacy were observed through the use of codes in the form of alphabetical letters.

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FINDINGS AND DISCUSSION

Factors Influencing Adoption and ICT Use

This study focused on factors that influence university lecturers' use of technology for instructional literacy. The results from interviews and questionnaires suggest that there is enough evidence to conclude that, age significantly affects the use of ICTs in literacy instruction. Older lecturers (55+ years) did not readily accept the use of ICT in lecture delivery. Chances could be that when these lecturers joined the university system, the use of ICT was not all that prevalent. In concurrence to this, Bebell, et.al, (2004); Inan and Lowther, (2010) reveal in their findings an inverse correlation between ICT use, age and years of teaching experience. They state that this supports the fact that ICT use decreases with age and teaching experience of teachers and those younger teachers incorporate ICT tools into their teaching more than their older counterparts.

On the issue of gender, the results of the study suggest that there is enough evidence to conclude that gender significantly affects the use of ICTs in teaching at the university level. Male lecturers were found to use ICT tools more as compared to their counterparts. This is also similar to findings by Jones et.al, (2009) who noted that males spend more time online and were more likely to go online at night than females. Huang, Hood and Yool's (2012) survey of technologies for learning concluded that confidence in using web platforms and programmes was higher among male participants. The results from the interviews indicated that ICT incompetence on the part of the female lecturers was largely influenced by the females' nurturing behaviour whereby after work they were involved in household chores which left them tired and unable to visit the Internet for research. Males on the other hand had more time to do research online and feel confident doing it.

According to the results from questionnaires, an upgrade in academic qualifications and age (PhD holders and Professors) resulted in a decrease in the use and adoption of ICTs in teaching by university lecturers in the school under study. This was unexpected and does not conform to the literature which submits that as one increase educational qualification it is expected that the use of ICTs also increases. The results are different from those of the Pew Research Center (2012) which found out that individuals with higher levels of education used the Internet more frequently; only 61% of individuals without a high school diploma used the Internet while 94% of individuals with some college and 97% with a college degree or higher were Internet users. Deducing from the above assertions one can be forced to claim that when these participants attained their doctorates the use of ICTs was not a common practice. Thus, learning new ICT skills could be a burden to them because it does not add any value to their knowledge acquisition.

The results of the study suggest that there is enough evidence to conclude that tenure is insignificant in affecting the use of ICTs in literacy instruction as shown by the questionnaire responses. Both tenured and untenured members of the school were almost at par in their use of ICTs in teaching. This is in contrast to the literature review as evidenced by Fortin's (2000) study where differences were found between tenured and tenure-track faculty members on the perceived value of the Internet to meet their research and classroom information needs. Tenure-track faculty members reported a higher average Internet use per week than tenured faculty members.

The results shown for members of the school indicate that academics do not put much effort into their tenure status, rather they put more emphasis on their work. Thus, tenured members use the Internet for research and lesson delivery in pursuit of further promotion and tenure track members also use the same in preparation for tenure.

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Furthermore, data gathered through questionnaires and interviews indicate an inverse relationship between work experience and the use of ICTs. The results indicated that, as one gains experience on the job, he/ she is less likely to adopt new ways of executing tasks. The lecturers concerned were comfortable doing their work using the traditional methods of teaching. New members of the school (less than 16 years' work experience) are more likely to embrace the use of ICTs in teaching and learning than their counterparts. Teo (2008) notes that this is at variance with previous research where it was found that the years of computer usage are positively correlated with the level of computer confidence.

CHALLENGES FACED BY LECTURERS IN THE USE OF TECHNOLOGY

Results of the study indicate that there are challenges that university lecturers face in embracing and using ICTs in teaching and learning. Some research questions in the questionnaires addressed the issue of challenges that lecturers face in the use of ICTs in teaching.

How would you pronounce your experiences of the challenges of e-learning?

Concerning the above question, the participants' responses exposed some inherent challenges faced by lecturers in the use of technology in literacy instruction. All participants interviewed in the study laid bare the fact that they experienced some challenges with e-learning during their interactions with students. A case in point is participants A and M who said:

Respondent A: *The University insists that I use Google Classroom for lecture delivery to my students. I am not yet fully acquainted with this application and my students always grumble about it.*

Respondent M: *The short in-house workshop I attended on the use of this application has not managed to fully equip me with the requisite skills to use to interact with my students. I have resorted to the use of WhatsApp and e-mail for my interactions with students.*

It should also be noted that lecturers' computer competence is a major predictor of integrating ICT in teaching. This entails being able to handle a wide range of varying computer applications for various purposes. The results of this study echo the sentiments of Heng and Sol (2020) who posit that some distinctive technological issues noted include lack of knowledge of how to use computer applications, unstable/slow internet connection, archaic communication devices, and incompatible browsers.

Other responses indicate that participants also had difficulties with internet connectivity as shown by the responses from respondents D, G, H and I:

We have always experienced challenges in accessing Wi-Fi. Most of our students from our classes also report having the same challenge. Even though some have managed to join Google Classroom they will not be active due to the erratic Wi-Fi on and off campus. In a certain class, 137 out of 334 of the students have joined Google Classroom. We have since migrated to the WhatsApp platform where we have almost 90% of the students participating.

The challenges of access to Wi-Fi were also compounded by the high costs of internet data which is unaffordable to many students and staff alike.

Lecturers' access to ICT infrastructure and resources is of paramount importance to the success of the use of the same in teaching and learning. Lecturers reported a lack of resources as indicated by their responses from the interviews where they said they were using archaic laptops and gadgets in the execution of their duties. In addition, the erratic supply of electricity compounded by load shedding made matters worse. Concerning this, the study shows that it is also critical to provide the lecturers with technical support with regard to repair and maintenance for the sustained use of

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ICT in schools. Thus, if there is no technical support for lecturers, they become frustrated resulting in their unwillingness to use ICT in teaching and learning.

BENEFITS OF USING TECHNOLOGY IN TEACHING AND LEARNING

Most lecturers whose age range is below 55 years remarked that online teaching and learning enabled them to acquire ICT skills such as emailing, surfing, conferencing, installing and using software. The tenure track participants stated that other benefits include perseverance, collaboration, communication, time management and research skills as a way of ensuring that their tenure was successful. On the other hand, some experienced, tenured and above 55 years respondents felt that they still needed more training in utilising online platforms such as Google Classroom and Turn-it-in. Three such lecturers, C, E and F, stated that they gained knowledge of using Google Classroom and other Google applications.

Overall, the majority of lecturers concurred that Google Classroom, Zoom, Google Meet, WhatsApp and Skype were advantageous because they reduced transport costs and were more flexible. The use of ICT also made communication, between lecturers and students easier through the Internet, for example, E-mail, chatting, Skype, teleconferencing, video conferencing and Zoom, among others. Respondents B, J, L, and Kalso expressed that they managed to proceed with lectures even from the comfort of the home environment. These findings are similar to the findings of studies conducted by Gunasekaran, et.al, (2002) and Brown, et.al, (2020). In their studies, they showed that online teaching and learning have such benefits as synchronous and asynchronous communication, multimedia capability, upskilling, and ubiquity. Tubaishat, et.al, (2006) cited in Babu and Reddy (2015) assert that the adoption of e-learning motivates and improves technical skills. The introduction of e-learning intervention demands key players to appreciate its benefits before implementation. It is imperative to note that, from the responses, the State University under study provides computers (in computer laboratories), multimedia projectors, and whiteboard facilities to support the teaching/learning process. This provision of infrastructure and resources consequently made it easy for them to integrate the use of ICT for the teaching/ learning process.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of this study, persistent poor or non-use of ICTs in literacy instruction due to lack of technical know-how, attitudes and lack of supporting materials and equipment as a result of the studied demographics and ensuing factors should not continue indefinitely. ICT innovations among female academics are facing challenges because of some cultural beliefs which predominantly believe that household chores are the domain of women. Equally, the study noted that highly qualified, experienced and old staff members are not motivated to learn new ICT skills since they feel that they have highly achieved or attained self-actualisation. Hence, ICT does not add any value to their knowledge.

The study recommends that telecommunications operators, government, organisations, businesses and universities should adopt an inclusive approach to service provision by offering reasonable services, uninterrupted support and awareness programmes. Institutions of higher learning should scale up their systems to avoid network crashes. It is also recommended that universities come up with clear ICT policies to guide lecturers and all stakeholders on the use of ICTs in research, lecture preparation, lesson delivery and assessment to enhance their performance. There is also a need for lecturer preparatory programmes to meet minimum requisite technology standards. This could be achieved through ICT-driven workshops or seminars that are precisely

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meant to capacitate new and old staff members. The provision of workshops to capacitate staff should not be a once-off initiative, but a continuous gesture which should be supported by policy as well as willpower from those in authority. Technology use should also be deeply integrated with instruction and should cut across all modules on offer and the whole university curricula rather than isolate them in two modules as is the case with the university under study. Further, research should be done with more than one university using a different research approach to avoid the fallacy of generalisation.

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AN EVALUATION OF THE ROLE OF NON-TIMBER FOREST PRODUCTS (NTFPS) IN RURAL LIVELIHOODS OF COMMUNITIES IN SOUTHERN AFRICA: A CASE STUDY OF *SCLEROCARYABIRREA* (MARULA TREE)

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ABSTRACT

Generally, rural communities in Southern Africa depend on rain-fed agriculture to sustain livelihoods. However, there is a need for diversification of livelihoods as a coping mechanism for climate change and climate variability. Sclerocaryabirrea (marula tree) is one plant species that plays an important role in rural livelihoods owing to its multiple uses. This review evaluated the literature on the role that non-timber forest products play in enhancing the rural livelihoods of communities in Southern Africa with a particular focus on the marula tree. Studies investigating the contribution of the marula tree to community livelihoods were identified and reviewed. The results of the review reveal that the utilisation and commercialisation of the marula tree in Southern Africa is growing and can offer livelihood options to several families. On the other hand, understanding the role played by the marula tree in livelihoods is a challenging task requiring long-term strategies crafted by stakeholders from a broad range of fields including marketers, product developers, natural resource managers and policy makers. Investments must be made in more research on technologies that can aid product development and improve the shelf life of marula products and eventually marketing.

Keywords: *Marula tree; livelihoods diversification; marginal lands; forest products; commercialization*

INTRODUCTION

Non-timber forest products (NTFPs) are defined as forest products consisting of goods of biological origin other than wood derived from the forest, and trees outside forests (FAO, 2014). The savannah biome is considered the most important source of NTFP diversity in Southern Africa with high fruit and seed yields (Lawes *et al*., 2004). Over the years, communities have collected delicious fruits from savannah trees and shrubs valued for their size, flavour, and nutrition. According to Shackleton and De Vos (2021), 3.5-5.8 billion people worldwide are benefiting from income, food, and nutrition security, medicinal and other socio-economic ecosystem services from NTFPs. Several studies revealed that in Southern Africa, rural communities have a strong reliance on locally available natural resources such as the marula tree (Koziell & Saunders, 2001; Munyati & Sinthumule, 2014). It is estimated that several million people in marginal lands earn their primary income from the sale of NTFPs like the marula tree products (Kaimowits, 2003; Mojeremane *et al*., 2004). Shackleton and Shackleton (2004) indicated that the significance of the marula tree to rural livelihoods and income generation caught the interest of many researchers during the 2000 decade.

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UNDP (2012) observed that the Swazi Secrets marula project in Eswatini is supporting 2400 rural women who earn a living by selling the marula kernels. Over the years, the role of NTFPs has remained underrated despite the fact that they are increasingly being recognized internationally (Falayi 2019; Wiersum *et al*., 2018; Wolfslehner *et al*., 2019). Many studies have focusedon the role of NTFPs in poverty alleviation and the provision of safety nets (Zinyama *et al*., 1990, Guinand & Lemessa 2001, Shackleton & Shackleton 2004, Paumgarten 2005, Muller & Almedom, 2008). Some studies indicate that wild food sources contribute to increased dietary diversity, which has been associated with good nutritional status (Fleuret & Fleuret 1980, Hatloy*et al*., 2000, Johns & Sthapit, 2004). Woittiez *et al.,* (2013) argued that wild fruits like marula fruits are used as a coping strategy in Zimbabwe because staple maize grain could not be stored for long mainly as a result of post-harvest losses and cash needs.

Numerous studies have tried to untangle the link between poverty and forest foods in developing countries (Anderson *et al*., 2006; Angelsen & Wunder 2003; Bukula & Memani 2006; Profor 2007; Raik & Decker 2007; Shackleton *et al*., 2006; Sunderlin *et al*., 2005). However, Neumann and Hirsch (2000) claimed that the harvesting of the marula tree and other NTFPs is generally about poverty alleviation than it is about giving people an option of livelihood. Vedeld *et al*. (2007) further stated that NTFP sales generate income and aid the rural poor in achieving livelihood security. Belcher (2005) concluded that NTFPs can only contribute to poverty alleviation if more research and support are given to developing efficient commercial production strategies and trade on value-added products. On the other hand, Neumann and Hirsh (2000) published a case study that seems to question the potential of NTFPs to alleviate poverty. On the same note, Wunder (2001) said that NTFPs are used as income gap fillers during stressful times and not as one of the main sources of consistent income.

Medicinal plants have always played a critical role in forest communities (Maundu *et al*., 2005, Sinthumele *et al*., 2019, Street *et al*., 2012). Several biomedical studies have pointed out the existence of medically important chemical constituents in the marula tree that, if adequately explored or pharmacologically proven, could be used as an alternative to curb some diseases (Todorov & Dicks, 2009; Mawoza *et al.,* 2010; Bille *et al*., 2013; Hal *et al*., 2014; Oladunni *et al.,* 2018). In several rural areas and marginal communities, modern medicine and health care services are either financially unaffordable or difficult to access hence people turn to the use of traditional medicines from NTFPs like marula tree (Maundu *et al*., 2005). The nascent role of the marula tree in livelihoods has spurred international debates that have forced governments in many countries to work on putting in place operative management policies that will hinder over-utilization. While that might be the case in other parts of the world, in Southern Africa the regulatory frameworks for NTFPs are not definite, and many research papers have been calling for policy reforms (Arnold & Ruiz, 2001; Wynberg, 2012; Laird *et al*., 2010; Murye, 2018). Themarula tree providesseveral ecosystem services including fruits, medicine, timber, livestock food, carbon sequestration and nutrition security among other services. Consequently, there is an urgent need to adequately describe such ecosystem services for the benefit of communities. Therefore, documenting, and synthesizing knowledge on the role of the marula tree in sustaining livelihoods for people living in marginal lands of Southern Africa help identify potential research gaps. This paper is aimed at reviewing the literature on the role of NTFPs in Southern Africa centering on the marula tree.

MATERIAL AND METHODS

Study area

The marula tree (*Sclerocaryabirrea*) is indigenous to the miombo woodlands of Southern Africa where it is widely distributed at low and medium altitudes in the open woodlands (Jacobs & Biggs, 2002; Nghitoolwa *et al*., 2003). The tree prefers well-drained soils and sometimes granitic sands to sandy loams and basaltic clays (SEPASAL database, 2001). Marula is widely distributed in Southern Africa, (Figure 1) mainly in areas that consistently experience erratic rainfall regimes and inherent hot temperatures and poor soils such as Southern Zimbabwe, Northern South Africa, Botswana,

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Swaziland and Namibia (Ngorima, 2006; Munondo, 2005).

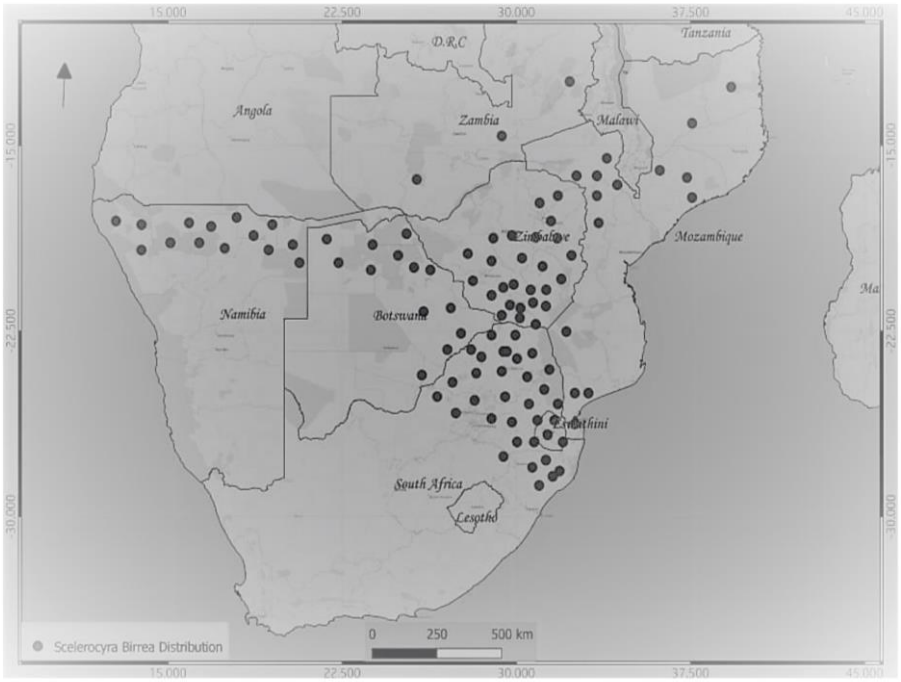

Figure 1: *Distribution of the marula tree in Southern Africa.*

This paper focuses on reviewing the available literature on the roles that the marula tree plays in marginal communities of Southern Africa. The literature search was kept wide in terms of the years it covered to determine the period where people began to be interested in writing about the marula tree while keeping the review manageable by restricting the search to articles whose cases are in Southern Africa, except when necessary. The literature search went as far as 40 years ago. Furthermore, to narrow the research, the researchers went through several abstracts to identify additional candidate studies that focused more on the uses of the marula tree. Overall, the literature search and application of the inclusion and exclusion criteria resulted in the identification of 189 studies that were relevant to the study. The researchers began a literature search on this topic in January 2022- January 2023. The study used the Scopus and Science Direct databases to evaluate trends in research growth in Southern Africa. However, the researchers acknowledge that some relevant studies may have been omitted or excluded. To cater for this, the researchers subsequently used GoogleScholar to capture potentially missing literature including grey literature. The research only included literature that focused more on the marula tree than the other non-timber forest products. A combination of search terms like marula tree; livelihoods diversification; marginal lands; forest products; commercialization and Southern Africa were used. The papers were grouped according to the thematic areas that they represented**.**

RESULTS AND DISCUSSIONS

An overview of marula Studies

A total of 189 articles were found relevant to this article of which130 were peer-reviewed papers, 23 were books, 16 were dissertations and unpublished articles. The perception that the collection of non-timber forest products was less threatening to the environment as compared to timber (Myers, 1988) spearheaded the interest of these early researchers in the 1980s. The Brundtland Report (1987) highlighted as key the use of forest products to support economic growth while the Rio Erath summit of 1992 underlined the role of NTFPs in sustainable development. As research progressed in the early 2000s, the economic importance and diverse uses of the marula tree gained momentum (Shackleton *et al.*, 2002; Shackleton & Shackleton 2004; Mojeremane *et al*., 2004). One of the early articles by

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Campbell *et al*. (1997) introduced the economic valuation of the marula tree. Thereafter, studies done in Southern Africa were dedicated to the contribution of NTFPs to household income (cash and non-cash) (Shackleton & Shackleton 2006, Angelsen *et al*., 2014). The commercialisation of NTFPs started growing after 1998 when products like marula beer (Shackleton & Shackleton 2004) and oil became a growing livelihood in Southern Africa. Shackleton's (2004) study found that by 2002 there were over 200 individuals selling marula beer in South Africa.

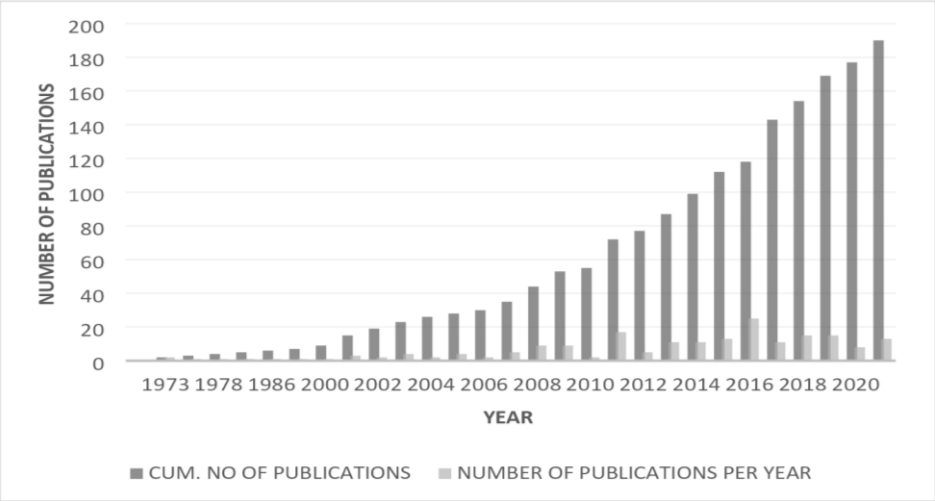

Figure 2: *Cumulative number of articles that were relevant to this study.*

In Figure 2, the period between 2001 and 2022 showed an upward trend in the number of publications in Southern Africa with the highest recorded in 2017. The period saw a rise in publications that focused on the population dynamics of the marula tree and the impact of elephants and fire on the tree (Jacob & Biggs, 2002; Munondo, 2002; Nghitoolwa *et al*., 2003). According to Persistence Market Research (2021), marula oil sales increased by 4.4% between 2016 and 2020 worldwide. The growth in the number of publications followed the high demand for marula oil and other products at the international level. The era brought in the need to research the composition of marula oil which had been overlooked for some time though Burger *et al*., (1987) had attempted a paper on the composition of the marula oil. The use of marula oil in cosmetics also gave rise to research on biomedicines, cosmetics and pharmaceuticals (Hal, 2014; Mariod *et al*., 2012; Mawoza *et al*., 2012; Street 2013). The increase in the demand for marula oil since the year 2000 may have been due to the need for more research into product development, markets, and increasing the shelf life of products.

Themes in reviewed articles

Out of the 189 articles that were used in this review, the following thematic areas were represented and each theme was explored in terms of studies that were focused on that theme and also the gaps in the literature.

Articles on the role of the marula tree in livelihoods and income generation

The articles under this theme concentrated on the roles played by the marula tree in the enhancement of livelihoods.

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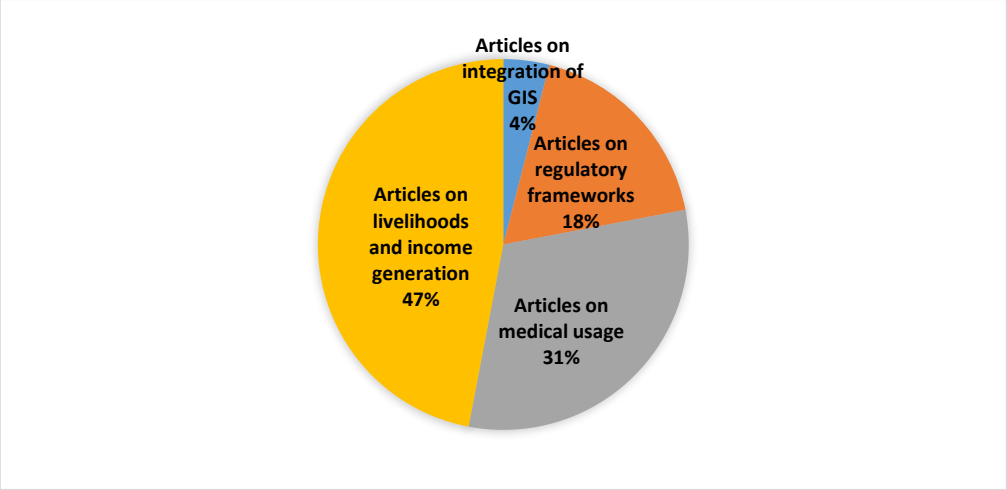

Figure 3: *Thematic areas of the marula tree articles.*

In Figure 3, the articles accounted for 49% of the total number of publications authored. There has been a great deal of research on the role that the marula tree plays in rural development, but much of it consists of how commercialisation can aid the development of livelihoods and reduce poverty. According to Marshall *et al*. (2006), the role and the contribution of NTFPs to communities has been researched greatly. This amount of research is thought to have been driven by the opinion raised in the 1980s stating that harvesting of NTFPs like marula fruit does not destroy the environment as much as timber harvesting would (Myers, 1988). Non-farm activities are considered a diversification of livelihoods and part-time employment for a majority of people residing in marginal lands (Sanchez, 2005).

The NTFP sector absorbs surplus labour in rural communities and helps communities cope with risks when farming fails (Gordon *et al*., 2001). In light of such evidence, it is clear that NTFPs have always been an important sector in reducing the rate of unemployment for rural communities. This has led to the continual use of the marula tree as a livelihood option. In marginal lands, people's livelihoods are based on land activities such as crop cultivation, livestock production, and harvesting of NTFPs (Shackleton *et al*., 2001). In essence, NTFPs can help diversify rural livelihoods and promote environmental sustainability whilst enhancing the social and economic capital of rural communities (Hebinck, *et al*., 2018). The Food and Agricultural Organization (FAO, henceforth) (2015) reports that 80% of people in transitional economies rely on NTFPs for their health and nutritional needs.

Ngorima (2006) indicated that communities living in the Zvishavane District of Zimbabwe began the commercialisation of marula in 2004 as a livelihood strategy through the sale of pressed oil and marula kernels. Therefore, the commercialisation of marula trees can play a significant role in alleviating poverty and improving food security and nutrition levels (Murye, 2017). The commercialisation of the marula tree not only increases the Gross Domestic Product (GDP) of a country, but also provides employment opportunities. In the past few decades, the tree has increasingly gained popularity in the international market due to demand for its many value-added -products like marula oil and the well-known Amarula cream liqueur (Wynberg *et al*., 2002). Thus, the sector can be boosted by adopting a more robust approach to product development. Trade in marula products is one of the principal income-generating projects for communities in Southern Africa (Campbell *et al*., 1997). In Eswatini, it has become a norm that during the marula season, people go out to harvest marula fruits and seeds (Murye & Pelser, 2018). This offers them a livelihood option hence they gain an income that helps them meet their daily needs.

Authors like Shackleton *et al.,* (2004) observed that the marula season comes at a critical time when schools are opening and money

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is required to pay school fees and purchase stationery (Murye, 2017). Lawes *et al*., (2004) reported that in South Africa, an average of 2000 tons of marula fruits are processed into liqueurs, 500 tons into fruit juice, and 40, 000 bottles of marula jelly are produced per annum. A study by Mariod and Abdelwahab (2012) found that the marula tree can be used to produce different varieties of beer. In South Africa, marula harvesters who supply raw fruits and kernels to large commercial enterprises gain an annual value that amounts to about R1.1 million (Wynberg *et al*., 2002; Shackleton, 2003). The biggest attraction to trading on marula besides income generation is its low labour needs during harvesting as the fruits are picked from the ground when ripe (Nghitoolwa *et al*., 2003).

The role of the marula tree in medicine

This theme is one of the central drivers of progress in the number of articles on the marula tree accounting for 31% of the articles in this paper (Figure 3). Recent years have seen a major revival in the importance of traditional medicine in Southern Africa attracting researchers both locally and internationally to explore botanic resources and the marula tree has been one of the major ones (Street, 2013). This has increased the number of publications in the natural science discipline. According to Ojewole *et al*. (2009), the marula tree is one of the most valued trees in Southern Africa as it possesses several ethno-therapeutic and pharmaceutical properties. Biomedical literature has discovered the presence of chemical constituents that are medically essential (Ojewole *et al*., 2009). Marula bark, roots, and leaves are mixed with other medicinal plants by traditional healers to treat various illnesses such as syphilis, leprosy, dysentery, hepatitis, rheumatism, gonorrhoea, diabetes, and malaria (Van *et al*., 2002). Roots and leaves can be used to treat menstrual problems, tooth pain, and ulcers (Kugedera, 2014). Based on a study by Kugedera (2014), the marula tree has a wide range of medicinal uses which are mostly principled to diseases such as dysentery, cold cough, and ulcers. The challenge is that the value of most NTFPs as medicine is based on the local knowledge system. Most of the NTFPs have not been registered and analysed by medical doctors and approved as medicine. Hence, there is a need for governments to sponsor additional research to establish the efficacy and safety of these plants as alternative options to manage diseases.

Management options for marula tree

Research on studies related to this theme accounted for 18% of the research articles. According to Sinthumele *et al*., (2019), communities in Southern Africa have a vested interest in conserving the marula trees mainly due to their socio-cultural significance. Traditional leaders in many areas have been the chief managers of the marula tree and rural communities have respected that (Arnold & Ruiz 2001; Michon 2005). The study by Wynberg and Laird (2007) in Namibia concurs that traditional leadership is vital in the management and conservation of marula trees. The role of government is seen mainly as that of providing enforcement (Katerere *et al*., 2000). However, due to little knowledge or lack of research on this theme community participation in the management of the marula tree remains relatively low in the region (Ngorima, 2006). The results of the study by Ngorima (2006) showed that for Zvishavane, in Zimbabwe most of the collectors were not aware of the rules and regulations on the harvesting of the marula tree. There is also a lack of general clarity on who is responsible for controlling NTFPs from extraction to marketing. According to Murye (2017), Swaziland has no specific policies or legal frameworks that regulate the access to, harvesting of, and sustainability of marula. Literature reveals that policies for the management of the marula tree in the region are old and outdated and are usually kept under different custodians (Ngorima, 2006; Wynberg & Laird, 2007; Murye, 2017). In Southern Africa, there is generally no coordination as policies overlap and that complicates implementation due to conflicting jurisdictions and roles for state agencies (Pandey *et al*., 2016). As the marula tree gains interest in the international market, there is a need for governments in the region to put down effective policies to manage the resource sustainably for the benefit of communities in marginal lands that depend on the marula tree.

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Integrating Geographical Information Science (GIS) and Remote Sensing in Predicting the Marula Tree Populations

In the literature search, the researchers came across only 4% of the articles that had integrated GIS and remote sensing in the management of the marula tree. Southern Africa is predicted to be severely impacted by climate change (Morton, 2007; Thornton *et al*., 2009) as mean global temperatures are forecasted to rise in the range of 1.0-3.7°C based on the Representative Concentration Pathway (RCP) selected (Intergovernmental Panel on Climate Change, 2014). However, research on projecting the potential habitat distribution of the marula tree in the region is lagging (Jinga *et al*., 2022). The global increases in temperatures may drive some plants like the marula tree to extinction.

Studying the response of the marula tree to future climate scenarios may help curb the effects of climate change on populations and help secure the livelihoods that are dependent on the marula tree. Several studies have looked at the impact of fire, elephants, and overharvesting on the marula tree (Jacobs *et al*., 2002; Cook *et al*., 2017; Endress *et al.*, 2006). However, only a few studies have infused the effects of climate change based on RCPs. The incorporation of GIS and remote sensing is critical in long-term planning in the management of the marula tree. Mapping the current distribution and modelling the suitable habitat has an immense contribution to policy-makers, foresters, and environmentalists who manage the marula tree utilization. There is, therefore, a need for approaches that reflect on current sustainability and how climate may affect the future distributions of the marula tree (Pulido & Caballero, 2006).

CONCLUSIONS AND RECOMMENDATIONS

A collection of 189 peer-reviewed papers, desertions, books, and unpublished articles were captured and reviewed as a representative sample of marula literature in Southern Africa. Literature showed that the marula tree forms an integral part of livelihoods and plays a central role in marginal lands of Southern Africa in terms of supplying food, and medicine and contributing to incomes. The literature reviewed in this paper reveals that the use of marula tree products in Southern Africa is a process that is recently gaining momentum and has the potential of offering a good livelihood option to several families that otherwise would have no source of income. The rising interest in commercialising the marula tree has also sparked a rapid increase in scientific research. Based on the reviewed literature, the region requires appropriate regulatory frameworks at the country level to promote harvesting and processing techniques that will empower people living in marginal areas.

The results of the literature review also showed that studies that integrate GIS and remote sensing in the management of the marula tree are still sporadic in the region hence, the need for the governments to deliberately support studies that reflect on current sustainability and how climate changes may affect the future habit distributions of the marula tree. There are, however, several challenges to the utilisation of the marula trees which include limited capacity within rural areas for value addition, lack of processing and storage equipment and poor knowledge of the policy incentives essential to accord higher priority to the marketing and processing of NTFPs. Above all degradation and deforestation levels could alter tree populations leading to failure to sustain the marula industry. Improved processing, storage and value-addition facilities should be developed to generate added value, reduce production costs and improve quality to meet international standar

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