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Article

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MANAGEMENT | RESEARCH ARTICLE

The role of technology adopted by Agricultural Marketing Cooperative Society (AMCOS) on performance of grapevine farmers in Tanzania

Fatuma Ndauka¹ and Salum Matotola^{2*}

Abstract: This paper examines the roles of technology adopted by AMCOS and its influence on performance of farmers under CHABUMA and UWAZAMAM AMCOS in Dodoma Tanzania. The study adopted a cross-sectional research design and performance was measured by considering the Return on Investment (ROI) and profit. The survey method was employed, and a questionnaire tool was adopted for data collection from 167 grapevine farmers from CHABUMA and UWAZAMAM AMCOS. Results revealed that there is a significant influence of technology adopted on performance of farmers at a 5% level of significance ($p < 0.05$), especially in the aspect of availability, accessibility, and utilization. However, in regression analysis, availability of technology significantly and negatively influences the performance of farmers thus, as the farmers failed to have adequate technology their performance will not be improved. Nevertheless, the utilization and accessibility of technology influence positively the performance of farmers and mostly occurred by considering

ABOUT THE AUTHOR

Salum Matotola is an accomplished lecturer at the University of Dodoma in Tanzania with over 10 years of experience in teaching, research, and consultancy activities. He holds a Bachelor's degree in Food Science and Technology, a Master's degree in Business Administration-Agribusiness, and a Ph.D. in Entrepreneurship. His areas of expertise include business management, marketing, entrepreneurship, project planning, implementation, and management. He has contributed significantly to the academic field by publishing journal articles and manuscripts for students. He has also participated in research and consultancy projects with various organizations and institutions. His vast experience and expertise have earned him various leadership positions, including the Head of the Department of Business Administrations and Statistics, and later the Head of the Department of Marketing and Entrepreneurship from 2016-2019. Currently, Dr. Matotola serves as the Postgraduate and Research Coordinator at the College of Business and Economics at the University of Dodoma in Tanzania.

PUBLIC INTEREST STATEMENT

To ensure that grape farmers have a high yield, it is advisable to operate under the Agricultural Marketing Cooperative Society (AMCOS). This will provide them with access to markets, information, and technology. While technology is an important factor in the performance of farmers, the accessibility of technology has a little influence on their performance. Therefore, it is essential to provide farmers with easy-to-access technology to improve their productivity. In conclusion, technology is crucial in enhancing the productivity of farmers, and it is vital to ensure that they have easy access to affordable and user-friendly technology. Further research is necessary to explore other factors that affect the performance of farmers and how technology can be integrated with other approaches to enhance their productivity. The implications of this study suggest that stakeholders should continue to invest in technology to support farmers and improve their livelihoods.



aggregate results than individual cases. Hence once the technology is available, utilized, and accessible to farmers, their performance will be improved. Inclusion of technology in grapevine production resulting to improved performance of farmers. This study contributes to the inclusion of technology on grapevine production from preparation up to the post-harvest stages whereby performance of farmers will be improved.

Subjects: Agricultural Development; Technology; Management of Technology; Marketing; Administration and Management

Keywords: AMCOS; grapevine; technology; performance

1. Introduction

It is well known that technology is a major source of growth in agricultural production (Mailena et al., 2021). The growth of agricultural production led to the recognition of the role of technology on supporting sustainable production with respect to population growth, inadequate agricultural resources in terms of quality and quantity, climate change, and switches in consumer preferences. According to Rehman et al. (2016) agricultural technology is considered among the most innovative and impactful areas of up-to-date technology which improves agricultural production significantly and sustainably. Also, technology in agriculture has several contributions namely, feeding the world, reduction of negative environmental impacts as well as mitigating climate change (Gaffney et al., 2019). Furthermore, technology had been received improves notable attention in recent years following a change in demand from consumers and producers of food and other products as well as services provided by the agriculture sector (Food and Agricultural Organisation [FAO], 2017).

Thus, the progress in the agricultural sectors has contributed to an increment in food production, particularly since the start of the Green Revolution in the early 1950s (Evenson & Gollin, 2003). However, the dissemination of agricultural technologies differs significantly across various regions and farming systems (Zhang et al., 2020). Studies by Abebe et al. (2013) and Pamuk et al. (2014) exposed that smallholder farmers in several African and Asian countries have relatively low adoption rates of agricultural technologies which prohibits them to benefit from agricultural production and livelihood improvement (Abebe et al., 2013). The consequence of low rates of technology adoption results in food insecurity and limits poverty alleviation since agriculture is considered the pillar of the local economies and essential for food security in smallholder agricultural systems (De Janvry & Sadoulet, 2002).

Among the primary reason behind the low adoption rate of technology in smallholder agricultural systems is the high transaction costs involved in accessing new technologies (Feleke & Zegeye, 2006; Ma et al., 2018; Pamuk et al., 2014; Valentinov, 2007). These include the costs of searching for the appropriate technology to adopt, costs of negotiating with suppliers of new technologies, and contract performance. All these costs are considered to be high for smallholder farmers whereby majority are not well-informed about new technologies and leading to being in a weak position to negotiate the prices with the sellers or suppliers. This in turn affects negatively market participation decisions of smallholder farmers and agricultural production following the higher transaction costs. In addressing the high costs farmers' cooperatives which also termed agricultural cooperatives become essential means which is used to economize the costs following it's promotion and experience in various developing countries (Francesconi & Heerink, 2011; Ito et al., 2012; Ma & Abdulai, 2017; Verhofstadt & Maertens, 2014). The evidence indicates that farm cooperatives can collectively purchase production inputs, provide technical assistance to their members as well as contribute to a reduction in transaction costs (Zhang et al., 2020).

The cooperative concept was established during the 19th century in Europe and North America (International Cooperative Alliance [ICA], 2015). Farmer's cooperatives such as the Agricultural Cooperative Society (AMCOS) are considered among the type of cooperatives introduced to support small agricultural producers (ICA, 2015). Farmers' cooperatives improve members economically and socially and generate rural employment through business models that are flexible to economic and environmental shocks (Food and Agricultural Organisation [FAO], 2012). Moreover, the study conducted by Rwekaza and Muhihi (2016) exposed that cooperatives are the potential model for rural development and empowerment by capturing agricultural mechanization, income-generating tools, agricultural input supports and developing good governance mechanisms.

Globally, the importance of cooperatives owned by members and controlled social economic institutions is considered more essential in the current economic era (Kimario, 2018). In developed countries for instance Spain, AMCOS had been acknowledged for their important contribution in food production and distribution systems, ensuring the sufficient distribution of farm produce to final consumers thus, the farmers tend to use their AMCOS as a central coordinator between producers and consumers (Giagnocavo et al., 2018). In developing countries such as Tanzania and other African countries, co-operatives in agriculture have been the dominant sector mainly focused on cash crops for export such as coffee, cotton, cashew nuts, tea, and tobacco (Anania et al., 2020). Among the roles played by AMCOS include being the main channel for the provision of marketing services for smallholder farmers, being a voice to the poor policy-making making structures, being innovative to ensure member incomes and benefits improved such as by linking producers and consumers, and facilitates social welfare (Sizya, 2001). Others include employment creation, facilitation of financial services to farmers, education supports to members and non-members, and enhancing women and youth participation in AMCOS.

Also, AMCOS empowers members by improving their livelihoods and enhancing their economic opportunities through self-help, improving production, processing, marketing and distribution of agricultural products (Odigbo, 1998). Other supports include the distribution of credit, fertilizers, and procurement of farm produce for national food stocks (Khumalo, 2014; Maghimbi, 2010). Additionally AMCOS supports marketing, agro-processing, warehousing activities, and assists members to boost their production and income by sharing resources and hence collective provisions of services and economic empowerment (Prakash, 2000). Other roles include the purchase and sale of agricultural inputs and equipment, purchase, storage and subsequent sale of agricultural commodities and transport services (Piesse et al., 2005). Despite the supports of AMCOS, performance of its members specifically farmers is not good.

Although various scholars addressed the performance of AMCOS, their studies focused mostly on social and economic contribution and downplayed the role of other factors concern performance of grapevine farmers. Additionally, the studies focused on cash crops products such as coffee (Anania & Rwekaza, 2016), cotton, cashew nuts, coffee and tobacco (Sizya, 2001), and cashew nut (Likwata & Venkatakrishnan, 2014). The needs to focus on grapevine farmers are based on the fact that, grapes are considered as among the major fruit crops with economic importance in Tanzania (Kulwijila et al., 2018). Other studies focused on inadequate farm inputs including technology in general. Based on that, the current study determines availability, accessibility and utilization of technology adopted by AMCOS and its influence on performance of grapevine primary producers under two AMCOS at Dodoma region in Tanzania as commented by Toroitich et al. (2020). According to Toroitich et al. (2020) there is a relationship between availability, access and utilization of agricultural extension technologies on the food security of smallholder farmers, the current study is focused on AMCOS and performance of grapevine farmers.

2. Theoretical framework

In determining the influence of technology adopted on performance of farmers by using availability, accessibility, and utilization, the theoretical framework of efficiency was applied since it explains optimization of producer behavior as commented by Sardar Shahraki et al. (2018).

According to Osborne and Rubinstein (2020), producer like consumer has a role to play in economic models. While consumer can trade and change distribution of goods among the agents in the economy, producer on the other hand can change the availability of goods, transforming inputs into outputs. Based on that, the optimizing a production which is the outputs and hence reflect performance, two directions can be looked upon namely, profit seeking and the other cost minimization (Shahraki et al., 2018). To ensure performance of AMCOS, members who are the producer will use technology adopted (available and accessible) and transform into outputs (utilization). The amount and type of inputs to be used is determined by the decision of producer which reflect the expected outputs. According to Osborne and Rubinstein (2020), many producers are not individuals rather organizations such as collectives, families, or firms. These organizations have typical hierarchical structures and mechanism in decision making. In this study CHABUMA and UWAZAMAM AMCOS management by using their skills are responsible to capture agricultural mechanization, income-generating tools, provision of agricultural input supports and developing good governance mechanisms. In doing so, AMCOS management tend to support the producer behavior on optimization which in turn influence performance of farmers by reducing unnecessary costs and increasing profitability.

3. Materials and methods

A cross-sectional research design was adopted in the study whereby the AMCOS members' i.e. farmers were involved at once, at a time, and unable to make the generalization of the findings. The cross-sectional design allows data to be collected at one point in time and also economical in terms of time, to conduct the study and able to estimate the outcome of the sample collected from the population of interest (Levin, 2006). In the selected cross-sectional design there are some limitations sometimes happening in the study. Among the expected limitation, include the availability of farmers for interviews as a researcher was not sure on the presence of farmers during the study. To counter this limitation, the researcher made a contact in advance with farmers and their AMCOS leaders finally to get the desired targeted sample and hence the interviews were conducted with the respondents.

A total of 167 farmers 66 from UWAZAMAM and 101 from CHABUMA AMCOS were interviewed. The questionnaire used during the survey had both open and closed-ended questions concentrated on the technology availability, accessibility, and utilization, and performance of farmers under each AMCOS. In addressing performance, in this paper Return on Investment (ROI) and Profit were employed as documented by Bengesi and Le Roux (2014). In order to capture the performances of farmers, among questions asked include expenses and variable costs, total sales made and income earned per unit sale of grapes, investment costs, and average total assets values of the farmers. Generated responses were used as inputs for computation of the performance measures namely return on investment (ROI), and profit. On the other hand availability, accessibility, and utilizations of technology was measured as proposed by Toroitich et al. (2020), whereby a Likert scale from 1–5 from strongly agree to strongly disagree was employed.

4. Data collection

Questionnaires were distributed randomly to farmers from UWAZAMAM and CHABUMA AMCOS and were told to fill and return, i.e., self-administered questionnaires. The researcher manager to collect information from 167 responses. Additionally, the information from 167 responses was recorded into different variables.

5. Confirmatory factor analysis, reliability and validity

Prior to conducting further analysis, confirmatory factor analysis (CFA) and the reliability test was conducted as commented by Ochoa Pacheco et al. (2023). Results concerning CFA indicate the data meet the specifications whereby CFI = 0.974; GFI = 0.951; NFI = 0.951; TLI = 0.958; RMSEA = 0.079 [90% CI: 0.040–0.116] and all factor loadings were statistically significant ($p = 0.007$). In addition Table 1 shows indicator variables, latent variables, and standardized loadings whereby the composite probability (McDonald Omega) (ω) coefficient estimates were satisfactory for all variables which is greater than 0.7 as commented by Considine et al. (2005).

Table 1. Reliability statistics

| Indicator Variables | Latent Variables | Standardized loadings | Square Standardized Loadings (A) | Measurement Error (1-A) | Sum of the Measurement Error (E) | Sum of the Standardized Loadings (B) | Square of the Sum of the Standardized Loadings (C) | C+E | Composite Reliability (ω) C/(C+E) |
|---------------------|--------------------------------|-----------------------|----------------------------------|-------------------------|----------------------------------|--------------------------------------|--|----------|--|
| TECHAV1 | ← Type of technology | 0.809 | 0.654481 | 0.345519 | | | | | |
| TECHAV2 | ← Quantity of technology | 0.778 | 0.605284 | 0.394716 | | | | | |
| TECHAV3 | ← Quality of technology | 0.627 | 0.393129 | 0.606871 | 1.347106 | 2.214 | 4.901796 | 6.248902 | .784425168 |
| TECHUT1 | ← Attitudes towards technology | 0.635 | 0.403225 | 0.596775 | | | | | |
| TECHUT2 | ← Intended work | 0.800 | 0.640000 | 0.360000 | | | | | |
| TECHUT3 | ← Intensity of technology | 0.804 | 0.646416 | 0.353584 | 1.310359 | 2.239 | 5.013121 | 6.32348 | .792778818 |
| TECHAC1 | ← Usage rate | 0.909 | 0.826281 | 0.173719 | | | | | |
| TECHAC2 | ← Technology affordability | 0.918 | 0.842724 | 0.157276 | 0.330995 | 1.827 | 3.337929 | 3.668924 | .909784177 |

Furthermore, the study conducted the validity test to determine whether the measure is measured what is intended (Field, 2005). In addition, validity explains the way data have been collected and covers the actual area of investigation (Ghauri et al., 2020). To ensure the validity of the study, triangulation methods have been adopted whereby interviews with managers and survey questionnaires with farmers had been conducted. Also, simple random sampling has been employed in the selection of farmers to ensure that everyone had an equal chance to participate. Additionally, a pilot study has been conducted on the related grape farmers producing group namely UWAZAMAH AMCOS located at Hombolo in Dodoma region, the responses from farmers and managers helped the study to improve the research tools prior the actual data collection.

6. Results and discussion

From the interview conducted with AMCOS managers, it had been exposed that, the technology available at UWAZAMAM is a value-additional technology for processing the grapevine into juice recipes before converted into wine which is a final product. Plate 1 shows UWAZAMAM Grape Juice Processing Plant. According to UWAZAMAM AMCOS management, despite the adoption of the technology they failed to get authority to produce the wine. Thus currently, they are looking for financial and institutional support to ensure their grapevine processing plant is authorized to proceed with wine processing since they have such capacity from materials and resources.

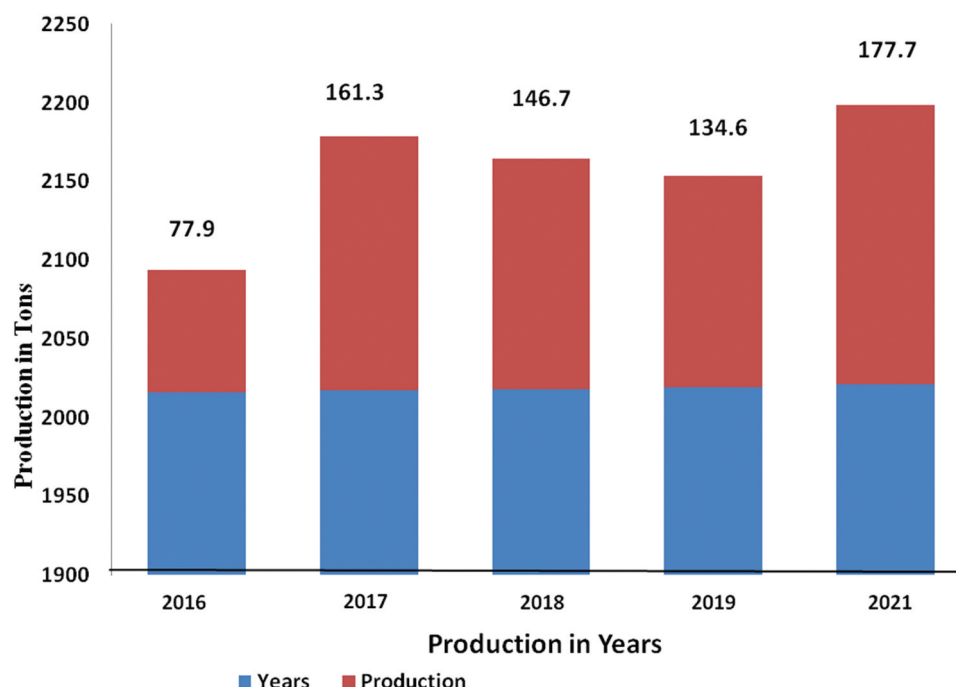
Having assurance on value addition by processing grapevine into juice and wine, enabled the AMCOS to boost the grapevine production and hence improve performance of farmers as depicted in Figure 1. According to Figure 1, the production trend of UWAZAMAM AMCOS had increased from 77.9 to 177.7 tons from 2016 to 2021 respectively following the introduction of processing activities. However, in the years 2018 and 2019 grapevine production declined following inadequate rainfall (irrigation technology is not accessible) as UWAZAMAM applied rain-fed technology and hence affect the performance of farmers. Thus, irrigation cost-effective technology should be in a place to ensure availability of water for irrigation purposes all the time.

Plate 1. UWAZAMAM grape juice processing plant.



Figure 1. Production trend of grapes from UWAZAMAM AMCOS.

Source: (UWAZAMAM Profile, 2021).



While CHABUMA AMCOS management during the interview the AMCOS leader commented that ...

... The technology available and adopted by CHABUMA AMCOS is irrigation which has some more extra operating costs to run since the machine tend to use electricity to pump water for grapevine irrigation from bore hole to the farm and hence affect their performance. According to him, the best approach is to look for alternative user friend technology and hence their performance will be improved. See [Plates 2 and 3](#).

Despite availability of irrigation technology, CHABUMA AMCOS grapevine farmers faced some challenges in their grapes production leading to declining in grapevine production. According to the management, production trends were 50 to 22.7 tons from the year 2011–2017 respectively and results revealed that the year 2011 to 2013 performances was good. The highest production has been experienced in the year 2013, however, the production declined from the year 2014–2017 as depicted in [Figure 2](#).

Plate 2. Pump house to support adopted irrigation technology by CHABUMA AMCOS.

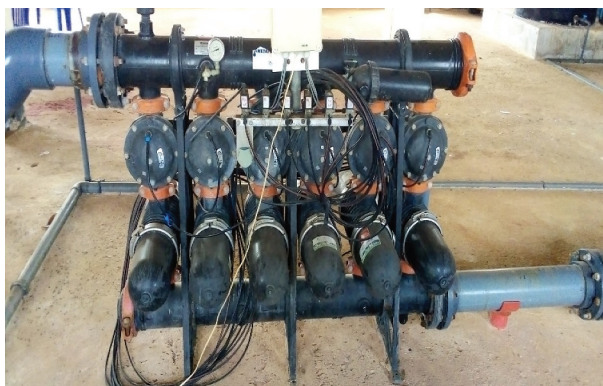


Plate 3. Dam used for irrigation of grapevine adopted by CHABUMA AMCOS.



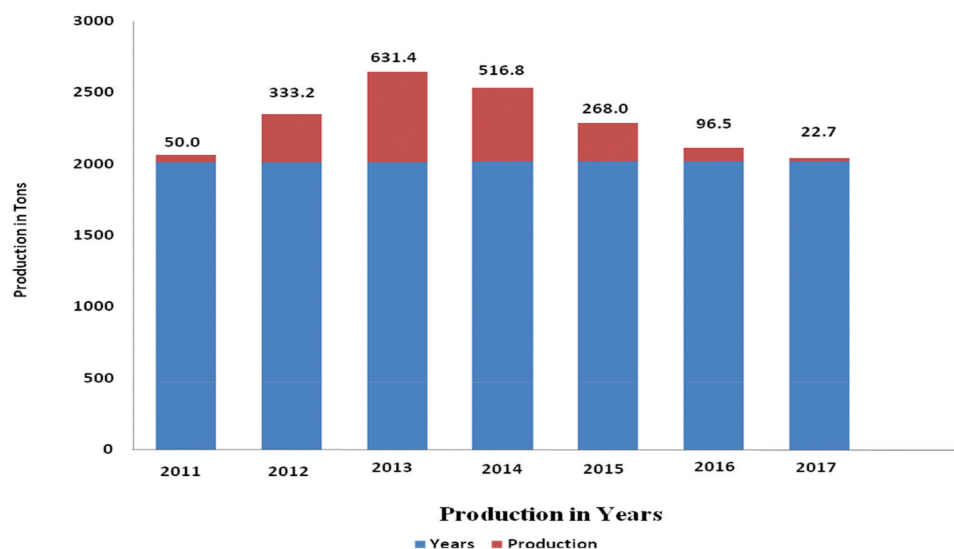
Among the reasons behind declination in the production of grapevine include the high operating cost of available irrigation technology by the AMCOS which in turn affected other farm and crop management, and hence the production of grapevine decreased tremendously. The AMCOS should seek alternative sustainable energy technology or any other cost-effective technology to improve performance of their grapevine farmers.

Before determining the influence of adopted technology on performance of grapevine farmers, correlation analysis was conducted to determine the association between the variables in the study. Correlation analysis is important to determine the relationship between two (2) variables whereas any changes in one variable tend to affect other variables (Schober et al., 2018). Detailed correlation analysis expresses the relationship between the type of technology available, utilization and accessibility technologies, and performance of grapevine farmers in terms of ROI and profit, as depicted in Table 2. In addition, correlation analysis between variables is addressed by using Karl Person's Coefficient, commonly known as Pearson Moment Method (Sadiku-Dushi, Dana, and Ramadani, 2019). While technology availability was measured using type, quality, and quantity of technology; utilization involved attitudes and experience, intended work, the intensity of technology; and accessibility addressed by considering the usage rate (ease to use, etc.), needs and skills level, cost (affordability) (Karamti, 2016) and (Sey et al., 2015).

The major aim of this paper is to address the influence of adopted technology by AMCOS on performance of grapevine farmers. Table 2 shows that the Pearson correlation between the type of

Figure 2. Production trend of grapes from CHABUMA AMCOS.

Source: (Chamwino DC Profile, 2020).



| Table 2. Correlation analysis | | | | | | |
|-------------------------------|---------------------|-------------|-----------|------------|---------|---------|
| | | Techn_avail | Tech_util | Tech_acces | PROF | ROI |
| Techn_avail | Pearson Correlation | 1 | .278** | .276** | -.215** | -.230** |
| | Sig. (2-tailed) | | 0.000 | 0.000 | .005 | 0.003 |
| | N | 167 | 167 | 167 | 167 | 167 |
| Tech_util | Pearson Correlation | .278** | 1 | .293** | -.256** | -.231** |
| | Sig. (2-tailed) | .000 | | .000 | .001 | .003 |
| | N | 167 | 167 | 167 | 167 | 167 |
| Tech_acces | Pearson Correlation | 0.276** | 0.293** | 1 | -.0153* | -.0187* |
| | Sig. (2-tailed) | .000 | .000 | | .048 | .015 |
| | N | 167 | 167 | 167 | 167 | 167 |
| PROF | Pearson Correlation | -.215** | -.256** | -.153* | 1 | .942** |
| | Sig. (2-tailed) | 0.005 | 0.001 | 0.048 | | 0.000 |
| | N | 167 | 167 | 167 | 167 | 167 |
| ROI | Pearson Correlation | -.230** | -.231** | -.187* | .942** | 1 |
| | Sig. (2-tailed) | 0.003 | 0.003 | 0.015 | .000 | |
| | N | 167 | 167 | 167 | 167 | 167 |

Notes: **. Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

available technology, utilization, and accessibility is significant at 0.01 and 0.05 with the performance of grapevine farmers in terms of profit and ROI. This means the available technology is currently accessed and utilized by grapevine farmers which influence performance of farmers.

In determining the causal-effect relationship, results from Tables 3 and 4 show that there is a significant influence ($p < 0.001$) in terms of availability, accessibility, and utilization of technology on the performance of farmers under both CHABUMA and UWAZAMAM AMCOS. Meaning that despite the challenge faced by the technology adopted there is a relationship between the technology currently used by farmers and the Return on Investment (ROI) and profit generated by farmers through their AMCOS. These results to some extent exposed that, if AMCOS for instance CHABUMA can manage to reduce some operating costs, their performance can be improved. On the other hand, despite the usage of rain-fed technology by UWAZAMAM AMCOS, adoption of value-addition technology improve their return on investment (ROI) and profit generated by farmers. Therefore, introduction of cost-effective technology probably can boost the performance of farmers beyond the current form.

In a subsequent section, the regression analysis was conducted to see the causal-effect relationship involving technology availability, accessibility, and utilization against the performance of farmers by using ROI and profit. According to Table 5, there is a significant relationship between technology availability and utilization ($p < 0.05$) and the performance of farmers (ROI) while technology access has not significantly influenced the performance of farmers ($p > 0.05$). Hence, there is a need to ensure that despite availability and utilization the technology should be accessible to farmers aiming to improve their performance. Therefore access to technology is a necessary attribute for the significant performance of farmers from both CHABUMA and UWAZAMAM AMCOS.

Results from Table 5 and Table 6 indicate a negative relationship between dependent and independent variables.

Table 3. Influence of technology on performance of farmers using ROI

ANOVA^a

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|------------|----------------|-----|-------------|-------|--------------------|
| Regression | 6468.795 | 3 | 2156.265 | 5.541 | 0.001 ^b |
| Residual | 63428.267 | 163 | 389.130 | | |
| Total | 69897.062 | 166 | | | |

Notes: a. Dependent Variable: ROI

b. Predictors:(Constant), Tech_avail, Techn_util, Tech_access.

Table 4. Influence of technology on performance of farmers using profit

ANOVA^a

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|--------------|--------------------|------------|-------------|-------|--------------------|
| Regression | 2.25016E+15 | 3 | 7.50053E+14 | 5.476 | 0.001 ^b |
| Residual | 2.23244E+16 | 163 | 1.36959E+14 | | |
| Total | 2.45745E+16 | 166 | | | |

Notes: a. Dependent Variable: PROF b. Predictors:(Constant), Tech_avail, Techn_util, Tech_access.

Table 5. Influence of technology on performance of farmers using ROI

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|--------------|-----------------------------|------------|---------------------------|--------|---------------|
| | B | Std. Error | Beta | | |
| (Constant) | 37.606 | 7.102 | | 5.295 | 0.000 |
| Techno_avail | −5.726 | 2.857 | −0.159 | −2.004 | 0.047* |
| Techn_util | −5.992 | 3.023 | −0.158 | −1.982 | 0.049* |
| Tech_acces | −5.419 | 4.170 | −0.103 | −1.300 | 0.196 |

Notes: a. Dependent Variable: ROI *=Significant (at p=0.05).

Table 6. Influence of technology on performance of farmers using profit

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|-------------|-----------------------------|-------------|---------------------------|--------|---------------|
| | B | Std. Error | Beta | | |
| (Constant) | 21072231.075 | 4213328.920 | | 5.001 | 0.000 |
| Technoavail | −3053588.666 | 1694804.291 | −0.143 | −1.802 | 0.073 |
| Techutil | −4489656.880 | 1793376.058 | −0.199 | −2.503 | 0.013* |
| Techacces | −1937244.449 | 2473754.146 | −0.062 | −0.783 | 0.435 |

Notes: a. Dependent Variable: PROF *=Significant (at p=0.05).

Since the regression Coefficients indicate a negative relationship, a transformation of data (dependent variables) has been conducted. According to Murtaugh (2007) when y depends on x transforming data and analyzing them with the least square is adequate in statistical analyses. Results from Tables 7 and 8 show that there is a significant influence ($p < 0.001$) in terms of availability, accessibility, and utilization of technology on the performance of farmers under both CHABUMA and UWAZAMAM AMCOS. Meaning that there is a relationship between the technology currently used by farmers and the Return on Investment (LnROI) and (LnPROFIT) generated by farmers through their AMCOS.

After the transformation of data, Table 9 depicted that, there is a significant relationship between technology availability, utilization, and accessibility ($p < 0.05$) and the performance of farmers (LnPROF). Results from Table 9 revealed that if the technology availability failed to be improved by 1 unit, performance of farmers tends to decrease by 0.211 units while improvement of technology utilization by 1 unit, the performance of farmers tends to increase by 0.295 units, while an improvement on the access to technology by 1 unit, the performance of farmers tends to increase by 0.496 units as presented in the linear regression model below.

Table 7. Influence of technology on performance of farmers using LnProfit

ANOVA^a

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|------------|----------------|-----|-------------|--------|--------------------|
| Regression | 14.528 | 3 | 4.843 | 46.087 | 0.000 ^b |
| Residual | 17.128 | 163 | 0.105 | | |
| Total | 31.656 | 166 | | | |

Notes: a. Dependent Variable: LnPROF

b. Predictors: (Constant), Technoavail, Techutil, Techacces

*=Significant (at p=0.001).

Table 8. Influence of technology on performance of farmers using LnROI

| | ANOVA ^a | | | | |
|------------|--------------------|-----|-------------|--------|--------------------|
| Model | Sum of Squares | df | Mean Square | F | Sig. |
| Regression | 11.398 | 3 | 3.799 | 32.205 | 0.000 ^b |
| Residual | 19.229 | 163 | 0.118 | | |
| Total | 30.627 | 166 | | | |

Notes: a. Dependent Variable: LnROI

b. Predictors: (Constant), Technoavail, Techutil, Techacces

*=Significant (at p=0.001).

Table 9. Influence of technology on performance of farmers using profit

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|-------------|-----------------------------|------------|---------------------------|--------|---------------|
| | B | Std. Error | Beta | | |
| (Constant) | 0.331 | 0.102 | | 3.235 | 0.001 |
| Technoavail | -0.077 | 0.024 | -0.211 | -3.243 | 0.001* |
| Techutil | 0.124 | 0.038 | 0.295 | 3.266 | 0.001* |
| Techacces | 0.216 | 0.041 | 0.496 | 5.243 | 0.000* |

Notes: a. Dependent Variable: LnPROF *=Significant (at p=0.05).

$$\text{Performance of Farmers} = \beta_0 - \beta_1 \text{Techavail} + \beta_2 \text{Techutil} + \beta_3 \text{Techacces} + e \quad (1)$$

In addition, after the transformation of data, Table 10 depicted that, there is a significant relationship between technology availability, utilization, and accessibility ($p < 0.05$) and the performance of farmers (LnROI) ($p > 0.05$). Results from Table 10 revealed that if the technology availability failed to be improved by 1 unit, performance of farmers tends to decrease by 0.262 units while improvement of technology utilization by 1 unit, the performance of farmers tends to increase by 0.222 units, while an improvement on the access to technology by 1 unit, the performance of farmers tends to increase by 0.499 units as presented in the linear regression model.

$$\text{Performance of Farmers} = \beta_0 - \beta_1 \text{Techavail} + \beta_2 \text{Techutil} + \beta_3 \text{Techacces} + e \quad (2)$$

Hence, results from Tables 9 and 10 indicate that there is a need to ensure that technology should be available, utilized, and accessible to farmers aiming to improve their performance. Therefore

Table 10. Influence of technology on performance of farmers using ROI

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|-------------|-----------------------------|------------|---------------------------|--------|-------|
| | B | Std. Error | Beta | | |
| (Constant) | 0.536 | 0.109 | | 4.940 | 0.000 |
| Technoavail | -0.095 | 0.025 | -0.262 | -3.745 | 0.000 |
| Techutil | 0.092 | 0.040 | 0.222 | 2.277 | 0.024 |
| Techacces | 0.214 | 0.044 | 0.499 | 4.898 | 0.000 |

Notes: a. Dependent Variable: LnROI *=Significant (at p=0.05).

Table 11. Influence of technology on performance of farmers using PROFIT

Coefficients^a

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|----------------------|-----------------------------|------------|---------------------------|--------|---------------|
| | B | Std. Error | Beta | | |
| (Constant) | 2.410 | 0.266 | | 9.070 | 0.000 |
| Type | 0.059 | 0.062 | 0.073 | 0.954 | 0.342 |
| Quantity | −0.245 | 0.062 | −0.270 | −3.972 | 0.000* |
| Intended work | 0.294 | 0.072 | 0.335 | 4.109 | 0.000* |
| Intensity | 0.182 | 0.081 | 0.191 | 2.255 | 0.025* |
| Usage rate | 0.043 | 0.098 | 0.049 | 0.438 | 0.662 |
| Afford | 0.155 | 0.098 | 0.177 | 1.583 | 0.115 |

Notes: a. Dependent Variable: PROFIT *Significant (at p=0.05).

Table 12. Influence of technology on performance of farmers using ROI

Coefficients^a

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|----------------------|-----------------------------|------------|---------------------------|--------|---------------|
| | B | Std. Error | Beta | | |
| (Constant) | 2.935 | 0.270 | | 10.854 | 0.000 |
| Type | 0.018 | 0.063 | 0.023 | 0.286 | 0.775 |
| Quantity | −0.241 | 0.063 | −0.279 | −3.835 | 0.000* |
| Intended work | 0.292 | 0.073 | 0.349 | 4.007 | 0.000* |
| Intensity | 0.074 | 0.082 | 0.081 | 0.897 | 0.371 |
| Usage rate | 0.284 | 0.068 | 0.331 | 3.897 | 0.000* |
| Afford | 0.166 | 0.100 | 0.199 | 1.665 | 0.098 |

Notes: a. Dependent Variable: ROI *Significant (at p=0.05).

availability, utilization, and accessibility of technology are necessary attributes for the significant performance of farmers from both CHABUMA and UWAZAMAM MCOS.

Also, when considering the items used to measure availability, utilization, and accessibility variables. Results depicted that, quantity, intended work, and intensity of technology influence performance of farmers significantly ($p < 0.05$) as shown in Table 11. These results are supported by Zawislak et al. (2018), the level of technology adopted plays a significant role. Thus as the technological levels adopted are high the outcomes will tend to exceed those with low levels of technologies.

Additionally, Table 12 reveals that quantity, intended work, and usage rate significantly influence the performance of farmers ($p < 0.05$). These results indicate that the number of technology available as well as their integration with primary users (intended uses) and the rate they use and ease to use tends to influence the performance of farmers as proposed by Kiwango et al. (2018).

These results indicate the role of availability (quantity), utilization (intended uses) and usage rate (accessibility) influence the performance of farmers. Despite the composite relationship between the influence of technology and performance of farmers, some individual variables as shown in Tables 11 and 12 indicate positive non-significant influence ($p > 0.05$). Based on this, it is worth considering the

composite relationship in addressing the influence of technology on the performance of farmers than taking into account individual variables. According to Mathijssen et al. (1997) aggregating individual scores (family members in their study) can be valuable since it involve a number of items than their individual items (family members). Thus, combining different individual cases into a composite score in this study provides a significant contribution compared with individual cases and hence the new study can focus on the influence of individual cases on the performance of farmers.

In general, based on the above findings, it is safe to conclude that AMCOS needs to ensure that the adoption of technology should involve the type of technology available, utilization, and accessibility. Once one aspect is missing performance will be compromised as shown in the presented results. However, technology availability has been shown to influence performance of farmers negatively by considering ROI and PROFIT as performance parameters of both AMCOS. Based on that, the study can conclude that there is a need to strengthen availability, accessibility, and utilization of technology, especially in those AMCOS involving the use of technology in their daily operations like the presence of tractors, planters, irrigation schemes, combined harvesters, and grape juice processing machines. This will improve performance of farmers and also the value addition of the final products prior to being sent to the market.

7. Conclusion, implication, and areas of further research

This study aimed to understand the way availability, accessibility, and utilization of technology influence performance of grapevine farmers operated under two AMCOS namely CHABUMA and UWAZAMAM both locate in Dodoma Region in Tanzania. The study extends the knowledge from Toroitich et al. (2020) concerning the relationship between availability, access, and utilization of agricultural extension technologies on the food security of smallholder farmers. The current study is focused on AMCOS and performance of grapevine farmers.

The study not only focused on the way availability, access, and utilization of technologies improved performance of grapevine farmers but also recommend to AMCOS to ensure on adoption of technology should consider cost-effective technology to avoid operating costs like what happened to CHABUMA AMCOS. Also, on the other side, the study recommends UWAZAMAM to shift from rain-fed irrigation to rainwater harvest or any cost-effective irrigation technology to ensure availability of water all the time and hence operate their farms profitably.

The limitations of the study include sending the self-administered questionnaires whereby the deep insight of respondents was missing in the document. Additionally, the study was conducted in Dodoma region whereby the CHABUMA and UWAZAMAM AMCOS exist in Tanzania, thus the future study can expand to several regions so that general views of farmers under their respective AMCOS will be collected. Also, the study found an inverse relationship between availability of technology and the performance of farmers, and hence a further study can be conducted in this area. Furthermore, the study failed to consider a case-by-case analysis since the number of respondents from UWAZAMAM (66) was not enough to draw an inference hence the next study can observe this and hence come up with a good comparative case by case studies. Finally, a future study can consider individual variables and the way influences the performance of farmers.

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