Journal of Agricultural Science and Practice
Volume 8(6), pages 114-120, December 2023
Article Number: B3D5D4233
ISSN: 2536-7072
https://doi.org/10.31248/JASP2022.364
https://integrityresjournals.org/journal/JASP

*Full Length Research*

# Effect of sociodemographic factors on the adoption of environmental conservation practices in Kimao dam catchment, Baringo County, Kenya

**Emily Jepkorir Kiplagat[1]*, Mark Ndunda Mutinda[1], Shadrack Kinyua Inoti[2] and Collins Wafula Masinde[3]***

[1]Department of Environment and Natural Resource Management and the School of Science and Technology of Africa, Nazarene University, P. O. Box 53067 – 00200 Nairobi, Kenya.
[2]Department of Natural Resource, Egerton University, P. O. Box 536 – 20115, Egerton, Kenya.
[3]Central Highlands Eco-Region Research Programme section, Kenya Forestry Research Institute, P. O. Box 20412 - 00200 Nairobi Kenya.

*Corresponding author. Email: emilykiplagat90@gmail.com/cmasinde83@gmail.com



Received 24th July 2022; Accepted 11th August 2022

**ABSTRACT:** Demographic and land size owned by households often impact the adoption of environmental conservation approaches in wetlands. Kimao dam is at risk of sedimentation, considering the steep topology and reduced vegetation cover. Contemporary attempts by stakeholders to restore water catchments are insufficient due to the low adoption rate of the environmental conservation measures. The study assessed factors that cause the low adoption rate of the environmental conservation practices among households within the Kimao catchment area in Kimalel location, Baringo County. The objectives of the study were to: (i) determine the effects of sociodemographic factors (age, gender, household number) on the adoption of environmental conservation practices, and (ii) establish the effects of land size owned by households on the adoption of environmental conservation practices. The *ex-post-facto* research design was used. A stratified proportional random sample of 225 households was surveyed using a structured questionnaire. The data were analyzed using descriptive and inferential statistics in a Statistical Package for the Social Sciences (IBM SPSS version 26). The results showed that the level of adoption of environmental conservation practices was low ($M=9.47$, $SD=4.7$) on a scale of 1 to 22. The level of adoption of environmental conservation practices within the Kimao dam catchment area was found to be affected by age of the household head ($\beta=.294$, $t=4.59$, $p=.001$) and household number ($\beta=0.147$, $t=2.22$, $p=0.027$) but not gender ($t=-0.648$, $df=223$, $p=0.518$). The Land size ($\beta=0.162$, $t$-$2.45$, $p=0.015$), also affected the level of adoption of environmental conservation practices. Demographic factors act independently or synergistically with other factors to influence policy adoptions in water ecosystem management. Stakeholders need to provide sound scientific and feasible policies to collaboratively manage the Kimao dam. The findings of the study will influence policy development in implementing environmental conservation practices in Baringo County.

**Keywords**: Environmental conservation, household, land size, sociodemographic, water catchment.

## INTRODUCTION

Per the global sustainable development goals (SDGs) that were stipulated in 2015, terrestrial ecosystems should be self-sustainable. In particular, urgent measures are inevitable to reduce natural habitat degradation to avert the extinction of threatened species. Moreover, the accord also put forth further actions required for the restoration of degraded lands and soils (FAO and Intergovernmental Technical Panel on Soils, 2015). However, these achievements are yet to materialize, considering multiple shortcomings in combating degradation. Land degradation is termed as the act of reducing the land's capacity to produce ecosystem services (FAO and Intergovernmental Technical Panel on Soils, 2015). These ecosystem goods include soil health, water quality, and quantity, which produce social and economic value to the local inhabitants. On the other hand, ecosystem services include biodiversity and the maintenance of hydrological, nutrient and carbon cycles (Nachtergaele *et al*., 2011).

However, the current state regarding environmental conservation is wanting. A remotely sensed data survey from 1999 to 2010 revealed a factual situation on the ground. All the forty-seven counties are seriously degraded. As a matter of fact, their findings showed that 64.1 per cent of the total Kenyan land is degraded while 27.2 per cent is very highly degraded. Of all regions, Arid and Semi-Arid Lands (ASALs) face rampant degradation owing to the highly erodible soils and high intensity storms that create excessive runoff and soil erosion (Republic of Kenya, 2016). In this regard, the natural land cover in ASALs is reduced leaving the soils bare. This condition leaves the soils uncovered, which increases erosion and sediment loading. Soil degradation inherently reduces or eliminates soil functions and their ability to support ecosystem services essential for human well-being (FAO and Intergovernmental Technical Panel on Soils, 2015). Conversion of natural land cover in water sheds into agricultural lands or for other anthropogenic uses reduces the natural land cover. In response, ecosystem services such as water quality and quantity are detrimentally impacted. Besides, watershed degradation is an avenue for increased sedimentation diminishing the capacity of reservoirs and increasing water pollution. Extra costs would be required to restore the water and make it safe for human consumption (Abulnaga, 2018).

Multiple efforts by governmental, non-governmental organizations, and individuals have been directed towards achieving conservation goals to achieve a sound ecosystem in Baringo County (Koskei and Kitetu, 2019). The conservation measures aim to guard water catchment areas through soil and water conservation. Notable conservation measures that are in place include bench terrace, check dams, contour bunds and hedgerows, and stone bunds, coupled with planting pits/zai pits, stone lines, trash lines, grass strips, grassed waterways, cut-off drains, mulching, and cover cropping (Dagnachew et al., 2020; Telles et al., 2019). However, the above-mentioned methods of conserving the land from degradation are cheap because materials for their implementation are readily available. On the contrary, there exist conventional methods that require a substantial investment of resources. Therefore, the common people lack the finances to implement these current methods (Mekuriaw et al., 2018). The problem is compounded by the communal land ownership scheme in the lowlands of Baringo, which stands at 80 per cent making the people shy away due to high costs (Baringo County Government, 2018).

Consequently, the increasing population inflicts pressure on the land and water resources due to overexploitation. For instance, frequent conflicts often arise in the Tugen Hills of Baringo among residents clashing over land encroachment by neighbours. It is worth noting that the underlying root causes are embedded in the socio-economic conditions of the society (Gebremeskel et al., 2018). There is apparent evidence with regard to the adoption of sound scientific methods of soil conservation to keep the environment sustainable in producing ecosystem goods and services. Thus, the limited success in the adoption of soil conservation measures necessitates the investigation of the social and economic factors that influence farmers' willingness to invest in conservation measures. This present study evaluated the social and economic factors and household head knowledge influencing the adoption of environmental conservation measures in the Kimau dam in Baringo County. Therefore, the objectives of the study were i). To determine the effects of social and demographic factors (age, gender, education level) on the adoption of environmental conservation practices by households within the catchment area of Kimao dam in Baringo County, and ii). To establish the effects of land size owned by households on the adoption of environmental conservation practices by households within the catchment area of Kimao dam in Baringo County.

## METHODOLOGY

### Study area

Kimao dam is a water catchment feature located in Kimalel location, Baringo County on the floor of the Rift Valley in Kenya. This natural feature lies between 0°27'03.3"N 35°50'11.5"E and the elevation is 892 m above sea level. There are two rain seasons; the long rains occur from March to August while the short rains occur from November to December while the rest of the year is hot and dry.

### Study design

The research study used an *ex-post facto* research design, considering its potential to explore situations occurring over time without the researcher's manipulation. A researcher-administered structured questionnaire was used to collect data among the randomly stratified selected participants. The survey gathered a broad range of data for analysis from January 31, 2017, to April 3, 2017. The study was conducted within the borders of the catchment area around Kimao dam in Kimalel location. Responses from the interviewees were prepared and put in excel sheets for further analysis.

### Data collection methods

Questionnaires were administered through face-to-face interviews among the targeted population with the help of research assistants that filled questionnaires, while the respondents were given prior consent forms to fill out before participating in the survey. The interview was conducted in the local dialects of the prevailing area where the assistants helped in the interpretation and translation of responses into English. Participants' information was then used to make generalizations about the characteristics of the broader population.

A sample representative of residents within the catchment area of Kimao dam was included in the research study. The region has three (3) sub locations named Kimalel, Sabor and Koriema. The sub locations formed the strata. The proportional allocation method was used to distribute the samples within the different sub locations. Children and the mentally ill were excluded from the participation in the study.

## Sample size

Population, cost, and time are considered the primary factors in sample size determination. Besides, the researcher must factor in time, convenience when collecting data, and the need for sufficient statistical power. The ideal sample size of this study was 225 households based on the formula (Taherdoost, 2017).

## Questionnaire

The questionnaire was derived based on the validity testing that entailed experts from the Nazarene University board cross-checking the questions for consistency with the objectives. The data was collected from individuals in the selected households within the study area. The questionnaire consisted of two domains (i) demographic information, (ii) land size owned by households on the adoption of environmental conservation practices.

## Data analysis

Once the measuring instrument was administered, the raw data was systematically organized through coding to facilitate analysis. Descriptive and Inferential statistics were used to make inferences about the influence of socio-economic factors on the adoption of environmental conservation practices. The Statistical Package for Social Sciences (IBM SPSS version 26) was used to aid in data analysis. Inferential statistics used was regression analysis.

# RESULTS

## Effects of social and demographic factors (age, gender, education level) on the adoption of environmental conservation practices by households within the catchment area of Kimao dam

The majority (73.3 %) of the households were male-led, while the women-led households were 26.7 % (Table 1). The results showed that the level of adoption of environmental conservation practices was low (M=9.47, SD=4.7) on a scale of 1 to 22 (Table 2). Regarding marital status, 73.3% of the household heads were married, 13.8% were single, 12% widowed and 0.9% were divorced. On the other hand, most participants had attained the form four level of formal education (65.3%), while only 10.7% completely lacked any level of education. Therefore, indicating a reasonable level of understanding. The average number of people living in the households was (M=5.4, SD=2.7), and ranged between 1 and 13 (Table 1). The mean of the dependent variable adoption of environmental conservation practices by the household head in Kimao dam catchment area was (M=9.47, SD 4.7) and ranged between 1 and 22 (Table 2).

## Effects of land size owned by households on the adoption of environmental conservation practices by households within the catchment area of Kimao dam.

The effect of land size on the adoption of environmental conservation practices by households within the Kimao dam was determined by the use of simple linear regression analysis. The land size ($\beta$=0.162, t=2.45, p=0.015), also affected the level of adoption of environmental conservation practices (Table 4). The land size owned by the households formed the independent variable, while the index of level of adoption of environmental conservation practices formed the dependent variable. The results of the regression model summary shows that there is a strong correlation between the size of land owned by an individual and the adoption of environmental conservation practices (Table 3).

The model indicates an adjusted $R^2$ value of .213; meaning that the independent variable land size explained approximately 2.1 % of the variation in the dependent variable adoption of environmental conservation practices by households, which was low. The overall regression model was found to be significant ($F$ (1, 223) = 6.034, $p$=.015). The regression coefficients of the model showing the *beta, t* statistics and the collinearity statics are shown in Table 4. The regression analysis shows that land size owned by households had a statistically significant ($\beta$= 0.162, $t$= 2.456, $p$ = .015) (Table 4) effect on the adoption of environmental conservation practices by households in the Kimao dam catchment area. This could be due to the fact that the larger sized farms provided an opportunity to implement the practices.

# DISCUSSION

The study explored and evaluated how sociodemographic factors and land size owned by households impact the adoption of policies regarding water catchment management in the Kimao dam. From the findings, it was noted that three sociodemographic factors (age, education, and household number) were found to

**Table 1.** Sociodemographic factors influencing the adoption of environmental conservation practices.

| Demographics | Frequency | Percentage |
|---|---|---|
| Age | | |
| 20-30 | 59 | 26.2 |
| 31-40 | 60 | 26.7 |
| 41-50 | 41 | 18.2 |
| 51-60 | 40 | 17.8 |
| 61-70 | 18 | 8.0 |
| 71-80 | 6 | 2.7 |
| Above 81 | 1 | 0.4 |
| | | |
| Gender | | |
| Male | 165 | 73.3 % |
| Female | 60 | 26.7 % |
| Marital status | | |
| Married | 165 | 73.3 |
| Single | 31 | 13.8 |
| Widowed | 27 | 12.0 |
| Divorced | 2 | 0.9 |
| | | |
| Level of formal education | | |
| Never went to school (illiterate) | 24 | 10.7 |
| Lower primary (1-4) | 13 | 5.8 |
| Upper primary (5-8) | 41 | 18.2 |
| Kcse (Form 4) | 56 | 24.9 |
| Teacher (P1) | 39 | 17.3 |
| College (diploma) | 22 | 9.8 |
| Undergraduate degree | 28 | 12.4 |
| Master and above | 2 | 0.9 |
| | | |
| Household number | | |
| 1.00 | 20 | 8.9 |
| 2.00 | 11 | 4.9 |
| 3.00 | 32 | 14.2 |
| 4.00 | 23 | 10.2 |
| 5.00 | 32 | 14.2 |
| 6.00 | 29 | 12.9 |
| 7.00 | 26 | 11.6 |
| 8.00 | 16 | 7.1 |
| 9.00 | 21 | 9.3 |
| 10.00 | 11 | 4.9 |
| Above 10 | 4 | 1.7 |

adversely affect the adoption of environmental conservation practices, while gender had no significant consequence. The findings of the present study are congruent with Mango et al. (2017) who found that age and education level influences the adoption of conservation measures. Likewise, adoption decisions are proportional to the sizes of the pieces of land owned and farmer membership groups (Mango et al., 2017).

Sociodemographic factors are known to adversely affect the adoption of environmental conservation practices by farmers. However, factors affecting the adoption of technologies by farmers to align with environmental conservation are heterogeneous in nature (Llewellyn and Brown, 2020). The age and education level of the farmer positively affected the adoption of environmental conservation by farmers (Mango et al., 2017). Oftentimes,

**Table 2.** Descriptive statistics and frequency distribution of adoption of environmental conservation practices.

| Scale | Frequency | Per cent |
|---|---|---|
| 1-3 | 19 | 8.4 |
| 3.1-5 | 46 | 20.4 |
| 5.1-7 | 20 | 8.9 |
| 7.01-9 | 23 | 10.2 |
| 9.01-11 | 29 | 12.9 |
| 11-01-13 | 39 | 17.3 |
| 13.01-15 | 25 | 11.1 |
| 15.01-17 | 16 | 7.1 |
| 17.01-19 | 5 | 2.2 |
| Above 19 | 3 | 1.3 |
| Total | 225 | 100.0 |

Mean 9.47±.313, Median 10, Mode 4, Std. Dev 4.7, Minimum 1 and Maximum 22.

**Table 3.** Regression model summary for land size and the adoption of environmental conservation practices by households.

| R | R square | Adjusted R square | Std. error of the estimate |
|---|---|---|---|
| 0.462 | 0.213 | 0.210 | 4.655 |

**Table 3.** ANOVA for the Regression Testing the Fit of the model.

| | Sum of squares | *df* | Mean square | *F* | *p* |
|---|---|---|---|---|---|
| Regression | 130.77 | 1 | 130.77 | 6.03 | 0.015 |
| Residual | 4833.28 | 223 | 21.67 | | |
| Total | 4964.06 | 224 | | | |

**Table 4.** Regression coefficients for land size and adoption of environmental conservation practices.

| | Unstandardized coefficients | | Standardized coefficients | t | p | Collinearity statistics |
|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | VIF |
| (Constant) | 8.69 | 0.443 | | 19.61 | 0.001 | |
| Land size | 0.231 | 0.094 | 0.162 | 2.45 | 0.015 | 1.000 |

sociodemographic factors act synergistically to bring an effect to individual choices. This is not the case for the present study, considering that gender never had an impact on the adoption of conservation measures in Kimao catchment region. Younger, more educated farmers who operated larger farms and were optimistic about the future of precision farming were most likely to adopt site-specific information technology (Batte and Arnholt, 2003). Similar results are presented in this study; however, in addition to age and land owned by individuals, farmer group membership and land-to-man ratio also influence conservation decisions (Batte and Arnholt, 2003). In this regard, in an environment with dynamic technology, farmers with more education are better able to make technology adoption decisions in a dynamic economic and technical environment (Shang et al., 2021). In spite of the influence as demonstrated by the level of education, the prevailing environment and level of enlightenment hasten the process of making sound scientific decisions. In contrast, age, education level and land holding size have no influence on knowledge flow and in technology adoption (Ramirez, 2013). Socioeconomic factors often influence farmers' adoption of *Brachiaria* grass species in the Eastern and Western regions of Kenya (Maina et al., 2020).

Consequently, the size of land owned by the households in the Kimao water catchment area significantly affected the adoption of environmental conservation practices. The case is not different according to a study done by Mango et al. (2017) that established a strong correlation between the land owned and land-to-man ratio in influencing the adaption of current techniques profitable to the farm. Households with huge chunks of land responded positively to the adoption of environmental conservation initiatives. This agrees with the finding of the study that household number has a positive and significant influence on the adoption of practices. Therefore, the size of land owned by the farmers has been shown to influence the adoption of improved farming methods that consider the sustainable utilization of ecosystem goods and services (Liu and Brouwer, 2022). Such best practices include agroforestry, inorganic fertilizer application, and planting of highly adaptable seed varieties that are less toxic to the natural vegetation and soils (Tsufac et al., 2021). For instance, improved wheat varieties and forage/browse legume technologies were noted to positively promote sustainable land management (SLM) in Ethiopia and in the Niger basin of Benin (Haregewoin et al., 2018). Nonetheless, soil and water conservation practices are labour intensive besides being expensive (Haregewoin et al., 2018) owing to the multiple workers required for the implementation of these practices.

The adoption of land or environmental conservation practices by small scale farmers in different river catchments can affect the size of land owned among other factors (Wolka et al., 2018). The adoption of agroforestry practices in rural Ethiopia was affected by land size and tenure security (Abulnaga, 2018). The number of SWC techniques practised was affected by the arable land size owned by the farmer (Haregewoin et al., 2018). Multiple adoptions of innovations are mostly explained by access to key resources (credit, income and information), and the size of land owned by the farmer (Mango et al., 2017). The adoption of precision agriculture by farmers in the US was found to be influenced by land size, among other factors (Daberkow and McBride, 2003). Moreover, Rahman and Zhang (2018) found that farm size was negatively related to fertilizer adoption on small farms, who are under pressure to adopt inorganic fertilizer and intensive production techniques. Farmers have been shown to avert risk by not adopting new innovations, hence explaining the negative adoption (Barne et al., 2019). Studies by Miheretu and Yimer (2017) showed that land tenure security had significant influences on the adoption of land management practices in Ethiopia. Two land aspects that affect the adoption of conservation measures by farmers are noted: they include the size of the land and the tenure, however, the latter was not considered in the current study.

## Conclusion

Overall, age, education, and household numbers have significant effects on the adoption of environmental conservation practices. However, gender had no impact on the adoption of the current conservation measures towards the Kimao dam. Besides, the land size owned by the households was also significant in affecting the adoption of environmental conservation practices.

## Recommendations

In the light of the above study, the following recommendations are put forward:

1. The natural resource conservation stakeholders should build the capacity of the participants in terms of knowledge of environmental conservation measures and create awareness of the problem of dam siltation due to activities conducted on the farms. This can be accomplished through farmer-to-farmer contact.
2. Stakeholders should provide inputs needed in environmental conservation practices. This can be done by creating tree nurseries to provide tree seedlings to the households, provision of grass seeds for planting, and also equipment for making soil conservation structures.
3. Stakeholders should re-evaluate the situation and come up with sound policies to protect water catchment areas from suffering further loss through unacceptable conservation practices.

## ACKNOWLEDGEMENT

The authors wish to thank Rufford small grants foundation (UK) for sponsoring the research. Further recognition is granted to Harriet Maiyo for her concern and support, household heads for their willingness to provide information and finally the enumerators, who assisted us in data collection. May the Almighty God bless you all.

## CONFLICT OF INTEREST

The authors do not have any conflict of interest concerning the current research study.

## REFERENCES

Abulnaga, B. E. (2018). Community development by de-silting the Aswan High dam reservoir. Grand Ethiopian Renaissance Dam Versus Aswan High Dam. In: *The Handbook of Environmental Chemistry book series*, *79*, 357-383.

Baringo County Government (2018). County integrated development plan 2018-2022: Transformational agenda for the people of Baringo County through focused investment in all sectors of the economy. Retrieved from https://www.baringo.go.ke/images/downloads/Budget_Documents/CIDP/Baringo-CIDP-2018-2022-Approved.pdf.

Batte, M. T., & Arnholt, M. W. (2003). Precision farming adoption and use in Ohio: case studies of six leading-edge adopters. *Computers and electronics in agriculture*, *38*(2), 125-139.

Daberkow, S. G., & McBride, W. D. (2003). Farm and operator characteristics affecting the awareness and adoption of precision agriculture technologies in the US. *Precision Agriculture*, *4*(2), 163-177.

Dagnachew, M., Moges, A., Kebede, A., & Abebe, A. (2020). Effects of soil and water conservation measures on soil quality indicators: the case of Geshy subcatchment, Gojeb River catchment, Ethiopia. *Applied and Environmental Soil Science*, Volume 2020, Article ID 1868792, 16 pages.

FAO and Intergovernmental Technical Panel on Soils (2015). *Status of the world's soil resources (SWSR) – Main report.* Food and Agriculture Organization of the United Nations and Intergovernmental Technical Panel on Soils, Rome, Italy.

Gebremeskel, G., Gebremicael, T. G., & Girmay, A. (2018). Economic and environmental rehabilitation through soil and water conservation, the case of Tigray in northern Ethiopia. *Journal of arid Environments*, *151*, 113-124.

Haregewoin, T., Belay, B., Bezabeh, E., Kelemu, K., Hailu, D., & Daniel, F. (2018). Impact of Improved Wheat Variety on Productivity in Oromia Regional State, Ethiopia. *Greener Journal of Agricultural Sciences*, *8*(4), 74-81.

Koskei, E., & Kitetu, J. (2019). Awareness and Adaptation to climate change in arid and semi-arid lands. A case of Baringo County. *Conference Proceedings of The Kabarak University International Conference on The Environment and Energy*. Maghanga, C. M. (ed.) 16th - 17th September. KABU Repository. Pp. 24-32.

Liu, H., & Brouwer, R. (2022). Incentivizing the future adoption of best management practices on agricultural land to protect water resources: The role of past participation and experiences. *Ecological Economics*, *196*, 107389.

Llewellyn, R. S., & Brown, B. (2020) Predicting adoption of innovations by farmers: What is different in smallholder agriculture? *Applied Economics and Perspectives 4*(1), 100-112.

Maina, K. W., Ritho, C. N., Lukuyu, B. A., & Rao, E. J. O. (2020). Socio-economic determinants and impact of adopting climate-smart Brachiaria grass among dairy farmers in Eastern and Western regions of Kenya. *Heliyon*, *6*(6), e04335.

Mango, N., Makate, C., Tamene, L., Mponela, P., & Ndengu, G. (2017). Awareness and adoption of land, soil and water conservation practices in the Chinyanja Triangle, Southern Africa. *International Soil and Water Conservation Research*, *5*(2), 122-129.

Mekuriaw, A., Heinimann, A., Zeleke, G., & Hurni, H. (2018). Factors influencing the adoption of physical soil and water conservation practices in the Ethiopian highlands. *International Soil and Water Conservation Research*, *6*(1), 23-30.

Miheretu, B. A., & Yimer, A. A. (2017). Determinants of farmers' adoption of land management practices in Gelana sub-watershed of Northern highlands of Ethiopia. *Ecological Processes*, *6,* Article number 19.

Nachtergaele, F., Biancalani, B., Bunning, S., George, H. (2011) Land degradation assessment: The LADA approach. 19th World Congress of Soil Science, Soil Solutions for a Changing World 1 – 6 August 2010, Brisbane, Australia.

Rahman, K. A., & Zhang, D. (2018). Effects of fertilizer broadcasting on the excessive use of inorganic fertilizers and environmental sustainability. *Sustainability*, *10*(3), 759.

Ramirez, A. (2013). Influence of social networks on agricultural technology adoption. *Procedia - Social and Behavioral Sciences 79*, 101-116.

Republic of Kenya (2016) *Land degradation assessment (Lada) in Kenya: Based on a study of Land Degradation Assessment (LADA) with Remote Sensing and GIS, for Sustainable Land Management (SLM) in Kenya.*

Shang, L., Heckelei, T., Gerullis, M. K., Börner, J., & Rasch, S. (2021). Adoption and diffusion of digital farming technologies-integrating farm-level evidence and system interaction. *Agricultural Systems*, *190*, 103074.

Taherdoost, H. (2017). Determining sample size; how to calculate survey sample size. *International Journal of Economics and Management Systems*, *2,* 237-239.

Telles, T. S., Lourenco, M. A., Oliveira, J. F., Costa, G. V., & Barbosa, G. (2019). Soil conservation practices in a watershed in Southern Brazil. *Anais da Academia Brasileira de Ciências, 91*(3), e20180578.

Tsufac, A. R., Awazi, N. P., & Tchamba, M. N. (2021). Addressing the soil infertility conundrum through agroforestry: Empirical evidence from Cameroon. *Challenging Issues on Environment and Earth Science 7*, 146-174.

Wolka, K., Mulder, J., & Biazin, B. (2018). Effects of soil and water conservation techniques on crop yield, runoff and soil loss in Sub-Saharan Africa: A review. *Agricultural water management*, *207*, 67-79.