Enhancing Climate Change Adaptation through Participatory Monitoring and Evaluation practices: Evidence from Coffee Farming Households in Southwestern Uganda

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ABSTRACT

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| Participatory Monitoring and Evaluation (PM&E) practices play a major role in enhancing adoption of climate adaptation measures. A convergent parallel mixed-method design was therefore used to determine the contribution of PM&E practices in enhancing climate change adaptation among coffee farming households in Ntungamo district, southwestern Uganda. A structured questionnaire was administered to a sample of 385 respondents and the data were analyzed using correlation, regression and analysis of variance (ANOVA) methods. Results showed that participatory planning, needs assessments, monitoring with farmers, farmer-to-farmers exchange visits, and, participatory evaluation were positively and significantly (p=0.00) correlated with planting of the recommended shade trees in their coffee fields as well as soil and water conservation practice as interventions for adapting to climate change. However, regular data collection had a weak negative but significant correlation with farmers’ access to timely climatic information (r=-.155; p=0.00), use of soil and water conservation practices as a means of climate change adaptation (r=-.158; p=0.00) as well as farmers having knowledge in the management of pests and diseases (r=-.178; p=0.00). This implies that most of the assessed PM&E practices enhance the planting of shade trees as well as the use of soil and water conservation practices as interventions for adapting to climate change in the coffee agrosystems. We therefore recommend increased participation of coffee farmers in local Government planning, monitoring and evaluation discussions deliberations This bottom-up approach will increase farmers’ ownership and commitment to better adoption, implementation and sustainability of climate change interventions, ultimately enhancing smallholder livelihoods. |

Key words: *Bottom-up-approach, exchange-visits, local-Government, needs-assessments, planning, planting-shade-tree, soil-and-water-conservation*

1. INTRODUCTION

Coffee is the second most traded agricultural commodity in the world, after gold [1], with a pivotal role in sustaining agrarian economies such as Uganda [2]. The crop remains Uganda’s most important cash crop, contributing about 18% of the country’s export earnings that translates to US$ 1.50 billion from coffee exports for twelve months (December 2023-November 2024) [3]. It is grown by more than 1.7 million households on an estimated 353,907 hectares of land, with 90% of them owning gardens ranging between 0.5 and 2.5 hectares in size [4, 5, 6]. Coffee also supports more than 9 million people in Uganda who derive their livelihood from coffee-related activities along the value chain [4]. Despite the importance of coffee to the smallholder farmers and the national economy of Uganda, its production and productivity remain low in most parts of the country including the south-western region. For example, a research study by [7] reported that the actual yield of Arabica coffee in the southwestern region of Uganda ranged between 164 and 2243 kg ha−1 year−1. This is far below that the 5,000 kg ha−1 year−1 obtained in some closely spaced and unshaded large-scale coffee blocks planted with compact-type Arabica cultivars, e.g., in Brazil, Colombia, and Kenya [8]. This is due to a number of constraints, with climate variability being paramount and is exacerbated by the low adoption of change adaptation [9, 10, 11].

Climate change adaptation refers to modifications in natural, communal, or monetary aspects in response to actual or expected climatic stimuli and their consequences to weather variations [12, 13]. Climate change adaptation options commonly employed by farming households in Africa include: use of drought resistant varieties of crops, diversification, changes in cropping pattern and calendar of planting, conserving soil moisture through appropriate tillage methods, improving irrigation efficiency, and afforestation and agro-forestry, among others [14, 15, 16]. Nevertheless, recent research indicates that climate change adaptations have more proficient results with Participatory Monitoring and Evaluation (PM&E) practices [17, 18, 19, 20] and this can lead to achievement of food security and improvement of livelihoods [21, 22, 23]. Various scholars have underscored the relevance of PM&E in enhancing climate change adaptation. For example, [24] argues that strategic planning with the relevant parties ensures ownership and sense of responsibility to make informed decisions for climate change adaptations while, [25] argue that participatory planning contribute a lot in empowering farmers, researchers, government officials through ownership in attaining climate change interventions. Furthermore, [24] and [25] argue, that planning sessions ensure accountability which has been the norm in the M&E practices in climate adaptation as a requirement for donor-funded programs. Also, [23] adds that accountability is increasing transparency among the farmer members. However, [26], compared the farmer groups' dynamics of PM&E but did not elaborate more on climate change adaptations.

On the other hand, [10] and [27] point out that farming communities have well-adjusted to the climate interventions instances where PM&E’s have been in place. Furthermore, [28], share the view that PM&E generates learning lessons which are vital concept in adaptation measures and provides the farmer with judgment on which intervention worked well, considering the advantages and the financial implications. Participatory monitoring emphasizing learning through participatory approaches has a far-reaching impact on transformation in aspects of climate variations. Also, [24] agrees that M&E plays a critical role in knowledge capital and effectiveness of the intervention adaptations. Though [23], compared the effectiveness of three farmer groups with PM&E practices, some concepts of climate adaptation were not clearly stated in their research. Research findings by [29] draw the attention that information is often up- bottom approach rather than a bottom-up approach. However, studies by [29] lacked in elaborating how P&E can enhance climate adaptations. M&E contributes a lot to this decision-making and learning from outcomes of the program requirements to make evidence-based decisions [17] and [30] believe that making evidence-based decisions on climate adaptations perform well with approaches that work best. Relatedly, [31] conducted a study on the role of native knowledge in weather alterations, whose findings showed that farmers tend to make decisions in response to the climate adversities. However, [25] focused a lot on PM&E’s whose context was in natural resource management.

Basing on the above backdrop therefore, a study was conducted in Ntungamo district, southwestern Uganda to understand the relevance of PM&E practices in the context of climate adaptations among the coffee farmers.

2. material and methods

**2.1 Study Area**

This study was conducted in Ntungamo district (Fig. 1) located in south-western Uganda; between latitudes 0ᵒ35’ and 1ᵒ15’south and longitudes 30ᵒ05’ East [32] at an elevation of 1300-1560 m.a.s.l [33]. The district has a bimodal distribution of rainfall (800-1500 mm) falling between March to mid-May, and September to December. It also experiences a mean annual temperature of 26oC and mean annual minimum of 14.5oC. High temperatures are recorded in the months of January – February and June- August which correspond to dry spells [33, 32]. Ntungamo borders with Kabale district in the south, Rukungiri district in the west, Shema and Mitooma districts in the north, Mbarara district in the northeast, Isingiro district in the east, the Republic of Tanzania and Rwanda in the south east. It has 15 sub-counties, three (3) town councils and one (1) municipality with thee (3) divisions [32].



Figure 1: Location of Ntungamo district in south-western Uganda

**2.2 Data Collection**

**2.2.1 Data Sources**

The study population comprised of 724 respondents, including, members of the district council and steering committee whereas, the coffee farming households were the main respondents that answered the structured questionnaires. The categories were selected because of their involvement in monitoring activities in their respective cooperatives. The coffee farmers were selected from Ankole Coffee Producers Cooperative Union (ACPCU) [34] residing in Ihunga and Kibatsi sub-counties.

*2.2.1.1 Sampling Criteria*

The sample size (Table 1) was selected using [35] table.

Table 1. Sampling criteria adopted for the study

|  |  |  |  |
| --- | --- | --- | --- |
| **Category of study population** | **Study****Population** | **Sample Size** | **Selection Criteria** |
| Members of the district council | 15 | 14 | Simple random sampling  |
| Members of the district coffee steering committee. | 15 | 14 | Simple random sampling  |
| Coffee farmers in Kibatsi sub-county Kibariko parish, Kihumuro village | 444 | 205 | Simple random sampling  |
| Coffee farmers in Ihunga sub-county, Rukarango Parish, Rukarango 1 village | 250 | 152 | Simple random sampling  |
| **Total** | **724** | **385** |  |

*2.2.1.2 Survey Questionnaire*

The questionnaire survey method was used to understand the contribution of PM&E among coffee farming households. It is a method used for gathering information about the characteristics, attitudes, of a population by using a structured set of questions [36]. This questionnaire was administered to the coffee farmers, members of the district council, and, members of the coffee steering committee with the help of trained research assistants who explained the questions to the respondents. The method was also used because it was easy to construct and can handle large data sets [37].

**2.2.2 Quality Control (Validity and Reliability of instruments)**

*2.2.2.1 Validity*

Validity of a research instrument assesses the extent to which the instrument measures what it is designed to measure [38]. It is the degree to which the results are truthful. On the other hand, content validity refers to the degree to which an assessment instrument is relevant to, and representative of, the targeted construct it is designed to measure. The content validity was established through a qualitative expert review of tools [39]. It refers to the degree to which the tool adequately samples the research domain of interest when attempting to measure [38].

 ……………….. Equation (1)

Our results showed Content Validity Index (CVI) of 0.73 for the Dependent Variable (Table 2) and 0.81 for the Independent Variable for the instrument. This is in line with [40] proposition that shows that CVI greater than 0.7 is considered to be good while that at 0.9 is considered to be excellent. The instrument was therefore considered to be valid. The obtained CVI of 0.73 for the dependent variable and 0.81 for the independent variable therefore, indicates that the data collection tool was valid.

Table 2. Validity index for the dependent variable

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Number of questions** | **Relevant items** | **Validity Index** |
| Expert 1  | 6 | 5 | 0.8 |
| Expert 2 | 6 | 4 | 0.7 |
| **Content Validity Index (CVI) Average** | **0.73** |

Source: Primary data (2021)

Table 3. Validity index for the independent variable

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Number of questions** | **Relevant items** | **Validity Index** |
| Expert 1  | 8 | 7 | 0.875 |
| Expert 2 | 8 | 6 | 0.75 |
| **Content Validity Index (CVI) Average**  | **0.81** |

Source: Primary data (2021)

*2.2.2.2 Reliability*

According to [41], reliability is the trustworthiness in the context of measuring an instrument. The instrument was tested for reliability in order to ascertain if it would consistently measure whatever it was supposed to measure after several trials. Test-retest reliability was done by administering the same questionnaire on the same group of respondents at two different points in time. The correlation between the two sets of results was computed using Cronbach’s alpha co-efficient which employs this formula (Equation 2): -

 ………………….. Equation 2

Where; rα - coefficient alpha, N - Number of items, V1 -Variance of one item, Vt -Variance of the total test scores, α ≥0.7 is acceptable.

Cronbach’s Alpha for the dependent variable of 0.71 (Table 4) and that of independent variable of 0.891 (Table 5) implies that the instrument is considered reliable because >0.7 is considered reliable. Internal consistent above or greater than 0.7 would be acceptable and data collection instrument was considered reliable while when Cronbach’s alpha is less than 0.7 would be considered unreliable [41].

Table 4. Reliability Statistics for the Climate Change adaptations Dependent Variable (DV)

|  |  |
| --- | --- |
| **Cronbach's Alpha** | **Number of items** |
| 0.714 | 5 |

Source: Primary data (2021)

Table 5. Reliability Statistics for Participatory Monitoring and Evaluation (PM&E) Practices Independent Variable (IV)

|  |  |
| --- | --- |
| **Cronbach's Alpha** | **Number of items** |
| 0.891 | 7 |

Source: Primary data (2021

**2.3 Data Analysis**

The data were cleaned, sorted, coded and entered into the computer system using the statistical package for social scientists (SPSS) version 26 for analysis. Descriptive statistics and inferential statistics were generated. This was appropriate since a sample was obtained from the population to make interpretations and draw conclusions [42]. Spearman correlation was used to assess the strength, association and linkage of PM&E practices and climate change adaptations. This type of analysis was appropriate for this study because the data were non-parametric [43, 44]. Furthermore, inferential statistics such as Analysis of Variance (ANOVA) along with Regression analysis were also performed.

3. results and discussion

**3.1 Relationship between Participatory Monitoring and Evaluation (PM&E) practices and climate change adaptation measures**

Participatory climate adaptation planning with the local community integrates local knowledge and needs with scientific information, allowing for responsive adaptation interventions that best reflect the community’s risk level and values [45, 46]. Increased community-based planning is therefore vital for addressing trade-offs and synergies between the three pillars of productivity, adaptation and mitigation [47]. Results of the Spearman correlation between participatory monitoring and evaluation (PM&E) practices (independent variable) and climate change adaptation measures (dependent variable) are summarized in table 6 below. Participatory planning with farmers’ representatives at district/sub-county/cooperative level as well as needs assessment during the planning process with farming communities were positively and significantly correlated with adoption of planting shade trees (r=.272\*\*; p=0.00 and r=.203\*\*; p=0.00, respectively). However, the both correlations were weak, implying that increment in participatory planning with farmers’ representatives as well as needs assessment during the planning process with farming communities, may not necessarily enhance adoption of planting shade trees. This could in part be due to land shortage and fragmentation in the district [48, 49, 50] and/or tree growing is not being prioritized in the area [51, 52]. Nevertheless, studies conducted in Ethiopia by [53], showed that limited participation of the local community in planning, resulted into limited planting of trees and many of them being planted on rocky areas and land inappropriate to sustain them. Participatory planning in planting trees has been reported to replace the top-down ‘reforestation’ approaches that are insensitive to local needs and preferences [54].

On the other hand, results further showed that participatory planning with farmers’ representatives at district/sub-county/cooperative level as well as needs assessment during the planning process with farming communities were positively correlated with soil and water conservation practices (r=.920, p=0.00; r=.684, p=0.00, respectively) as climate change adaptation measures. The correlation shows a strong association, implying that participatory planning with farmers’ representatives as well as needs assessment during the planning process with farming communities, resulted into increased use of soil and water conservation practices as a means of climate change adaptation. This finding is in agreement with several earlier studies which have demonstrated that participation of farmers in soil and water conservation planning, increases the acceptance and adoption of these climate adaptation measures [e.g. 55, 56, 57, 58, 59]. This is because these climate adaption measures solve problems that are perceived by farmers themselves [60, 57].

All in all, these findings spell out the contribution of decision making during strategic planning for governments in monitoring and evaluation that translate to the communities at grassroots levels [18, 24]. Our results confirm several research studies that revealed that farmers’ adoption of soil and water conservation practices and shade trees is influenced by their perception and prior knowledge and benefits to make such decisions [61, 62, 63, 64]. In addition, also [25] established that farmers attain empowerment from consultations. Needs assessment are crucial in participatory monitoring and evaluation processes.

Furthermore, our results showed that participatory monitoring with farmers was weakly and positively correlated with adoption of planting shade trees (r=.271\*\*; p=0.00). This implies that an increase in participatory monitoring with farmers does not necessarily enhance adoption of planting shade trees. This could in part be due to the fact that participatory monitoring is not usually applied in agroforestry project as reported by [65] and [66]. However, participatory monitoring with the farmer was moderately and positively correlated with soil and water conservation practices (r=.658\*\*; p=0.00). This implies that an increase in participatory monitoring with farmers enhances the use of soil and water conservation practices as a method of adapting to climate change. This finding is in agreement with scholars like [67] and [68] who spell the relevance of participatory monitoring approaches for adoption of soil and water conservation interventions. In fact, participatory monitoring recognizes the central role that local people can play in planning and managing their use of the environment [69].

Conversely, results showed that regular data collection had a weak negative correlation to farmers’ access to timely climatic information (r=-.155\*\*; p=0.00), implying that regular data collection does not necessary result into reduction into farmers’ access to timely climatic information. This implies that collection and availability of climate change information does not guarantee its utilization. Our finding is in agreement with other earlier studies which reported weak relationship between availability of climate change information and its utilization [70, 71, 72]. Other factors such as knowledge and relevance of the information could be limiting factors to utilization [72]. Nevertheless, farmers need to access timely information so as to make the right decisions for climate change adaptation [9, 10]. However, [24], highlights that data for climate change interventions are often underutilised in developing countries and this definitely affects stakeholders and practitioners to generate solutions to climate change. The Government should therefore formulate and implement policies that strengthen the provision of timely, simplified and adequately actionable climate information that suit the climate change adaptation needs of farmers [73].

Similarly, regular data collection had a weak negative correlation with soil and water conservation practices (r=-.158\*\*; p=0.00) as a means of climate change adaptation. This implies that regular collection of data will not necessarily increase farmers’ adoption of soil and water conservation practices as a climate change adaptation strategy, suggesting that the current data collection methods might not be effectively encouraging or supporting these practices. Similarly, though related studies show that coffee farmers are aware of the soil and water conservation practices [74, 75], the adoption and continued use of these measures have been limited in many smallholder households [75, 76, 77]. Soil and water conservation practices should therefore be scaled up through a concerted effort of extension workers, local administration and other relevant non-state actors [78, 76].

Our results also showed that regular data collection exercise had negative weak correlation with coffee farmers having knowledge in the management of pests and diseases (r=-.178\*\*; p=0.00). This implies that regular data collection exercise does not necessarily translate to management of pests and diseases. In fact, various scholars in Uganda [79, 80, 81, 82] and elsewhere [83, 84, 85] have reported that farmers have knowledge on coffee pests and diseases but their management remains a big challenge. This finding shows that there is still a conceptual gap between scientific knowledge developed at research institutions and the fulfillment of the farmers’ need to solve their major pest and disease problems [84]. This therefore calls for participatory approaches for pest and disease management in coffee agro-systems with the supervision of the extension officers [84, 81], with the aim of empowering farmers to develop sustainable crop production and protection systems, replacing the traditional role as passive recipients of information [86]. All in all, there is a need of data in monitoring and evaluation [18] to support climate change interventions and make informed and corrective action [17].

Participatory monitoring through farmer-to-farmer exchange visits was positively and significantly correlated with farmers planting shade trees (r=.444\*\*, p=0.00) as well as applying soil and water conservation (r=.445\*\*, p=0.00) as climate change adaptation measures. This implies that farmer-to-farmer exchange visits resulted into increased planting of shade trees as well as use of soil and water conservation practices as a means of climate change adaptation, agreeing with several earlier studies [e.g. 87, 88, 89]. Farmer-to-farmer exchange visits are opportunities for farmers to learn from each other's experiences and practices [90]. Exchange visits are vital as they provide concrete examples of technologies, innovations and practices that farmers apply to their own circumstances [88]. They also improve the skills of farmers in addressing various challenges facing them and enhance productivity of coffee [91] as well as fostering change in behavior and attitudes amongst farmers [88].

Furthermore, participatory evaluation with farmers and their leaders was positively and significantly correlated with planting of shade trees (r=367\*\*, p=0.00) as well as use of soil and water conservation measures by farmers as climate change adaptation measures. This implies that participatory evaluation with farmers and their leaders resulted into increased uptake of planting of shade trees as well soil and water conservation practices as a means of climate change adaptation, supporting earlier research studies [92, 93, 94].

All in all, PM&E is crucial for gathering data on the progress of development programs, allowing program managers to assess if implementation is on track, and take corrective action necessary adjustments or redesign based on emerging situations and new information in response to climate change adaptations. This will essentially ensure that the program remains responsive to changing circumstances and effectively achieves its goals [95]. Information collected through PM&E can be used to learn from past experiences and improve performance, operations, and strategic decisions [96]. PM&E is also increasingly being used for accountability and transparency for several interventions [96, 97].

Table 6. Spearman Correlation between the dependent and independent variables (n=385; significant p values are highlighted in bold)

|  |  |  |
| --- | --- | --- |
| **Independent variable** |  | **Dependent variables** |
|  | **DV 1** | **DV 2** | **DV 3** | **DV4** | **DV 5** |
| IV1 | Correlation coefficient  | 0.043 | -0.021 | **.272\*\*** | **.920\*\*** | 0.072 |
| P value | 0.40 | 0.68 | **0.00** | **0.00** | 0.16 |
| IV2 | Correlation coefficient | 0.059 | -0.074 | **.203\*\*** | **.684\*\*** | 0.081 |
| P value | 0.25 | 0.15 | **0.00** | **0.00** | 0.11 |
| IV3 | Correlation coefficient | 0.065 | -0.085 | **.271\*\*** | **.658\*\*** | 0.09 |
| P value | 0.20 | 0.10 | **0.00** | **0.00** | 0.08 |
| IV4 | Correlation coefficient | **-.155\*\*** | -0.018 | 0.036 | **-.158\*\*** | **-.178\*\*** |
| P value | **0.00** | 0.72 | 0.48 | **0.00** | **0.00** |
| IV5 | Correlation coefficient | -0.04 | -0.087 | **.444\*\*** | **.445\*\*** | 0.02 |
| P value | 0.44 | 0.09 | **0.00** | **0.00** | 0.70 |
| IV6 | Correlation coefficient | 0.004 | -0.056 | **.367\*\*** | **.428\*\*** | 0.06 |
| P value | 0.93 | 0.28 | **0.00** | **0.00** | 0.24 |
| IV7 | Correlation coefficient | 0.058 | -0.029 | 0.047 | 0.086 | 0.026 |
| P value | 0.25 | 0.57 | 0.35 | 0.09 | 0.61 |
| IV8 | Correlation coefficient | -0.05 | -0.061 | 0.031 | 0.035 | -0.037 |
| P value | 0.33 | 0.24 | 0.54 | 0.50 | 0.47 |

**Key**

IV1=Participatory planning with farmers representatives ensures inclusiveness at district/sub-county/cooperative level

IV2=Needs assessments during the planning process with farming communities yields higher results during implementation process of climate adaptations

IV3=Participatory monitoring with farmers encourages them to manage their coffee fields through learning good agronomic practices from other farmers.

IV4=Data collection exercise is done regularly during the field visits by extension staff to assess farmer's performance communities to work together to achieve high coffee yields through climate change adaption practices

IV5=Participatory monitoring through farmer-to-farmer exchange visits are vital to coffee farmers in providing skills knowledge and experience on how to improve or change the climate adaptation strategies

IV6=Participatory evaluation is often with farmers and farmer leaders to reflect on their actions and determine which intervention is working effectively

IV7=All stakeholders including farmers participate in the feedback sessions before the findings are disseminated to different platforms

IV8=Dissemination of findings and results are conducted during the meetings at the district headquarters

DV1=Coffee farmers have access to timely climatic information that can support climate adaptation measures

DV2=Coffee farmers have information on the availability and access of drought resistant varieties enhance climate adaptation

DV3=Coffee farmers often plant recommended shade trees in their coffee fields

DV4=Soil and water conservation measures can greatly contribute to climate change adaptations

DV5=Coffee farmers have the knowledge in the management of the pests and diseases through PM&E practices

**3.2 Regression between participatory monitoring and evaluation practices and climate change adaptation measures**

Results of a regression analysis between participatory planning with farmers’ representatives and the use of soil and water conservation measures which had the most outstanding Spearman Correlation Coefficient (0.92; table 6) are shown in the model summary below (Table 7). The R value of 0.858 indicates a strong positive correlation between participatory planning with farmers’ representatives and soil and water conservation measures. The observed adjusted R2 of 0.736 implies that 73.5% of the change in climate change adaptation is explained by participatory M&E practices. The remaining 26.5% could be attributed to other factors not exhibited in the model. This result is in agreement with [98], [99], and [100] who remarked that econometric model is considered to have high predictable power if the model has a high adjusted R-squared.

Table 7. Model Summary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Model** | **R** | **R-Square** | **Adjusted R Square** | **Standard Error of the Estimate** |
| 1 | .858a | .736 | .735 | .303 |
| 1. Predictors: (Constant), Participatory planning with farmer representatives ensures inclusiveness of stakeholders at district/sub-country/ cooperative level
 |

Furthermore, the analysis of variance (ANOVA) shown in table 8 indicated that the p-value was less than 0.05 (p=0.000, p<0.05) at 5% level of significance. This was statistically significant, insinuating rejection of the hypothesis that participatory planning with farmers’ representatives has no significant influence on the use of soil and water conservation measures as a method of climate change adaptation.The model thus exhibited that participatory planning with farmers’ representatives was statistically significant in influencing the use of soil and water conservation measures as a method of climate change adaptation, at 95% level of confidence. In addition, the ANOVA showed that the Fisher’s ratio (F statistic) is significant, since the P value is 0.00. Hence, it clearly indicates that PM&E practices significantly contribute and support climate change adaptation among coffee farmer households. Therefore, investing in PM&E practices within climate change adaptation initiatives is likely to lead to significant positive change by improving adaptation strategies. This finding is in line with several studies [e.g. 19, 17, 101, 24, 101].

Table 8. Analysis of Variance (ANOVA) results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Model** | **Sum of Squares** | **Df** | **Mean Square** | **F** | **Sig.** |
|  | Regression | 97.675 | 1 | 97.675 | 1066.134 | 0.00b |
|  | Residual  | 35.089 | 383 | 0.92 |  |  |
| 1 | Total | 132.764 | 384 |  |  |  |
| 1. Dependent Variable: Soil and water conservation measures can greatly contribute to climate change adaptations among coffee farming households
 |
| 1. Predictors: (Constant): Participatory planning with farmer representatives ensures inclusiveness at District/ Sub-country/ Cooperative level.
 |

Furthermore, the standardised coefficient Beta was 0.858 and highly significant with p=0.00 (Table 9), implying that a unit of efforts invested in PM&E practices would result into 0.858 change in terms of climate change adaptation among coffee farmer households. Results also showed that the coefficient of regression was highly significant (p= .00) for PM&E practices and therefore, the null hypothesis is rejected. PM&E practices are therefore, significant predictors of climate change adaptation among coffee farmer households as they provide crucial information to understand the effectiveness of adaptation strategies, identifying areas for improvement and allowing for adjustments to be made [24, 103, 102].

Table 9. Coefficients results

|  |  |
| --- | --- |
| Model | Coefficientsa |
| Unstandardized Coefficients | Standardized Coefficients | t | Sig. |
| B | Std. Error | Beta |
| (Constant) | .465 | .119 |  | 3.9000 | .00 |
| 1 | Participatory planning with farmer representatives ensures inclusiveness at district/sub-country/cooperative level | .887 | .027 | .858 | 32.652 | .00 |
| 1. Dependent Variable: Soil and water conservation measures can greatly contribute to climate change adaptations among coffee farming households.
 |

4. Conclusion

Our study aimed at defining the contribution of the various participatory monitoring and evaluation (PM&E) practices to enhancing adaptation of climate change measures by the coffee farming community of Ntungamo district, southwestern Uganda. Results revealed that participatory planning, needs assessments, monitoring with farmers, farmer-to-farmers exchange visits, and, participatory evaluation are good predictors of farmers’ use of recommended shade trees as well as soil and water conservation practice as interventions for adapting to climate in their coffee gardens. Coffee farmers should therefore be directly involved in planning discussions at local Government level to identify specific goals and develop climate change adaptation strategies that are tailored to their needs, experiences and capacity, using a bottom-up approach. This will significantly enhance farmers’ sense of ownership and commitment, leading to better implementation of climate change adaptation strategies.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

References

1. Slavova, G. & Georgieva, V. (2019). World production of coffee imports and exports in Europe, Bulgaria and USA. Trakia Journal of Sciences, 17(1), 619-626.
2. Poncet, V., van Asten, P. J. A., Millet, C., Vaast, P. & Allinne, C. (2024). Which diversification trajectories make coffee farming more sustainable?. Current Opinion in Environmental Sustainability. 68, 101432. 10.1016/j.cosust.2024.101432.
3. UCDA, 2024. Uganda Coffee Development Authority (UCDA). Monthly Report, November 2024. Report CY 2024/25 Issue 2.
4. NCP. (2013). National Coffee Policy (NCP). Uganda Coffee Development Authority (UCDA). Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Kampala, Uganda. 20 pp.
5. Mugoya, T. (2018). The financial viability of coffee farming in Uganda. Study Report, October 2018. Uganda National Coffee Platform. 40 pp.
6. Bunn, C., Lundy, M., Läderach, P., Fernández P. & Castro-Llanos, F. (2019). Climate-smart Coffee in Uganda. International Center for Tropical Agriculture (CIAT), Cali, Colombia
7. Wang, N., Jassogne, L., van Asten, P. J. A., Mukasa, D., Wanyama, I., Kagezi, G. et al. (2015). Evaluating coffee yield gaps and important biotic, abiotic, and management factors limiting coffee production in Uganda. European Journal of Agronomy, 63, 1-11.
8. Van der Vossen, H. A. M. (2005). A critical analysis of the agronomic and economic sustainability of organic coffee production. Experimental Agriculture, 41, 449–473.
9. Jassogne, L., Laderach, P. & van Asten, P. J. A. (2013). The Impact of Climate Change on Coffee in Uganda: Lessons from a case study in the Rwenzori Mountains. Climate Change and Resilience, 9(1), 51-66.
10. Mulinde, C., Mwanjalolo, M., Twinomuhangi, R., Mfitumukiza, D., Komutunga, E., Ampaire, E. et al. (2019). Perceived climate risks and adaptation drivers in diverse coffee landscapes of Uganda. NJAS - Wageningen Journal of Life Sciences, 88, 31-44.
11. Cuni-Sanchez, A., Twinomuhangi, I., Aneseyee, AB., Mwangi, B., Olaka, L., Bitariho, R. et al. (2022). Everyday adaptation practices by coffee farmers in three mountain regions in Africa. Ecology and Society, 27(4), 32.
12. Smit, B. & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. Global Environmental Change 16, 282–292.
13. IPCC. (2007). Climate change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, & L. A. Meyer, Eds.). Cambridge, UK; New York, NY: Cambridge University Press.
14. Akinnagbe, O. & Irohibe, I. (2015). Agricultural adaptation strategies to climate change impacts in Africa: a review. Bangladesh Journal of Agricultural Research, 39(3), 407–418.
15. Atube, F., Okello, D., Malinga, G., Nyeko, M. & Okello-Uma, I. (2022). Farmers’ adaptation to climate change and crop yield: a case of Amuru and Apac districts of Northern Uganda. International Journal of Agricultural Sustainability. 20. 10.1080/14735903.2022.2028400.
16. Takal, S. U., Tahiru, A. W., Fattah, I. R., Cobbina, S. J., Asare, W. & Abanyie, S. K. (2025). Enhancing resilience to climate change: a comprehensive PRISMA review of agricultural and non-agricultural adaptation strategies for Ghana. Cogent Social Sciences, 11(1). DOI:10.1080/23311886.2025.
17. Villanueva, P. S. (2010). Learning to ADAPT: Monitoring and evaluation approaches in climate change adaptation and disaster risk reduction – Challenges, gaps and ways forward. Strengthening Climate Resilience Discussion Paper 9.
18. Bours, D., McGinn, C. & Pringle, P. (2014). Monitoring & evaluation for climate change adaptation and resilience: A synthesis of tools, frameworks and approaches. Second edition. 10.13140/RG.2.1.1151.4645.
19. Dinshaw, A., Fisher, S., McGray, H., Rai, N. & Schaar, J. (2014). Monitoring and evaluation of climate change adaptation: Methodological Approaches. OECD Environment Working Paper No. 74. OECD Publishing, Paris.
20. Cradock-Henry, N. A., Blackett, P., Hall, M., Johnstone, P., Teixeira, E., & Wreford, A. (2020). Climate adaptation pathways for agriculture: Insights from a participatory process. Environmental Science and Policy, 107, 66-79.
21. Chesterman S. & Ericksen P. (2013). Monitoring adaptation to enhance food security: A survey of approaches and best practice. CCAFS Working Paper no. 51. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. 46pp.
22. Khanal, U., Wilson, C., Lee, B. L., & Hoang, V. N. (2018). Climate change adaptation strategies and food productivity in Nepal: a counterfactual analysis. Climatic Change, 148, 575–590.
23. Thapa, P., Ngwenya, P., & Kaufmann, B. (2017). Participatory Monitoring and Evaluation: a tool for making farmer groups function better. Appropriate Technology, 44(4), 43–45.
24. Ssekamatte, D. (2018). The role of monitoring and evaluation in climate change mitigation and adaptation interventions in developing countries. African Evaluation Journal, 6(1), 1–9.
25. Vernooy, R., Qiu, S. & Xu, J. (2006). The power of participatory monitoring and evaluation: Insights from south-west China. Development in Practice, 16. 400-411.
26. Ngwenya, K. (2014). Gender differentiated innovations in response to climate change: Evidence from smallholder Agriculture in 4 countries in East Africa. MSc thesis. University of Alberta. Canada. 136 pp
27. Dinshaw, A. (2018). Monitoring and Evaluating Mainstreamed Adaptation to Climate Change: A Synthesis Study on Climate Change in Development Cooperation. IOB Evaluation, 426.
28. Ford, J. D., Berrang-Ford, L., Lesnikowski, A., Barrera, M., & Jody Heymann, S. (2013). How to track adaptation to climate change: A typology of approaches for national-level application. Ecology and Society, 18. 40.
29. Nkoana, E. M., Verbruggen, A., & Hugé, J. (2018). Climate change adaptation tools at the community level: An integrated literature review. Sustainability 2018, 10(3). 796.
30. Siders, A., & Pierce, A. L. (2021). Deciding how to make climate change adaptation decisions. Current Opinion in Environmental Sustainability, 52, 1–8.
31. Egeru, A. (2012). Role of indigenous knowledge in climate change adaptation: A case study of the Teso sub-region, eastern Uganda. Indian Journal of Traditional Knowledge, 11(2), 217-224.
32. HRV, (2016). Ntungamo District Hazard, Risk and Vulnerability (HRV) profile. 76pp.
33. Okech, S. H., Gold, C. S., Bagamba, F., Masanza, M., Tushemereirwe, W. K. & Ssenyonga, J. (2005). Cultural control of banana weevils in Ntungamo, southwestern Uganda. In: G. Blomme, C. Gold and E. B. Karamura (Editors), Farmer participatory testing of integrated pest management options for sustainable banana production in Eastern Africa, Proceedings of workshop on Farmer-participatory testing of IPM options for sustainable banana production in Eastern Africa, Seeta, Uganda, December 8-9, 2003, pp. 116-128.
34. Kukundakwe P., Tuhirirwe, J. & Atwiine, D. W. (2024). The influence of effectiveness of promotion of marketing activities on performance of Ankole Coffee Producers’ Cooperative Union (ACPCU) in Sheema district. American Research Journal of Humanities and Social Science, 7(8), 29-37.
35. Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. Educational and Psychological Measurement, 30(3), 607–610.
36. Navarro-Rivera, J., & Kosmin, B. A. (2011). Surveys and Questionnaires. In The Routledge handbook of research methods in the study of religion, Michael Stausberg and Steven Engler (Eds). Routledge. Pp. 395–420.
37. Young, T. J. (2015). Questionnaires and surveys. In H. Zhu (Ed.), Research methods in intercultural communication: A practical guide. Oxford: Wiley. Pp. 165-180.
38. Cohen, L., Manion, L. & Morrison, K. (2017). Validity and reliability. In: Research methods in education. Routledge. Pp. 245-284.
39. Brod, M., Tesler, L. E. & Christensen, T. L. (2009). Qualitative research and content validity: developing best practices based on science and experience. Quality of Life Research, 18, 1263–1278.
40. Polit, D. F., Beck, C. T. & Owen, S. V. (2007). Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. Research in Nursing and Health. 30, 459-67.
41. Golafshani, N. (2003). Understanding reliability and validity in qualitative research. The Qualitative Report, 8(4), 597-606.
42. Bettany-Saltikov, J. & Whittaker, V. J. (2014). Selecting the most appropriate inferential statistical test for your quantitative research study. Journal of Clinical Nursing, 23(11–12), 1520–1531.
43. Ruscio, J. (2008). Constructing confidence intervals for Spearman’s rank correlation with ordinal data: A simulation study comparing analytic and bootstrap methods. Journal of Modern Applied Statistical Methods, 7(2), 416–434.
44. Schober, P., Boer, C. & Schwarte, L. A. (2018). Correlation coefficients: Appropriate use and interpretation. Anesthesia and Analgesia, 126, 1763-1768.
45. Kissinger, G., Lee, D., Orindi, V. A., Narasimhan, P., King’uyu, S. M., & Sova, C. (2013). Planning climate adaptation in agriculture. Meta-synthesis of national adaptation plans in West and East Africa and South Asia. CCAFS Report No. 10. Copenhagen, Denmark: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).
46. Kim, D. & Kang, J. E. (2016). Integrating climate change adaptation into community planning using a participatory process: The case of Saebat Maeul community in Busan, Korea. Environment and Planning B: Urban Analytics and City Science, 45(4), 669–690.
47. Vermeulen, S. J., Campbell, B. M. & Ingram, J. S. I. 2012. Climate change and food systems. Annual Review of Environment and Resources, 37, 195-222.
48. Tukahirwa, J. M. B. 2002. Policies, people and land use change in Uganda. A case study in Ntungamo, Lake Mburo and Sango Bay sites. The land use change, impacts and dynamics project working paper no. 17.
49. Ntakyo, P. R., Odongkara, K., Naluwairo, R., Kalunda, P. & Akello, B. (2011). Food security and minor crops in Uganda: The farmers’ perspective and policy implications. African Crop Science Conference Proceedings, 10,473-477.
50. Kanyesigye, J. (2023). Evaluation and adoption of biofortified bean varieties in Sheema and Ntungamo districts, southwestern, Uganda. MSc thesis. Bishop Stuart University, Uganda. 90 pp.
51. Agea, J., Nansereko, S., Obua, J., Waiswa, D., Buyinza, M. & Yikii, F. (2009). Attitudes of out-of-school youths towards tree planting activities in central Uganda: A case study of Masaka district. Discovery and Innovation. 21(1-2), 10.4314/dai.v21i1-2.48195.
52. Riedman, E., Roman, L., Pearsall, H., Maslin, M. & Ifill, T. (2022). Why Don’t People Plant Trees? Uncovering Barriers to Participation in Urban Tree Planting Initiatives. Urban Forestry and Urban Greening, 73, 127597. 10.1016/j.ufug.2022.127597.
53. Fikreyesus, D., Gizaw, S., Mayers, J., & Barrett, S. (2022). Mass tree planting prospects for a green legacy in Ethiopia. IED, London, ISBN 978-1-78431-973-1.
54. Van Noordwijk, M., Hoang, M. H., Neufeldt, H., Öborn, I. &Yatich, T., Eds. (2011). How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes. Nairobi: World Agroforestry Centre (ICRAF). 152 pp.
55. Mazengia, W. & Mowo, J. (2012). Role of collective actions in integrated soil and water conservation: The case of Gununo watershed, southern Ethiopia. Journal of Development and Agricultural Economics, 4(1), 23-36.
56. Okoba, B.O., Tenge, A., Sterk, G. & Stroosnijder, L. (2007). Participatory soil and water conservation planning using an erosion mapping tool in the Central Highlands of Kenya. Land Degradation & Development, 18, 303-319.10.1002/ldr.778.
57. Tenge, A. J., Okoba, B. O. & Sterk, G. (2007). Participatory soil and water conservation planning using a financial analysis tool in the West Usambara highlands of Tanzania. Land Degradation and Development, 18(3), 321–337.
58. Tumwesigye, W., Atwongyire, D., Ayebare, P. & Ndizihiwe, D. (2018) Climate Smart Soil and Water Conservation Practices: A Way forward for Increasing Crop Production among Smallholder Farmers in South Western Uganda. American Journal of Agriculture and Forestry, 6, 28-37
59. Indrawati, D. R., Supangat, A. B., Purwanto, Wahyuningrum, N. & Subandrio, B. (2022). Community participation in soil and water conservation as a disaster mitigation effort. IOP Conference Series: Earth and Environmental Science, 1109, 012030.
60. Okoba, B. O., Tenge, A. J., Sterk, G., & Stroosnijder, L. (2007). Participatory soil and water conservation planning using an erosion mapping tool in the central highlands of Kenya. Land Degradation and Development, 18(3), 303-319.
61. Buyinza, J., Nuberg, I.K., Muthuri, C.W., & Denton, M.D. (2021). Farmers’ knowledge and perceptions of management and the impact of trees on-farm in the Mt. Elgon region of Uganda. Small-scale Forestry, 21, 71-92.
62. Chuma, G. B., Mondo, J. M., Ndeko, A. B., Bagula, E. M., Lucungu, P. B., Bora, S. F. et al. (2022). Farmers’ knowledge and practices of soil conservation techniques in smallholder farming systems of Northern Kabare, East of DR Congo. Environmental Challenges, 100516. 10.1016/j.envc.2022.100516.
63. Yifru, G. S. & Miheretu, B. A. (2022). Farmers’ adoption of soil and water conservation practices: The case of Lege-Lafto watershed, Dessie Zuria district, south Wollo, Ethiopia. PLoS ONE, 17(4), e0265071.
64. Ntawuruhunga, D., Ngowi, E. E., Mangi, H. O., Salanga, R. J. & Leonard, K. L (2025). Farmers’ knowledge, attitude, and motivation for adoption of climate-smart agroforestry in two contrasting agroecosystems of Rwanda. Trees, Forests and People, 19, 100766.
65. Mukuralinda, A., Ndayambaje, J. D., Iiyama, M., Ndoli, A., Musana, B. S., Garrity, D. et al. (2016). Taking to scale tree-based systems in Rwanda to enhance food security, restore degraded land, improve resilience to climate change and sequester carbon. PROFOR, Washington D.C.
66. Evans, K., Guariguata, M. R., & Brancalion, P. H. S. (2018). Participatory monitoring to connect local and global priorities for forest restoration. Conservation Biology, 32(3), 525–534.
67. Shah, P., Bharadwaj, G. & Ambastha, R. (1988). Participatory impact monitoring of a soil and water conservation programme by farmers, extension volunteers and AKRSP in Gujara. PLA Notes CD-ROM, 1988-2001.
68. Atnafe, A. D., Husen, M. A.& Demeku, M. A. (2015). Determinants of adopting techniques of soil and water conservation in Goromti watershed, western Ethiopia. Journal of Soil Science and Environmental Management, 6, 168-177.
69. Abbot, J. & Guijt, I. (1998). Changing views on change: participatory approaches to monitoring the environment. SARL Discussion Paper, 2.
70. Antwi-Agyei, P., Dougill, J. A. &Abaidoo, C. R. (2021). Opportunities and barriers for using climate information for building resilient agricultural systems in Sudan savannah agro-ecological zone of north-eastern Ghana. Climate Services, 100226.
71. Baffour-Ata, F., Antwi-Agyei, P., Nkiaka, E., Dougill, A. J., Anning, A. K. & Kwakye, S. O. (2022). Climate information services available to farming households in northern region, Ghana. American Meteorological Society, 14(2), 467-480.
72. Dukper, K. B. (2022). Access and utilisation of climate change information by small-holder farmers in Bunkpurugu-Yunyoo districts, Ghana. Library Philosophy and Practice, 7151.
73. Matere, S., Busienei, J. R., Irungu, P., Mbatia, O. L. E., Nandokha, T. & Kwena, K. (2023). Do farmers use climate information in adaptation decisions? Case of smallholders in semi-arid Kenya. Information Development. 2023, 40, 602–619.
74. Mekonnen, H., Kebede, K., Hasen, M. & Tegegne, B. (2016). Farmer’s perception of soil and water conservation practices in eastern Hararghe, Ethiopia. Scientific Journal Warsaw University of Life Sciences, 16(4), 232–239.
75. Njenga, M., Mugwe, J., Mogaka, H., Nyabuga, G., Oduor, N., Kiboi, M. et al. (2021). Determinants of farmers’ knowledge on soil and water conservation technologies in dry zones of central highlands, Kenya. Journal of Agricultural Extension, 25. 127-143.
76. Turyahabwe, R., Wambede, N. M., Asaba, J., Mulabbi, A. & Turyabanawe, L. (2022). Factors affecting the adoption of soil and water conservation practices by small-holder farmers in Muyembe sub-county, eastern Uganda. Ghana Journal of Geography, 14(2), 24-49.
77. Belayneh, M. (2023). Factors affecting the adoption and effectiveness of soil and water conservation measures among small-holder rural farmers: The case of Gumara watershed. Resources, Conservation and Recycling Advances, 18, 200159.
78. Wordofa, M. G., Okoyo, E. N. & Erkalo, E. (2020). Factors influencing adoption of improved structural soil and water conservation measures in Eastern Ethiopia. Environmental Systems Research, 9, 13.
79. Luzinda, H., Nelima, M., Wabomba, A., Kangire, A., Musoli, P. C. & Musebe, R. (2015). Farmer awareness, coping mechanisms and economic implications of coffee leaf rust disease in Uganda. Uganda Journal of Agricultural Sciences, 16(2), 207-217.
80. Liebig, T., Jassogne, L., Rahn, E., Läderach, P., Poehling, H-M., Kucel, P/ et al. (2016) Towards a collaborative research: A case study on linking science to farmers’ perceptions and knowledge on Arabica coffee pests and diseases and its management. PLoS ONE, 11(8), e0159392.
81. Kagezi, G. H., Kucel, P., Kobusinge, J., Olango, D. N., Nakibuule, L., Nanjego, W. et al. (2018). Farmers’ knowledge and perception of the use of pesticides in Arabica coffee, *Coffea arabica* agro-ecologies of Uganda. Journal of Agriculture and Environmental Sciences, 7(2), 173-188.
82. Kobusinge, J., Kagezi, G. H, Kasoma, A., Kucel, P., Nakibuule, L., Perfecto, I. et al. (2018). Farmers’ knowledge of pests and diseases in the coffee-banana agroforestry systems of mid-eastern Uganda. Journal of Agriculture and Environmental Sciences, 7(2), 109-119.
83. Hillocks, R. J., Phiri, N. A. & Overfield, D. (1999). Coffee pest and disease management options for smallholders in Malawi. Crop Protection, 18(3), 199–206.
84. Segura, H. R., Barrera, J. F., Morales, H., & Nazar, A. (2004). Farmers’ perceptions, knowledge, and management of coffee pests and diseases and their natural enemies in Chiapas, Mexico. Journal of Economic Entomology, 97(5), 1491–1499.
85. Aranka, J., Apis, B., Asiota, B., Bafeo, M., Bekio, J., Curry, G. N., et al. (2021). Smallholder farmers’ knowledge of coffee pests and diseases in Eastern Highlands Province, Papua New Guinea. PNG Coffee Journal, 15(1), 23-29.
86. Williamson, S. (2002). Challenges for farmer participation in integrated and organic production of agricultural tree crops. Biocontrol News and Information, 23(1), 25–36.
87. Franzel, S. & Scherr, S. J. (Eds) (2002). Trees on the farm: Assessing the adoption potential of agroforestry practices in Africa. Wallingford: CABI.
88. Mlenga, A. (2019). Factors affecting adoption of soil and water conservation technologies in Mbwadzulu Extension Planning Area (EPA), Mangochi District, Malawi. United Nations University Land Restoration Programme. District, Malawi. United Nations [final project]. 36 pp.
89. Regreening Africa. (2020). Reversing land degradation in Africa by scaling-up evergreen agriculture. Annual Report, September 2019 - August 2020.
90. Khaila, S., Tchuwa, F., Franzel, S. & Simpson, S. (2015).The farmer-to-farmer extension approach in Malawi: A survey of lead farmers. ICRAF Working Paper No. 189. Nairobi, World Agroforestry Centre. DOI:<http://dx.doi.org/10.5716/WP14200.PDF>.
91. Ochago, R., Dentoni, D. & Mahdad, M. (2024). The effect of Ugandan coffee farmers’ role identity on their experiential learning. Journal of Experiential Education, 47(4), 767–800.
92. Hamilton, C., Rai, R. K., Shrestha, R. B., Maharian, M., Rasaily, L & Hood, S. (2001). Exploring visions: Self-monitoring and evaluation processes within the Nepal-UK Community Forestry Project, In: Learning from change. Pp. 15-31.
93. Evans, K. & Guariguata, M. R. (2008). Participatory monitoring in tropical forest management: a review of tools, concepts and lessons learned. Bogor, Indonesia: Center for International. Forestry Research (CIFOR). 56 pp.
94. Mgoba, S. A. & Kabote, S. J. (2020). Effectiveness of participatory monitoring and evaluation on achievement of community‑based water projects in Tanzania. Applied Water Science, 10, 200.
95. Zerfu, E. & Kebede, S. (2013). Filling the learning gap in program implementation using participatory monitoring and evaluation: Lessons from farmer field schools in Zanzibar. IFPRI Discussion Paper 1256. Washington, D.C.: International Food Policy Research Institute.
96. Woodhill, J. 2007. M&E as learning: Rethinking the dominant paradigm. In: Monitoring and evaluation of soil conservation and watershed development projects. J. de Graaff, J. Cameron, S. Sombatpanit, C. Pieri, and J. Woodhill. (Eds). World Association of Soil and Water Conservation. Enfield, New Hampshire, USA: Science Publishers.
97. Estrella, M., Blauert, J., Gaventa, J., Campilan, D., Gaventa, J., Gonsalves, J. et al. (2000). Learning from change: Issues and experiences in participatory monitoring and evaluation. London: Intermediate Technologies Publications.
98. Gujarati, D. N., Porter, D. C. & Gunasekar, S. (2012). Basic Econometrics 5th Edition, Tata McGraw Hill Educational Private Limited, New Delhi, India.
99. Gao, J. (2024). R-Squared (R2) – How much variation is explained? Research Methods in Medicine and Health Sciences, 5(4), 104-109.
100. Ozili, P. K. (2023). "The acceptable R-square in empirical modelling for social science research," MPRA Paper 115769, University Library of Munich, Germany.
101. STAP (2017). Strengthening monitoring and evaluation of climate change adaptation: A STAP advisory document. Global Environment Facility, Washington, D.C. 59 pp.
102. Dupuits, E., Garcés, A., Llambí, L. D. and Bustamante, M. (2024). Strategies for monitoring and evaluation of climate change adaptation: localizing global approaches into Andean realities. npj Climate Action, 3, 19.
103. FAO and UNDP. (2019). Strengthening monitoring and evaluation for adaptation planning in the agriculture sectors. Food and Agriculture Organization of the United Nations and United Nations Development Programme Rome. 94 pp.