 doi:10.20944/preprints202208.0336.v1

Article

Can Agroecology Provide a Panacea for Sustaining the Adoption of Soil Erosion Control Measures? A Case of Smallholder *Coffea arabica* Production in the Rwenzori Mountain Region Uganda

Thaddeo Kahigwa Tibasiima [1,2*], Deous Mary Ekyaligonza[1, 2] and Bosco Bwambale[2]

[1] Division of Organic Farming, Department of Sustainable Agricultural Systems, University of Natural Resources and Life Sciences, Vienna, Gregor-Mendel-Strasse 33, 1180 Wien
[2] Faculty of Agriculture and Environmental Sciences, Mountains of the Moon University, Fort Portal. P.O. Box 837, Uganda
*Corresponding author: tadsima2000@yahoo.com; Tel.: +256782313068

Abstract: Agroecological approaches are increasingly recommended for providing context-specific and sustainable solutions to issues confronting farming communities by enabling consorting the socioeconomic and ecological constraints on the farm. This study is the first attempt to test this argument based on the issue with sustaining adoption of soil erosion control measures among smallholder farmers producing *Coffea arabica* on the Rwenzori Mountain in Uganda. Here, the adoption of soil erosion control measures remains a challenge despite the increasing efforts through conventional agricultural advisory services in local governments. We contrast the elements of agroecology with the local discourses to identify if it would provide a panacea for sustaining adoption of soil erosion control measures. Results indicate that the agroecology elements harmonize with the local discourses on soil erosion control adoption in contrast to the conventional approach promoted through the agricultural advisory services. Drawing conclusions on the implication of this finding, we argue that, indeed, consideration of the agroecology elements at all stages in the process of soil erosion control would foster sustained adoption of soil erosion control measures.

Keywords: agroecological farming; discourse analysis; mountain conservation; sustainable adoption

1. Introduction

Soil erosion is a land degradation challenge, particularly in mountain areas where top fertile soil is lost on steeply sloping land. It is more recognized among farming communities where it results in drastic impaired crop growth [1, 2]. This is particularly a challenge for crops/plants that grow at high altitudes. One such crop, which is the focus of this study, is *Coffea Arabica*. It grows well in tropical regions and its production expansion is linked to land degradation in densely populated mountain areas [3, 4].

C. arabica is a high-value crop on the market and supports the socio-economic development of rural areas. The demand for coffee is also foreseen to increase, but due to climate change, the production of *C. arabica* is predicted to shift to higher altitude areas that are more prone to erosion [5, 6]. Therefore, the adoption of soil erosion control is considered important not only to support the production of *C. arabica,* but also to foster the attainment of the UN sustainable development goals (SDGs): Climate action (SDG 13) and responsible consumption and production (SDG 12) see Keesstra, Bouma [7].

To avert the challenge of soil erosion, among farmers of *C. arabica* on high altitude areas, several scholars and institutions have recommended numerous measures. Examples of these measures include the following: alley cropping, implementation of no-tillage practices, the establishment of water-catching trenches along contour lines, integration of

 doi:10.20944/preprints202208.0336.v1

cover legumes, agroforestry, trash bands, stone bands, and mulching [8]. These measures have been continuously promoted but their adoption remains low. This is argued to result from a mismatch between the recommended measures and the local context [9-11].

In contexts where *C. arabica* is grown at high altitude, adoption of soil erosion measures is found to be influenced by several factors: the nature of the land (particularly the slope), social aspects including membership in farmer organizations, and economic constraints such as labor demands [11]. These constraints can broadly be categorized into the socioeconomic and ecological context of the communities at risk of soil erosion. As such, the socioeconomic and ecological constraints are acknowledged to present a complexity, making it difficult for a one-size-fits-all solution for continued adoption of soil erosion control [11-13]. As a response, several studies on enabling adoption, have recommended context-specific approaches to address the complexities associated with dynamics brought about by varying social, economic, and environmental elements which vary both in space and time [12, 14-16]. To attain context fit, agroecology has been presented as a holistic approach [17-19].

Broadly, agroecology is defined as a science, a practice, and a social movement [20, 21]. It simultaneously applies ecological and social concepts and principles while optimizing interactions between the soils, plants, animals, and humans as well as considering the social aspects for attaining sustainable and fair food systems [22]. Thus, it is known for promoting collective action, locally appropriate technologies, participatory research, and participatory extension [17, 18, 23, 24]. The potential of agroecology building resilience against climate change through building resilient livelihood and food systems has been documented [25, 26]. However, the potential of agroecology in enabling sustainable adoption of soil erosion on smallholder farms has not been documented despite the holistic applicability of the agroecology elements. To the contrary, the limitations of agroecology in application to smallholder farmers has been documented albeit with criticism [27, 28].

Standpoint theorists would thus argue that if the elements of agroecology reflect in the local discourses on soil erosion control, they present a panacea towards sustaining soil erosion control [29, 30]. Therefore, this study aims to investigate the presence of the agroecology elements in the local discourses compared to the conventional agricultural advisory systems to find out if the local perspective, sustainable soil erosion control measures harmonize with the agroecology elements. We thus first theorize the elements of agroecology that would support sustained adoption of soil erosion control measures. Then we analyze them against a specific case in the Rwenzori highlands where the adoption of soil control measures is low despite the high erosion and the increasing conventional agricultural services [11]. The study is guided by one general question: How does agroecology align with the local discourses on soil erosion control in practice?

2. Theoretical perspective on Agroecology elements

According to FAO. [22], 10 elements are argued to make agroecology holistic and context-specific in practice. These include diversity, synergies, efficiency, resilience, recycling, knowledge co-creation and sharing, human and social values, culture and food traditions, responsible governance, and a circular and solidarity economy. These elements are interlinked in such a way that makes agroecology bring aboard the ecological, economic, and social aspects into play to define a feasible and appropriate approach for a specific context. For instance, 1) **Diversity** emphasizes the integration of different enterprises that support each other in a farming system. This feeds into one of the parts of 2) **Synergies,** the complementarity of combining different enterprises. Synergy also touches on the cooperation and partnerships of different actors working together at multiple scales. Here, then, already the ecological and social elements (actors) are brought into play. Other social elements are linked with the 3) **Human and social values** which fosters bottom-up approaches that enable rural people to be agents of their own change. This is closely connected with 4) **co-creation and sharing of knowledge** through participatory

 doi:10.20944/preprints202208.0336.v1

development of context-specific solutions among different stakeholders to fit the environmental, social, economic, cultural, and political system.

In improving the livelihoods of rural people, particularly smallholder farmers, agroecology puts emphasis on dignity, equity, inclusion, and justice. It builds the autonomy of women and youth as central to the sustainability of farming systems. The element that fosters this further is 5) **Culture and Food traditions** being central in developing sustainable farming systems understanding that cultural identity and sense of place are often closely tied to landscapes and food systems. Agroecology also argues for the hybridization of the ecological, social and the economy elements. The core element, in this case, is 6) **Efficiency,** aiming at optimizing the use of locally available resources and designing farming systems with biological, socio-economic, and institutional diversity and alignment in time and space to attain optimum output from minimum input. The other element is 7) **Resilience** which in the farming system is based on diversity enabling recovery from shocks and stresses. It emphasizes both ecological and socio-economic resilience; Both efficiency, synergies and resilience are also based on 8) **recycling** through using outputs of one system as inputs into another system. Through 9) **Responsible governance** traditional and customary models of governance to enhance synergy among stakeholders and provide incentives for the long-term investments that are necessary to protect soil, biodiversity, and ecosystem services. It also calls for the inclusion of 10) a **Circular and solidarity** economy that brings producers and consumers together so that producers can increase their incomes while offering a sustainable good quality product. However, mixed opinions about the potential of agroecology enabling sustainable transitions still exist in literature among scholars [28, 31].

Our argument is that the agroecology elements would be relevant in sustained adoption of soil erosion control if they can be situated within the local discourses on soil erosion control as proposed by the standpoint theory [29, 30]. Scholars recommend using as a starting point of the communities themselves, analyzing first where they are and then stepwise identifying entry points for adapting their practices [30]. Therefore, in this study, the motive is to find out if the agroecology elements relate to the local discourses on soil erosion control.

3. Materials and methods

3.1. Case study in the Rwenzori

The study was conducted in the Rwenzori Mountains, at the border between Uganda and the Democratic Republic of Congo. Rwenzori Mountains experience a tropical climate with bimodal rainfall (March-May: 286 mm, 23.3 °C and August-November: 375 mm, 22.9 °C) on average annual rainfall of 884 mm [32]. The soils in this area are erosion-prone Leptosols, which are predominantly loamy sand [33]. In this area, the main cultivated crop is *C. arabica* grown as a mono-crop under which approximately 60% of the land is prone to erosion due to steep slopes [34-37]. Soil erosion is also high due to population pressure and degrading farming practices [11, 34]. The population explosion in this region has also been associated with other environmental disasters, some of which co-occur with soil erosion, such as landslides. For a detailed description of the Rwenzori regarding landslides and erosion as well as related disasters reference is made to [37, 38]. Within the Rwenzori Mountains, the study was conducted among smallholder farmers in Kyondo sub-county located in Kasese district at 0°11'12.0"N, 30°05'17.0"E (Latitude: 0.186667; Longitude: 30.088050) at altitude 1300-1800 m above sea level (Figure 1).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 18 August 2022 doi:10.20944/preprints202208.0336.v1

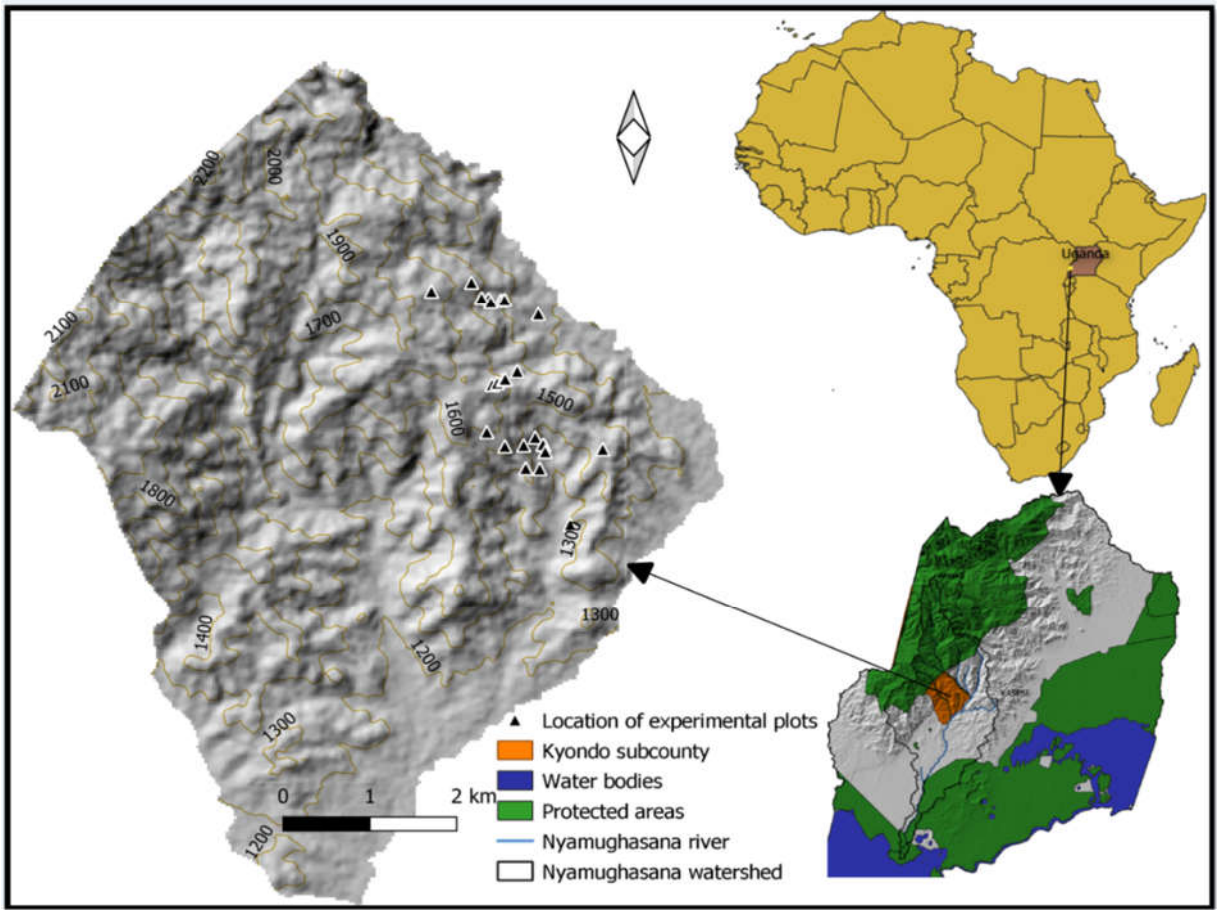

Figure 1. Study area showing the experimental plots on which interviews were conducted in the Rwenzori mountains.

Kyondo sub-county has a total population of 27400 inhabitants [39]. The area is part of the Rwenzori Mountains dominated by a local culture that promotes conservation-friendly livelihood systems related to agroecology [17, 30, 40]. For many years, conventional agricultural advisory services to avert soil erosion have been implemented in this area, but with limited success [11]. Although some organizations are known to have introduced agroecology in the Rwenzori Mountains [17], it is yet to be tested for its potential to enhance the uptake of soil erosion control measures and other issues that confront the smallholder farming community.

3.2. Data collection

The participants of this study included the following categories: smallholder coffee farmers, farmer advisers, researchers, local leaders (cultural, religious, and political), and agroecology experts (Table 1). To collect data from these categories, three methods were triangulated: field observations, individual interviews, and Focus Group Discussions (FGD). The specific questions that guided data collection were structured around three themes: the soil erosion control measures, the attributes of the soil erosion control measures that can enable sustainable adoption, and; the strategies for implementing sustainable soil erosion control measures.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 18 August 2022 doi:10.20944/preprints202208.0336.v1

Table 1. empirical study data sources.

Method	#Participants	Date, location	Characteristics	Selection criteria
Interviews	25	August 2019; February 2020, Kyondo sub-county	Coffee farmers	- Being affected by soil erosion - Belonging to a farmer organization that promotes soil erosion control.
FGD 1	09	June 2020, Nyamughasana valley farmers head office, Kyondo	Coffee farmers	- Participation in the farmer interviews
FGD 2	07	August 2020, Nyamughasana valley farmers	Cultural leaders and religious leaders	- Mentioned in the farmer interviews
FGD 3	06	December 2020, Mountains of the moon university campus	Agroecologists	- Agroecologists at Mountains of the moon University - Agroecology experts from Uganda Coffee Development Authority
FGD 4	06	March 2021, Mountains of the moon university campus	Extension advisor, National research institute	- Belonging to government extension and research
FGD 5	11	May 2021, Nyamughasana valley farmers	Farmers, Agroecologists, Conventional extension advisors, cultural, religious, and political leaders	- Participation in any of FGD1, FGD2, FGD3 and FGD4
Observation	25	August 2019 until May 2021, Coffee fields	Small holder C. arabica fields, Kyondo subcounty	- farm field of the interviewed farmers

The farmer interviews were conducted at the farms to enable combining the interviews with field observations of the soil erosion control measures being implemented. The specific farmers considered for farmer interviews were those belonging to a farmer association called Bukonzo East Training Team (BETT), mainly situated in Kyondo sub-county (Fig. 1). Moreover, with this farmer association as well as in this sub-county, a soil erosion control experiment had been conducted between 2018 and 2020. Farmers (25) that had hosted soil erosion control experiments participated in the interviews. The number 25 was determined by the saturation point, as recommended for qualitative research [41]. The data generated from the farmer interviews guided the questions for the FGDs.

From the 25 interviewed farmers, 11 farmers were selected for FGD 1 based on their vested knowledge and experiences as exhibited in the interviews. The FGD 1 was to triangulate the content of the farmer interviews. During preliminary interviews with the farmers, participants for FGD 2, FGD 3, and FGD 4 were suggested. The cultural and religious leaders are believed to have traditional views that relate to nature conservation [40]. As such, FGD 2 was conducted with the aim to find out if their views on soil erosion control connect with agroecological elements. This was followed by FGD 3 whose purpose was to connect the views of the agroecologists with farmers and the elements of agroecology. FGD 4 was the baseline comparison since it is the dominant agricultural advisory system. FGD 5 brought together the representatives of FGDs 1-4 to triangulate the

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 18 August 2022 doi:10.20944/preprints202208.0336.v1

different views. This representation (Table 1) of actors along the value chain integrates different knowledge, experiences, and interests.

3.3. Data analysis

Data were audio recorded, transcribed, and analyzed following thematic content analysis [42]. The codes were 1) discourses on soil erosion control measures 2) attributes of soil erosion control, and 3) Strategies for enabling sustainable adoption of soil erosion control measures. To find out the soil erosion control measures promoted among the smallholder farmers, we used the grounded theory since there were limited existing studies and theories to explain this empirical non-suggestive data [43]. The analysis of the data focused on finding connections between the local discourses and the 10 elements of agroecology that have been recommended by studies as central to sustainability. We thus set out to analyze the specific context of soil erosion control against the elements of agroecology as elaborated in section 2 (theoretical perspectives). Specifically, we analyze the local discourses and practices through the lens of the agroecology elements reflecting the attributes of the appropriate soil erosion control measures and strategies for enabling sustainable adoption of soil erosion control measures.

4. Results

4.1. Discourse on soil erosion control measures

Various soil erosion control measures were presented by the government farmer advisors but only partially implemented under the coffee fields (Table 2). Despite the training sessions that have been conducted by advisors, only the methods that were demonstrated through farmer institutions were known and to some extent being implemented under the coffee fields by the smallholder farmers. The low adoption is attributed, by farmers, to the inappropriate introduction of soil erosion control measures. Consider this example, *"most soil erosion control is based on theory. Well, a lot of soil erosion control measures such as water catching trenches and terraces have been suggested but in practice, these are difficult to implement"* (FGD 1, 2020).

Table 2. Soil erosion control measures identified in the coffee fields in the Rwenzori area.

Soil erosion control method	Source of data				Status of soil erosion control method at farm level (field observation)
	Farmer	Farmer institutions	Government extension	Field observation	
Trenches	✔	✔	✔	✔	Insufficiently implemented with only one trench per acre
Zero tillage			✔		Not implemented
Under sown legume covers (live mulch such as *Mucuna pruriens*)	✔	✔	✔	✔	Implemented via the experiment study (Mucuna pruriens and Milletia dura)
Contour bands			✔		Not implemented
Trash bands	✔	✔	✔		Not implemented
Stone bands			✔		Not implemented
Agroforestry	✔	✔	✔		Partly implemented
Terraces			✔		Not implemented
Mulching	✔	✔	✔		Partly implemented
Integrated trenches with stabilizers			✔		Not implemented

 doi:10.20944/preprints202208.0336.v1

4.2. Attributes of soil erosion control measures for sustainable adoption

As indicated in table 2, various soil erosion control measures are known by the different actors but few are implemented on the family farms. Based on field observations, some measures were only partially implemented. For example, trenches in most cases were not completely constructed or had been refilled by the eroding soil and agroforestry trees were only scantly implemented in the fields. The limited implementation was associated with the different attributes of the soil erosion control measures elaborated below.

4.2.1. Social acceptability and context-specific

Various soil erosion control measures whose adoption is influenced by culture and tradition in context were presented. Consider this elaboration, for example: *"the extension advisors told us to dig trenches, but these literally look the same as the traditional graves in the fields. We did the trenches but shortly stopped because we feared these could bring bad luck to our fields"* (FGD 1, 2020). The findings further indicate that smallholder coffee farmers are mainly traditional societies with cultural beliefs and their own Indigenous knowledge that either promote or are against some soil erosion control measures. There are practices that are recommended by the cultural traditions but at scales that do not make a meaningful impact. This was elaborated in this example: *"the Ficus natelensis is an agroforestry tree that we grow to mark the grave of the family heads, these trees improve the microclimate where they grow and the coffee under them is normally better. However, we cannot just plant many Ficus natelensis as would be recommended by experts because these trees are reserved to only mark burial sites of elders"* (Interviewee 7, 2019).

4.2.2. Economically feasible

The costs of the soil erosion control measures were commonly associated with the labor and equipment (financial investment) required. This was found to be a big influence on the soil erosion measures that would be adopted and sustained. Generally, the adoption of soil erosion control measures was considered a non-urgent cost since soil erosion measures competed with other daily basic needs, e.g., clothing, food, and health. Look for example at the interview response below: "*If it was not for our family labor, those trenches you see in the coffee field would not be there, but we use our free labor. From the coffee sold, we can't afford to pay for the labor and other daily needs of the family. We need solutions where we use several alternatives that can be reused, require little input but produce bigger returns" (*Interviewee 18, 2020).

4.2.3. Multiple benefits

According to the findings, smallholder farmers adopt methods that serve more than one purpose. For example, cover legumes are preferred since, besides controlling erosion, they are used as livestock feed, improve the fertility of the soil, and are a source of income through the sale of seeds: *"The coffee no longer yields well, we need plants to grow under the coffee so that when they are catching the soil, for us we are getting either food or pasture for our animals. We need to have different enterprises that produce several benefits"* (FGD 1, 2020).

The different actors (farmers, government extension, religious and cultural leaders) also have different expectations for implementing soil erosion control thus multiple benefits are expected if a soil erosion control measure is to be supported by different actors. This was clear both in the interviews and FGDs. For example, *"…us from the government particularly are interested in the long-term safety of the land and avoiding disasters such as landslides but most farmers are interested in having short term benefits such as a high yield and income"* FGD 4, 2021.

4.2.4. Quick and repetitive benefits

Soil erosion control measures that produce quick repetitive impact are preferred for adoption and could be continuously adopted by smallholder farmers. Measures that take

 doi:10.20944/preprints202208.0336.v1

a long to produce the desired impact are only accepted if there is a subsidy and would be implemented for a short time. A case in point is elaborated here:

"*…In 2018 we planted Mucuna and Milletia trees, the Mucuna was growing fast within three months and the soil was already covered and the coffee tree leaves green. All of us who were involved have continued to cover our soil with Mucuna and even other farmers are learning from us. We like it because we are recycling the Mucuna seeds. However, we did not see the benefit of the Milletia dura trees at first harvest, therefore we have not planted more unless the trees are provided free again*" (FGD 1, 2020).

4.3. Strategies for sustainable adoption of soil erosion control measures

Besides having the appropriate attributes for adoption, the strategies used in the process of soil erosion control adoption are important in sustaining the erosion control measures on the farm. Strategies in the soil erosion control process were suggested for developing the control measures through to their implementation in the field. These include: 1) Engagement of multiple actors with clear roles, 2) Participatory approach of engagement, 3) concurrent action by the different actors, and 4) motivation through a reward and punitive system.

4.3.1. Engagement of multiple actors with clear roles

Different roles in the soil erosion control process were identified: 1) developing the appropriate soil erosion control measures, 2) implementing the soil erosion control measures, 3) punitive and rewarding system, and 4) awareness creation for perception change. These roles are foreseen to be implemented by different actors including the farmer households, cultural and religious institutions, farmer advisors from the government, and community-based research institutions such as universities (Table 3). The extract below elaborates this scenario:

"*Different actors have different capacities but also different limitations. There is a need for a clear allocation of the roles for the different actors. Several things need to be done to enable sustainable adoption, but these cannot be done by one actor. For example, for us (government extension) we can support research on suitable measures, but farmers would instead expect us to give handouts from the government, yet this is not sustainable. The implementation of the erosion control measure is for the farmer*" (FGD 4, 2021).

Farmers noted that several roles to enable them to adopt were not being implemented. The different actors instead focused on awareness creation and mostly theoretical training. Thus, farmers remained without a practical sustainable solution except for the cover legumes (*Mucuna pruriens*):

"*…in practice, soil erosion control has been one of the subjects avoided by several farmer advisors. Most measures are just told to us by word of mouth, for example, no demonstration on how trenches should be done. We only do them in our way, but they quickly get destroyed. There is a need for trainings and support on establishing the measures such that training and action are done concurrently*" (Interviewees 8,10, and 13).

Although several interventions to control the erosion have been tried, these have only been short-lived and then abandoned in less than a year, particularly after the actor who introduced the measures leaves the responsibility to the farmers (Field observation). Thus, for sustainable soil erosion control adoption, the following roles and responsible actors were proposed as indicated in Table 3 below.

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 18 August 2022 doi:10.20944/preprints202208.0336.v1

Table 3. Proposed roles of different actors in sustainable adoption of soil erosion control measures in the Rwenzori area.

Roles	Actor	Description of role by actor and their relevance	Source of data
Developing the appropriate soil erosion control measures	Farmer families	Provide the indigenous knowledge and experience to inform the measures to be adopted	FGD 1, FGD 2, FGD 3, FGD 5
	Farmer institutions	Linking researchers, farmers, government extension, cultural and religious institutions	FGD 1, FGD 2, FGD 3, FGD 5
	Cultural and religious institutions	Indigenous knowledge on the beliefs of the local people reflecting in the soil erosion control measures	FGD 1, FGD 2, FGD 3, FGD 5
	Government extension and Uganda coffee development authority	Technical guidance	FGD 1, FGD 2, FGD 3, FGD 4 and FGD 5
	Research institutions	Technical scientific knowledge guidance	FGD 1, FGD 2, FGD 3, FGD 4 and FGD 5
Implementing the soil erosion control measures	Farmer families	Provide labor and land to implement the measures	FGD 1, FGD 2, FGD 3, FGD 4 and FGD 5
	Farmer institutions	Organize farmer families into farmer groups that work together on each other's farm	FGD 1, FGD 2, FGD 3 and FGD 5
Motivation through rewarding and punitive system	Cultural and religious institutions	Short term and long-term subsidies to family farms implementing soil erosion control measures. Fair price for coffee produced on farms that control erosion. Penalties for farmers not practicing erosion control.	FGD 1, FGD 2, FGD 3, FGD 4, and FGD 5
Awareness creation for a positive attitude toward soil erosion control adoption	Cultural and religious institutions	Creating confidence in the farmers and building a positive attitude	FGD 1, FGD 2, FGD 3, and FGD 5
	Farmer institutions	Trainings using documented data from field experiences	FGD 1, FGD 2, FGD 3, FGD 4 and FGD 5
	Farmer families	Farmer to farmer experience sharing and solidarity	FGD 1, FGD 2, FGD 3 and FGD 5

4.3.2. Participatory development of appropriate soil erosion control measures

This is a role viewed as universal for all actors (farmers, farmer institutions, government extension, researchers, religious and cultural institutions) involved in soil erosion control. It entails the process of identifying possible measures, testing them, and adapting them to the local context. It was revealed that most methods were not appropriate for sustainable adoption because they were developed without considering aspects regarded

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 18 August 2022 doi:10.20944/preprints202208.0336.v1

as important for other actors, particularly the farmers. Consider this example, *"…. we all need to participate in developing the soil erosion control measures such that our expectations are all equally fulfilled. All of us have different expectations from controlling the erosion but also different limitations which must be addressed through joint action. But in most cases, experts come with their difficult methods for us to impliment"* (Interview 2, 2019). However according to the extension advisors and researchers from the government, the role of developing the soil erosion control measures is for the technical people *"…. erosion control is a highly scientific subject hence appropriate soil erosion control measures must be developed by pure scientists and researchers"* (FGD 4, 2021).

4.3.3. Complementary implementation of the soil erosion control measures

This role was mostly perceived by the FGD participants to be implemented by the farmers supported by their farmer institutions, the government, and the solidarity of the consumers of their products through a fair price. Participants further perceived that, through participatory approaches, support to establish the measures can be through a pooled source of labor for example as was the organizing in the farmer family learning groups.

"*In promoting the adoption of soil erosion control, it is good to keep in mind that the farmer is the end user and leads in implementing on the farmer. Therefore, the perception of the farmer towards the different measures determines a lot how they will be sustained on the farm, if the farmers believe in it, it will work but they also need to be supported in managing the costs for implementing and sustaining the soil erosion control measures…*" (FGD 5, 2021).

Similarly, the farmer interviews revealed that:

"*…if we prove that the methods fulfill our expectations such as the quick impact of the methods, then we shall implement them. But some methods especially those that require too much labor may be difficult to implement alone except with the support of group members*" (Interviewee 4, 2019).

However, extension advisors and researchers from the government emphasized that the role of implementation was solely a task of the farmers as indicated in this example *"… policies to govern the implementation of the soil erosion control must be put in place such that those farmers that do not control erosion on their farms are held solely responsible for the consequences"* (FGD 4, 2021).

4.3.4. Awareness creation for attitude change

Soil erosion control was perceived as a silent challenge that does not easily manifest to the farmers hence it causes damage slowly without the farmers realizing it. Therefore, farmers have a negative attitude towards dedicating their efforts to soil erosion control because they do not directly connect soil erosion to low yields on their farms. An example can be cited in this narration

"*…. yes, when it rains, we see that water is caught in the trench. Trenches have a quick impact but most farmers don't have the trenches so they cannot quickly see the erosion …. most farmers still need to be educated about the negative impacts of soil erosion*" (Interviewee 11, 2020).

Thus, continuous awareness creation on soil erosion is vital in the sustainable adoption of soil erosion. Awareness creation was perceived by the farmers as a role suitable for actors who are closely linked to the farmer families that is, the farmer institutions, cultural and religious institutions. Awareness creation by these institutions is believed to be trusted since in most cases it is done not as a paid job but as a social responsibility.

"*When a fellow farmer or your own church leader encourages protecting nature, we quickly trust them better than the scientists coming from outside the community. For cultural and religious leaders, we follow whatever they say is good for us because they care about our livelihoods and they are with us in all situations, but government workers mind only their pay*" (FGD 1, 2020).

Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 18 August 2022 doi:10.20944/preprints202208.0336.v1

Farmers have a negative attitude towards government institutions, and it would be an outright failure to place such institutions at the forefront of creating awareness of the adoption of soil erosion control.

"… When we hear it is government intervention again, our fears of having been forced to plant coffee come back. Maybe our farmer organizations and cultural institutions can help us but government advice, we are skeptical. Let researchers come and demonstrate their practices, we select what works then our traditional leaders are there to deal with non-adopters"[1] (FGD 5, 2021).

4.3.5. Participatory approach of engagement

For soil erosion control to be sustainably adopted, measures must be selected following a participatory approach with farmers taking lead. This will enable ownership of the measures, especially by the farmers who are central in the practical implementation in the fields. Consider this example from the FGDs,

"…we need to practically learn about the different soil erosion control measures, understand how it all works and its implications on our farms…… it's not about experts teaching us one day and they leave us confused, it should be a long-term engagement so that after working together with experts we see what works and fits us, then we can expand it in our fields. This joint action will enable us all to learn especially the contextual fit of the different measures…" (FGD 1, 2020).

Different knowledge and experiences exist about soil erosion control among the farmers, researchers, and farmer advisors. Therefore, dialogue and joint action are required to prove to the different actors what works in practice without one actor taking the decision on which erosion control measures are to be adopted.

"When we engage farmers and other actors, we would be able to learn the weaknesses of our recommendations then adjust. The farmer is key because they make the final decision to implement or not to implement. We tried several times to teach the farmers, but they did not learn and we also learnt nothing. Now is the time we all come together as experts and learn from each other but also un-learn the ways that do not work (FGD 4, 2021)".

4.3.6. Concurrent action by different actors

Several actors were identified for participating in promoting soil erosion control. These include the farmer families, farmer advisors from the government, the farmer institutions promoting organic coffee production, researchers (e.g., Mountains of the Moon University), the cultural, and religious institutions. These mainly were creating awareness about existing soil erosion control measures through organizing farmer training meetings. Participants of the FGDs identified that there is a gap in the way the process of soil erosion control was being handled. They suggested that the actors should not only do what they think is right but rather plan together and implement together to create synergy. This manifested in several ways for example:

"…soil erosion control is composed of intertwined processes. The implementation of practices by the farmer needs the researcher to follow up and guide on adaptation meanwhile the bylaws be also implemented at the same time to ensure that all farmers in the landscape are implementing. If these things are not being done at the same time, then for sure always expect a mismatch in progress resulting into short term attempts to controlling soil erosion." (FGD 5, 2021).

"We all need to move together such that when farmers are implementing the practices, we are also motivating them to continue because it is a big job but benefits us all… We should attack the challenge from all corners at the same time so that the constraints are addressed from the different complexities. Not us doing our part when the others are doing nothing then we go back to zero" (FGD 2, 2020).

[1] Coffee was introduced in the Rwenzori area by government coercion to generate revenue.

 doi:10.20944/preprints202208.0336.v1

4.3.7. Motivation through punitive and rewarding system

Soil erosion control is viewed as an ongoing intervention on the farm that is done for the benefit not only of an individual farm but for the entire community. Once erosion is controlled on one farm, neighboring farms benefit through the reduction of runoff and flooding. However, there is no reward for those that control the erosion and no penalty for those that do not. This results in a short-lived adoption of the control measures. This is exemplified in the following:

"*… there is basically no difference between us, who control soil erosion, and those who do not. Sometimes government threatens to penalize nonadopters but that never happens. We try to control the erosion but when we realize that the government is not concerned, we also relax our efforts. But we know that if nonadopters are penalized, the fines would be used as rewards for the adopters. This system should not be a one-off act but rather continuous. Other rewards can be realized through ensuring a better price for the coffee on those farms that adopt soil erosion control*" (Interviewee 7, 2020).

Government extension staff indicated that farmers require to be persuaded for them to adopt soil erosion control measures in their fields since the government would otherwise be tasked to provide relief aid in case soil erosion-related disaster occurred. This shows clearly in the following FGD:

"*When we talk about erosion control, the farmers take it to be to the benefit of the farmer advisor and the government. In most cases, they don't directly see the loss due to the erosion and in the short term, they do not realize the benefit. Therefore, they think they are doing it for us and deserve a reward for controlling the erosion*" (FGD 4, 2021).

In line with the above (perception, the reward, and punitive measures), localized instruments such as bi-laws and ordinances which in detail describe measures to enforce sustainable implementation of soil erosion control need to be put in place. This will bring out the context-specific issues and practically possible measures to implement.

"*…… bi-laws and ordinances would be more practical to implement at a local level reflecting the national policies which rather have general recommendations that are not easy to translate into the local context. We need to have clear regulations which are easy for the local people to understand and put into action*" (FGD 5, 2021).

According to the farmers, the responsibility of implementing the reward and punitive system was seen as most relevant for the cultural and religious institutions in their communities. An example cited from the FGDs in line with this follows,

"*… but also, to penalize nonadopters is not easy for the government and political leaders (policymakers). This is why soil erosion control is always not taken seriously. However, our cultural and religious leaders who act without seeking an electoral mandate are very transparent. We believe in the cultural and religious leaders because they have respect for nature, are transparent, and have natural powers to oversee that life in the mountains is not at risk*" (FGD 1, 2020).

5. Discussion

5.1. Soil erosion control measures and their adoption in the context of Agroecology

Soil erosion control measures are known for a long time and also recommended, but cultural beliefs hinder their implementation. Measures such as terraces are not efficient and have not been developed within local context beliefs and convictions as opposed to agroecology elements 3 and 6. The water trenches are not socially acceptable and are costly to maintain. This is contrary to the agroecology elements 7 and 8. Hence, even when a practice is introduced, adoption is only short-lived since it is not within context [11, 44].

The limited adoption also relates to the approach of the different actors introducing the soil erosion control measures. For example, FGD 4, 2021 showed that the government extension advisors were recommending methods irrespective of whether they are relevant for the local context in which they were to be implemented. The same has been reported

 doi:10.20944/preprints202208.0336.v1

on government programs [45]. On the other hand, the farmer institutions were selective regarding methods to propose for adoption (Table 3). They considered the local context which is important in fulfilling the social, economic, and ecological aspects [18, 44]. Thus, the measures recommended by the farmer institutions were more adopted as has been proposed by [19]. This confirms that soil erosion control measures conforming to the agroecology elements 3, 4, 5, 6, 7, and 8 can be sustainably adopted as opposed to those that do not.

Discourse on soil erosion control measures indicates that different actors expected different benefits from the soil erosion control measures. As such, implementing a method that serves one purpose and fulfills the aim of one actor may not be sustainably adopted. This could explain why some soil erosion control methods such as water trenches are not implemented long after the external intervention is ceased. In other words, once the actor whose interests are fulfilled by a particular soil erosion control measure withdraws, the farmers do not perceive the intervention beneficial. On the contrary, field observations indicated that the cover crop legumes that were introduced in 2018 were until the time of this study being implemented because cover legumes fulfill the expectations of the different actors: controlling the erosion, providing livestock feed, suppressing the weeds, and generate income from the sale of seeds. Thus, soil erosion control measures that align with the agroecology elements 2, 6, and 7 were seen to be more sustainably adopted.

5.2. Attributes of soil erosion control measures for sustainable adoption

Several attributes that make a soil erosion control measure to be sustainably adopted connect with the agroecology elements. For example, social acceptability, multiple benefits, and quick and repetitive benefits that manifested in the local discourses point to the relevance of the agroecological elements such as 4, 5, 6, and 8 towards the sustainable adoption of soil erosion control measures.

The economic feasibility of soil erosion control measures is also considered important for adoption and is mostly expressed in terms of cost for labor (interview 18, 2019) see also Nabalegwa and Asaba [11]. To address this, the local discourses point to the agroecology elements 1,6, and 8.

Soil erosion control measures were expected to deliver more than one benefit and should interact positively with existing crops. This collaborates the agroecology elements 1 and 2 which suggest that systems should build resilience based on positive interactions in diversity and should be synergistic [22].

Quick and long-lasting impacts of soil erosion control measures are another attribute that enables sustainable adoption of soil erosion control (Farmer interview 11, 2020). In the local discourses, this connects to the agroecology elements 6, 7, and 8.

5.3. Perspective on strategies for sustainable adoption

5.3.1. Participatory development of the soil erosion control measures

The living environment of farmers, their beliefs, and convictions are currently not adequately integrated in the process of developing soil erosion control measures (FGD 1, 2020 and FGD 4, 2021). The participatory approach proposed by agroecology elements 2, 3, 4, and 5 were found present in the local discourses for example FGD 1, 2020; FGD 2, 2020; FGD 3, 2020; FGD 5, 2021 and interview 2, 2019. Similar elements have also been considered important in participatory action research processes conducted in the Rwenzori area [23]. Similarly, calls for the consideration traditional farming systems as basis for transitioning into sustainable farming systems and the involvement of different fields such as sociology, economy, anthropology and ethics have been indicated as important in sustainability [21, 24]. This implies that consideration of these elements when developing soil erosion control measures could contribute to sustainable adoption of the developed soil erosion control measures as opposed to a non-participatory approach proposed by government extension advisors and the national research team (FGD 4, 2021).

 doi:10.20944/preprints202208.0336.v1

5.3.2. Motivation through reward and a punitive system

In the local discourses, sustainable adoption of soil erosion control was reflected as requiring an external influence from the authorities in form of rewarding those who adopt and penalizing those who do not (interview 7, 2020 and FGD 1, 2020). This connects with the landscape impact of adopting or not adopting recognized through a systems interaction which is considered critical in agroecological systems reflected in agroecology elements 1 and 2. The discourses point to the agroecology element 9 where actors should be held responsible for their actions and inactions and element 10 provides for a fair price of products to enable farmers to implement best practices.

The cultural and religious leaders are strongly put at the center of ensuring that rewards and penalties are justly administered because as a traditional society these are known to possess extraordinary powers. This builds on the agroecology elements 3, 5, and 9 and collaborates with the finds of Bwambale, Muhumuza [46] and Stacey [47]. This is also built on the experience that government, political and civil society have limitations to implement particularly measures that negatively affect their leadership position [48]. Although policies are known as vital in enabling the adoption of soil erosion control [11], the reward and punitive system was seriously recommended based on context-specific regulations (FGD 5, 2021). The agroecological elements also emphasize context specificity (elements 4 and 5). It is known that national policies whose recommendations are generalized are more difficult to implement than context-specific regulations such as bi-laws and ordinances [49].

Studies have indicated that there is a need for support to cover costs if farmers are to sustainably adopt soil erosion control [50]. This is confirmed by the fact that local discourses also call for rewards for adopting farmers that can be fulfilled through the agroecology elements 9 and 10.

5.3.3. Participatory engagement

Collective action by the farmers, government extension, farmer institutions, and cultural and religious leaders through working, learning, and making decisions together (FGD 1, 2020; FGD 2, 2020; FGD 4, 2021) was encouraged as key in ensuring sustainable adoption of soil erosion control. This fits with agroecology not attempting to radically modify local farming systems but optimizing their design and use of local resources and skills by emphasizing the inclusion of local knowledge and traditional cultivation methods such as those that promote agroforestry [51]. Moreover, farmers that use traditional methods are known to have a high-income potential [52]. It also connects with the agroecology elements 2, 3, 4, 9, and 10 which highlight joint action. In the Rwenzori region, the use of such participatory engagements has been linked with agroecological interventions and these have been successfully adopted [18, 23, 53]. Participatory processes are viewed as being enablers of continuous adoption because, during the process, farmers get used to the control measures being practiced [44]. Contrary to this, the government extension and researchers suggest that some stages of soil erosion control be reserved for experts (FGD 4, 2021). In these roles, still, other actors for example government institutions would participate through agroecology elements 9 and 10.

5.3.4. Concurrent implementation of the different roles

The different activities involved in soil erosion control complement each other thus these activities being done at the same time are vital (FGD 1, 2020; FGD 2, 2020; FGD 3, 2021; and FGD 5,2021). For example, implementation of the control measures by the farmers should be concurrently done with rewards for adopters and punitive measures for non-adopters (FGD 2, 2020). The agroecology elements that were highlighted in the discourse on a concurrent implementation include 1, 2, 4, 6, and 9. Non-concurrent interventions have been blamed for the inconsistent adoption of soil erosion control and result in wasting efforts on the adoption of soil erosion control and implementing measures in a way that exposes the land to more erosion (FGD 2, 2020).

 doi:10.20944/preprints202208.0336.v1

5.3.5. Clear allocation of roles in soil erosion control

Different roles for the different actors were identified as key in the sustainable adoption of soil erosion control. These roles were assigned to different actors in accordance with their relevance in fulfilling a particular role and how effectively they would be able to fulfill the assigned roles. The need for actors to work together in fulfilling the complexity of agroecology has been known as important in ensuring sustainable transitions [25, 48]. In the discourses, the different roles and relevant actors were linked mainly via different elements of agroecology such as

5.3.6. Implementing of the soil erosion control measures

Discourses on soil erosion control by the local actors indicate that once an appropriate soil erosion control measure is developed, its implementation in the farming system at both field and landscape level is majorly a role of the farmer families. These are then supported through rewards and punitive measures (element 9) and responsible markets (element 10) that enable farmers to meet their costs (Table 3; FGD 2, 2020 and FGD 5, 2021). At this level, the agroecology elements that constitute an appropriate soil erosion control measure (1,2,5,6,7 and 8) are expected to already be inbuilt into the soil erosion control measure and the agroecology element 6 must be maintained during implementation (FGD 5, 2021). The role of government in ensuring the implementation of soil erosion control methods was not manifesting in the discourses rather the religious and cultural leaders were considered appropriate. This could be connected to the fact that government actors were using the top-bottom approach (FGD 4, 2021). A similar finding was made in another study that government extension as an actor in Uganda had less impact on soil erosion control, but non-government organizations had tremendously contributed to the control of soil erosion [16].

5.3.7. Awareness creation for perception change towards soil erosion control

It is known that unless farmers know that their soil is prone to erosion, they cannot adopt soil erosion control measures [54]. Therefore, apart from motivating farmers through rewards and punitive measures, continuous awareness creation (FGD 2, 2021 and interview 11, 2020) was in the local discourses considered important in creating a positive attitude toward investing in soil erosion control. The same has been recommended by a study by the Ministry of Land, 2006. The cultural, religious, and farmer institutions were prioritized as the relevant actors in awareness creation on soil erosion control adoption because they are considered to uphold the agroecology elements 3 and 5. These elements were considered as potential for creating a solidarity movement through the social capital building for joint action which is necessary for the continued adoption of soil erosion control [55]. On the other hand, government extension, and academic and research institutions were not considered appropriate for awareness creation due to top-bottom approaches that are contrary to agroecology elements 4 and 5 and hence do not build into sustainable adoption (FGD 5, 2021).

6.. Conclusion

The objective of this study was to find if agroecology manifests in the local discourses on soil erosion control. Interviews and FGDs were conducted and analyzed to find out the link between the local discourses on soil erosion control and agroecology elements. Results indicate that agroecology elements reflect strongly in the local discourses on, soil erosion control measures, the attributes of appropriate soil erosion control measures, and the proposed strategies for sustainable adoption of soil erosion control. This suggests that agroecology offers a platform for enabling context-specific sustained adoption of soil erosion control. We recommend that the agroecology elements should guide the participatory process of developing and implementing soil erosion control measures. The agroecology elements should also be the basis for the formulation of local regulations (by-laws

and ordinances) on soil erosion control such as on motivating and penalizing adopters and non-adopters respectively.

Acknowledgments: This study was supported by funding from the Austrian Partnership Programme in Higher Education and Research for Development (APPEAR). The authors appreciate the participants for their voluntary participation and for providing the data that enabled this study.

Disclosure statement: The authors report there are no competing interests to declare.

References

1. Sanchez, P.A.J.S., *Soil fertility and hunger in Africa.* 2002. **295**(5562): p. 2019-2020.
2. Ananda, J. and G. Herath, *Soil erosion in developing countries: a socio-economic appraisal.* Journal of environmental management, 2003. **68**(4): p. 343-353.
3. Pender, J.L., et al., *Development pathways and land management in Uganda: Causes and implications*. 2001.
4. Etienne, H., *Somatic embryogenesis protocol: coffee (Coffea arabica L. and C. canephora P.)*, in *Protocol for somatic embryogenesis in woody plants*. 2005, Springer. p. 167-179.
5. Ovalle-Rivera, O., et al., *Projected shifts in Coffea arabica suitability among major global producing regions due to climate change.* PloS one, 2015. **10**(4): p. e0124155.
6. Van Asten, P., et al., *Mapping and evaluating improved intercrop and soil management options for Ugandan coffee farmers*. 2012, Technical report.
7. Keesstra, S.D., et al., *The significance of soils and soil science towards realization of the United Nations Sustainable Development Goals.* 2016. **2**(2): p. 111-128.
8. Iijima, M., et al., *Erosion control on a steep sloped coffee field in Indonesia with alley cropping, intercropped vegetables, and no-tillage.* 2003. **6**(3): p. 224-229.
9. Karamage, F., et al., *Soil Erosion Risk Assessment in Uganda.* Forests, 2017. **8**(2): p. 52.
10. Wang, N., et al., *Evaluating coffee yield gaps and important biotic, abiotic, and management factors limiting coffee production in Uganda.* European Journal of Agronomy, 2015. **63**: p. 1-11.
11. Nabalegwa, M.W. and J. Asaba, *Socio-Economic Factors Assessment Affecting the Adoption of Soil Conservation Technologies on Rwenzori Mountain.* The Indonesian Journal of Geography, 2015. **47**(1): p. 26.
12. Mwangi, M., S.J.J.o.E. Kariuki, and s. development, *Factors determining adoption of new agricultural technology by smallholder farmers in developing countries.* 2015. **6**(5).
13. Bonabana-Wabbi, J., *Assessing factors affecting adoption of agricultural technologies: The case of Integrated Pest Management (IPM) in Kumi District, Eastern Uganda*. 2002, Virginia Tech.
14. Tessema, I. and B.J.E.P. Simane, *Vulnerability analysis of smallholder farmers to climate variability and change: an agro-ecological system-based approach in the Fincha'a sub-basin of the upper Blue Nile Basin of Ethiopia.* 2019. **8**(1): p. 1-18.
15. Isgren, E., *No quick fixes: Four interacting constraints to advancing agroecology in Uganda.* International Journal of Agricultural Sustainability, 2016. **14**(4): p. 428-447.
16. Pender, J., et al., *Strategies to increase agricultural productivity and reduce land degradation: evidence from Uganda.* 2004. **31**(2-3): p. 181-195.
17. Isgren, E. and B.J.S. Ness, *Agroecology to promote just sustainability transitions: Analysis of a civil society network in the Rwenzori Region, Western Uganda.* 2017. **9**(8): p. 1357.
18. Méndez, V.E., et al., *Agroecology as a transdisciplinary, participatory, and action-oriented approach.* 2013. **37**(1): p. 3-18.
19. Jeanneret, P., et al., *Agroecology landscapes.* 2021. **36**(8): p. 2235-2257.
20. Wezel, A., et al., *Agroecology as a science, a movement and a practice. A review.* Agronomy for sustainable development, 2009. **29**(4): p. 503-515.
21. Francis, C., et al., *Agroecology: The ecology of food systems.* 2003. **22**(3): p. 99-118.
22. FAO., *The 10 elements of agroecology: guiding the transition to sustainable food and agricultural systems.* 2018c, http://www.fao.org/3/i9037en/i9037en.pdf: Rome.
23. Jumba, F.R., et al., *COVID 19: Lets act now: the urgent need for upscaling agroecology in Uganda (2020).* International Journal of Agricultural Sustainability, 2020. **18**(6): p. 449-455.
24. Nicholls, C.I., M.A.J.A. Altieri, and S.F. Systems, *Pathways for the amplification of agroecology.* 2018. **42**(10): p. 1170-1193.
25. Leippert, F., et al., *The potential of agroecology to build climate-resilient livelihoods and food systems*. 2020, Food and Agriculture Organization of the United Nations FAO and Biovision.
26. Diacono, M., A. Trinchera, and F.J.A. Montemurro, *An overview on agroecology and organic agriculture strategies for sustainable crop production*. 2021, MDPI. p. 223.
27. Nassib, M. *After Agroecology: Why Traditional Agricultural Practices Can't Transform African Agriculture*. Alliance for science, 2019. **2019**.
28. Isgren, E. and T.J.B.J. Kahigwa Tibasiima, *In Defense of Agroecology: Response to Nassib Mugwanya's "After Agroecology"*. 2019. **11**.
29. Figueroa, R., S. Harding, and S.G. Harding, *Science and other cultures: Issues in philosophies of science and technology*. 2003: Psychology Press.

30. Bwambale, B. and M.J.E.S. Kervyn, *Testing Interscience in Understanding and Tackling Disaster Risk. Front.* 2021. **9**: p. 783264.
31. Mugwanya, N.J.O.o.a., *Why agroecology is a dead end for Africa.* 2019. **48**(2): p. 113-116.
32. FAO., *New_LocClim; Local climate estimator*. 2005, http://www.fao.org/nr/climpag/pub/en3_051002_en.asp (Accessed 11th March 2021)
33. FAO, *Harmonised World Soil Database Viewer (Version 1.2). FAO, IIASA, ISRIC and ISS-CAS, JRC FAO. Rome, Italy and IIASA, Laxenburg, Austria*. 2012.
34. Berry, L., J. Olson, and D. Campbell, *Land degredation in Uganda: It's extent and impact*, in *Assessing the extent, cost and impact of land degradation at the national level: findings and lessons learned from seven pilot case studies*. 2003: https://wedocs.unep.org/.
35. Galabuzi, C., A.J.R.M.C. Tumwesigye, and E.M.P.S. Report, *Current Knowledge, Attitudes and Practices of Local Communities Surrounding Rwenzori Mountains National Park.* 2009.
36. Mertens, K., et al., *The direct impact of landslides on household income in tropical regions: A case study from the Rwenzori Mountains in Uganda.* 2016. **550**: p. 1032-1043.
37. Jacobs, L., et al., *The Rwenzori Mountains, a landslide-prone region?* Landslides, 2016. **13**(3): p. 519-536.
38. Jacobs, L., et al., *Reconstruction of a flash flood event through a multi-hazard approach: focus on the Rwenzori Mountains, Uganda.* Natural Hazards, 2016. **84**(2): p. 851-876.
39. UBOS, *The National Population and Housing Census 2014 – SubCounty Report. Uganda Bureau of Statistics. Kampala, Uganda.* 2016.
40. Bwambale, B., M. Muhumuza, and M.J.J.J.o.D.R.S. Nyeko, *Traditional ecological knowledge and flood risk management: A preliminary case study of the Rwenzori.* 2018. **10**(1): p. 1-10.
41. Guest, G., A. Bunce, and L.J.F.m. Johnson, *How many interviews are enough? An experiment with data saturation and variability.* 2006. **18**(1): p. 59-82.
42. Schreier, M., *Qualitative content analysis in practice*. 2012: Sage publications.
43. Glaser, B.G. and A.L. Strauss, *The discovery of grounded theory: Strategies for qualitative research*. 2017: Routledge.
44. Teshome, A., J. de Graaff, and L.J.F.i.E.s. Stroosnijder, *Evaluation of soil and water conservation practices in the north-western Ethiopian highlands using multi-criteria analysis.* 2014. **2**: p. 60.
45. Kjær, A.M., J.J.P. Joughin, and Society, *The reversal of agricultural reform in Uganda: Ownership and values.* 2012. **31**(4): p. 319-330.
46. Bwambale, B., et al., *Foundations of indigenous knowledge on disasters from natural hazards: lessons from the outlook on floods among the Bayira of the Rwenzori region.* 2021.
47. Stacey, T., *The snows of Rwenzururu and the Kingdom*, in *Rwenzori: histories and cultures of an African Mountain*. 2008, Fountain Publishers Kampala. p. 7-17.
48. Isgren, E.J.J.o.R.S., *'If the change is going to happen it's not by us': Exploring the role of NGOs in the politicization of Ugandan agriculture.* 2018. **63**: p. 180-189.
49. Ministry of lands, h.a.u.d.h.m.g.u.w.-c.u.N.-L.-u.-P.p.a.t.J., *The National land use policy*, MAAIF, Editor. 2006: Kampala.
50. Verburg, R., et al., *An innovation perspective to climate change adaptation in coffee systems.* Environmental Science & Policy, 2019. **97**: p. 16-24.
51. Altieri, M.A., F.R. Funes-Monzote, and P. Petersen, *Agroecologically efficient agricultural systems for smallholder farmers: contributions to food sovereignty.* Agronomy for Sustainable Development, 2012. **32**(1): p. 1-13.
52. Ighodaro, I., B. Lewu, and B.J.I.J.o.A.R. Omoruyi, *Smallholder Farmers' Adoption Decision-making Regarding Soil Erosion Control on Food Security in South Africa.* 2021. **55**(1).
53. OeAD. *Strengthening of Higher Education, Research and Community Outreach in Agro-Ecology in the Rwenzori Region in Western Uganda*. 2016-2021 [cited 2022 17 January 2022]; Available from: https://appear.at/en/projects/current-projects/project-websites/project125-aer/.
54. Okoye, C.J.S. and T. Research, *Comparative analysis of factors in the adoption of traditional and recommended soil erosion control practices in Nigeria.* 1998. **45**(3-4): p. 251-263.
55. Vaarst, M., et al., *The Rwenzori experience: The farmer family learning group approach to human and social capital building, environmental care and food sovereignty*. 2012: Third World Network.