



## Assessing farmer's perception of conservation status of agrobiodiversity in selected agroecological zones of Tanzania

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### Abstract

Agrobiodiversity serves as the foundation for resilient agricultural systems, sustainable food availability and nutritional diversity, and ecologically sound livelihoods of the community. Ecological services provided by rich agrobiodiversity ensure that people earn their livelihood and the sustainability of the coming generations is certain. Understanding how communities depend on agrobiodiversity may be well captured on the merit of agroecological landscapes because they entail how each species accrues to the agroecosystem thus enabling accurate judgment on the importance of such agrobiodiversity from the collective view of farmers, ecologists and agricultural scientists. The participatory four-cell assessment was employed in gender disaggregated focus group discussions (FGD) conducted in three contrasting agroecological zones of Tanzania to assess the status of agrobiodiversity conservation and utilisation in rural farming communities. Diversity indices were calculated to determine relative species richness and abundances across AEZ, Species Threat Index was calculated using modified IUCN formula to determine the influence of each farming systems, topography and gender roles on collective farmer's perception of conservation and use of agrobiodiversity, t-test and analysis of variance (ANOVA) was used to infer the observed index score. The results show that species abundance and distribution were lowest in semi-arid agroecology and highest in the coastal zone despite showing highest similarity in species composition. Generally, farmers perceived the status of agrobiodiversity as fairly secure with species threat index ranging from 0.39 to 0.59, mean = 0.48 (s.d = 0.06). Interesting pattern of variations in perception was observed across AEZ, along topographies and between genders despite statistical insignificances. Nevertheless, these findings emphasize the importance of understanding the human-environment interaction that determine sustainability of agrobiodiversities. This paper serves as base information on the quest to understand underlying factors determining farmers' constant need to decide on the utilisation and conservation of agrobiodiversity.

**Key words:** *Agrobiodiversity; Conservation; Modified IUCN equation; Species Threat Index*

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## Introduction

Agricultural biodiversity is fundamental for global food security as it provides valuable ecosystem services and functions for agricultural production (Thrupp, 2000). Agrobiodiversity can be defined as the variety and variability of species in agricultural landscapes (Paudel *et al.*, 2021). It is the interaction between agricultural management practices, resource endowed, and species (Brookfield and Stocking, 1999). The sustainability and resilience of agroecosystems depend on the interactions between farmers and agrobiodiversity (Mariel *et al.*, 2021). Jackson *et al.* (2012) found a positive association between biodiversity richness and the knowledge of the flora and fauna shared among farmers.

Agrobiodiversity is crucial for environment stability and livelihood of the local communities (Baul *et al.*, 2015). The majority of rural households in developing countries depend on the diversity of plant species for food and to support their livelihoods (Bellon *et al.*, 2016). Many small-scale farmers extensively utilise plant diversity available in their surroundings for home consumption, as dietary sources, as a form of medicine, and as an additional income source (Kahane *et al.*, 2013). One may notice what seems to be subtle conflicting demands existing between different actors of agroecosystems such that the farmers and the environmentalists, this is largely because the values of ecosystem services are expressed differently to various ecosystem functions (Bennett *et al.*, 2015). Montoya *et al.* (2020) addressed the need to reconcile the demands of different stakeholders of ecosystems services to ensure biodiversity conservation and sustainable food production. However, Brussaard *et al.* (2010) assured that although the development of production ecology and conservation biology are largely separated, they are actually counterproductive.

The potential of agrobiodiversity managed by rural community however is greatly untapped. Hammer *et al.* (2003) noted the gaps in distribution of species diversity preserved in ex situ to be among many others, underrepresentation of underutilised species and their wild relatives. Wood and Lenneâ (1997) proposed that on-farm conservation of

agrobiodiversity can be achieved by enhancing farmer's capacity to manage useful genetic resources. This notion is feasible because local communities have a specific and holistic understanding of their environment which contributes to their capacity to manage natural resources sustainably in an adaptive way to cope with the ever-changing environment (Mariel *et al.*, 2021).

To understand the status of agrobiodiversity conservation and use particularly of the seemingly underutilised species this study assessed the perception of the farmers, the custodians and immediate beneficiary of ecosystem services and how their perception prejudice to their nature-dependending socioeconomic activities, heterogeneity in agricultural landscapes and interaction with the species as a results of gender specific roles.

## Materials and methods

### *Description of study area*

The study was conducted in three regions representing three contrasting agroecological zones of Tanzania. A semi-Arid agroecological zone is located in the central part of Tanzania's mainland comprising Dodoma and Singida regions and some parts of Iringa, Tabora and Morogoro, being in the internal drainage basin and experiencing unimodal rainfall distribution this area is characterised by prolonged dry season prompting the adoption of farming systems such as mixed farming and pastoralism for subsistence. Northern highlands agroecological zones stretch from the Northern regions of Kilimanjaro, Arusha and Manyara to part of the Northern-East of Tanzania in the West Usambara mountain range in Lushoto Districts Tanga, this zone is characterised by volcanic soils emanating from volcanic mountains such as Kilimanjaro and Meru, evergreen vegetation, all year round river streams and cool temperatures in the upland and the relatively barren land, warm and dry temperature with year-round springs in the lowland, the mountains and river streams and reliable rainfalls in this zone ensures all seasons agricultural activities along Pangani river basin making predominant farming systems to range from agroforestry and perennial crops on highland to intensive field and horticultural crops production on lowlands. The coastal agroecological zone is

located in the Eastern part of Tanzania stretching from the North-East region of Tanga to the South-East region of Mtwara other regions in this AEZ are Dar es Salaam, Pwani and Morogoro, soils in these regions range from alluvial sand to in lowland to clay loam in higher elevations, several perennial rivers namely Pangani, Ruvu

and Rufiji are found in these AEZ with two river basins Wami-Ruvu and Rufiji, these rivers and river basins result to agriculture being the main socioeconomic activities followed by artisanal fishing. A summary of the characteristics of representative regions for each AEZ is shown in (Table 1).

**Table 1**  
*Characteristics of the study locations*

AEZ	Semi-Arid	Northern Highland	Coastal
Region	Dodoma	Kilimanjaro	Tanga
Altitude (M.A.S.L)	1,000 - 1,500	1,000 - 2,500	0 - 2,200
Rainfall (mm/annum)	500-800	1,000-2,000	1,000-2,000
Edaphic	Clay loam	Volcanic soils	Alluvial sand, clay and loam
Farming systems	Subsistence, mixed	Perennial crops,	Artisanal fishing, mixed
Cropping systems	maize-sorghum	maize-legumes, and banana-coffee.	Citrus, spices orchards, and maize-legumes

Source: URT-NBSAP (2001)

### *Sampling*

Three regions representing three agroecological zones (AEZ); semi-arid (Dodoma), northern highland (Kilimanjaro), and coastal (Tanga) were purposefully selected to assess the relationship between the agricultural systems and agrobiodiversity available on-farm, in the markets, and the dietary diversities of the households, it is well-established that AEZs are characterized by more or less distinct farming, cropping and food systems designated to adapt to the environmental limiting resources such as water, land, soil

fertility, and climatic factors. Two Districts within each region were selected based on elevation differences, we hypothesize that topography may have an influence on the richness and distribution of species and that may affect the perception of farmers because of socioeconomic activities associated with landscape and microclimates within broader AEZ. Village extension officers or village leaders selected participants in focus group discussions based on gender, farming experience, and age (Table 2).

**Table 2**

*Distribution of Participants in Focus Group Discussions*

Region	District	Gender	Count	Percentage
Dodoma	Chamwino	Men	6	40
		Women	9	60
	Bahi	Men	5	33
		Women	10	67
Kilimanjaro	Moshi rural DC	Men	11	65
		Women	6	35
	Hai	Men	3	43
		Women	4	57
Tanga	Muheza	Men	5	38
		Women	8	62

Pangani	Men	5	50
	Women	5	50

## Methodology

### Focus group discussion

Focus group discussions (FGD) were conducted in each of the six districts, extension officers and village leaders were asked to identify individuals who can provide insights into the status and trends of agricultural biodiversity richness and distribution as well as their utilisations in the community. The discussions were conducted in a gender disaggregated manner to capture information that may be influenced by gender roles played by each gender in conservation and utilisation of agrobiodiversity (See Table 2). Participants were briefed on the purpose of the discussion and were asked for consent before beginning the discussion.

### Agrobiodiversity Four-Cell Analysis

Agrobiodiversity four-cell analysis is a simple participatory technique used to assess the status of agrobiodiversity available and utilised in the localities as perceived by the collective knowledge of farmers (Mijatovic *et al.*, 2018; Paudel, 2021). The methodology involved the placement of species in one of the four cells based on the extent of availability or frequency of utilisation and the proportion of households in the community cultivating or utilising the species. The four cells (cells) emanate from two lines, a vertical line dividing the plane into two, left for species cultivated and utilised by many households and right for species cultivated and utilised by few households, the second is a horizontal line dividing the plane into two, upper for species available in a large area, large number or frequently utilised and lower for species available in a small area, a small number or rarely utilised. Farmers were then asked to name extinct species if there are any and these would be placed in the fifth cell. The four-cell analysis conducted through FGD was used to elicit information on; (a) an inventory of food plants and animal species that exist in their locality as domesticated, semi-domesticated and in the wild, (b) an inventory of food plants and animal species

consumed, and (c) inventory of food plants and animal species sold or bought in the markets using the agrobiodiversity four-cell analysis methodology. Finally, participants were asked to mention collective reasons for placement of species in the particular cell.

### Data Analysis

Descriptive statistics were used to determine the characteristics of participants of FGDs and the variations between different AEZs. Species richness (S) was determined as the total number of species available in all study sites known as gamma diversity. Jaccard similarity coefficient (J) was calculated using equation (1) below to determine relative diversities between agroecological zones also known as beta diversities. Where;  $J(A, B)$ ; is Jaccard similarity coefficients between site A and B;  $|A \cap B|$ ; the total number of species available in both sites A and B; and  $|A \cup B|$ , the total number of species available in either site A or B.

$$J(A, B) = \frac{|A \cap B|}{|A \cup B|} \quad (1)$$

Shannon-Wiener index (H) was used to determine species richness and abundance in a localised area (AEZ) also known as alpha diversity using equation (2) below. Where; H is Shannon-Wiener Index;  $p_i$  is the relative abundance for  $i^{\text{th}}$  species in the community; and  $\ln(p_i)$  is the natural logarithms of relative abundance for  $i^{\text{th}}$  species in the community

$$H = \sum (p_i * \ln(p_i)) \quad (1)$$

The species threat index for each AEZ was calculated using the modified IUCN equation (3) as explained by (Dulloo *et al.*, 2021) where; M, is the expected species threat score determined by multiplying the total number of species listed by a group by the maximum weight of the threat score (5); and T; is the observed species threat score determined as a total sum of products of the total number of species in a cell and the weight of the corresponding cell

$$\text{Species Threat Index} = 1 - \left[ \frac{M-T}{M} \right] M \quad (2)$$

## Results

### *Descriptive Statistics*

Willingness to participate in focus group discussions was higher for women 42 (55%) compared to men, 35 (45%). We also observe the participants were mostly middle-aged and elders with few youths.

### 3.2 Diversity Indices of Food Plants and animals available in AEZs

**Table 3**

*Species richness (S) for each Agroecological Zone*

Index	Semi-arid	Northern highland	Coastal zone
Richness	59	82	95

Jaccard similarity coefficients were used to determine similarity in species composition of agricultural diversities between agroecological zones, Jaccard index was highest between Coastal zone and Semi-arid (0.68), followed by Coastal

Species richness described as the total number of species mentioned in all AEZs was 144, Coastal zone reported the highest number of species, 95 (66%), followed by Northern highland, 82 (57%) and Semi-arid had the lowest number of species identified 59 (41%) (See Table 3). Analysis of variance (ANOVA) showed that the differences in species richness were/were not statistically significant.

zone and Northern highland (0.64) and the least similarity was observed between Semi-arid and Northern highland agricultural diversities (See Table 4). Figure 1 shows the Jaccard dissimilarity Distance for the Jaccard indexes.

**Table 4**

*Jaccard similarity coefficients*

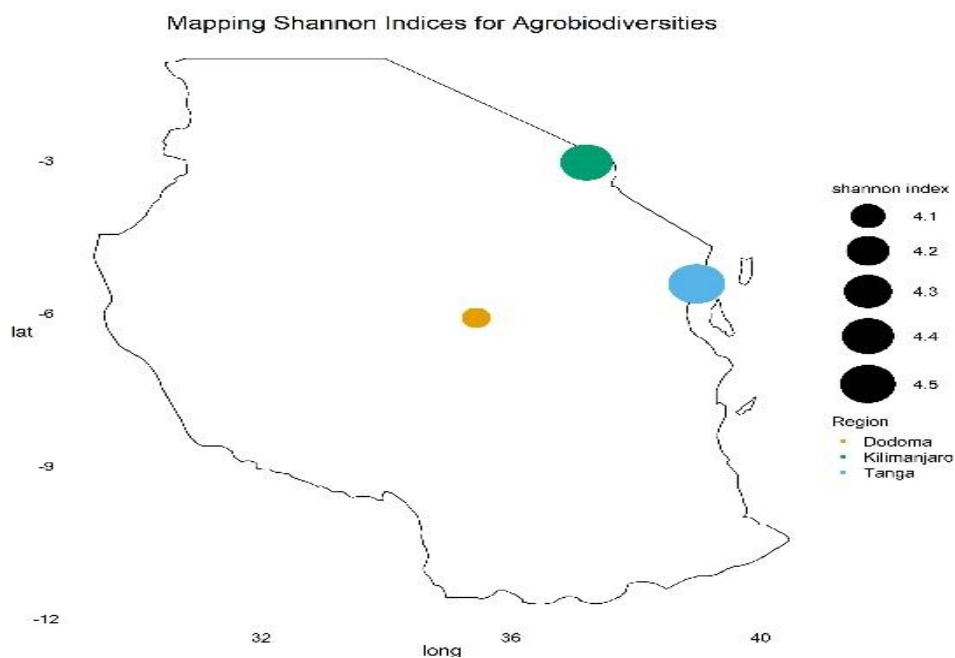
	Semi-arid	Northern highland
Northern highland	0.62	
Coastal zone	0.68	0.64

Shannon-Wiener diversity index (H) was used to determine species richness (abundance) and evenness (spread), Coastal zone had the highest index score (4.55) followed by Northern highland (4.41) and Semi-arid had the least score (4.08).

Table 2.5 and Figure 2.1 show the Shannon-Weiner index and a map of Tanzania showing the richness and evenness scores for the three AEZs using the Shannon-Wiener index in the three study AEZs respectively

**Figure 1**

*Species threat index scored across Agroecological Zones, wards and gender*



***Species threat index***

The species threat index was computed to assess the perception of the farmers on the status of agrobiodiversity conservation and use in their communities based on gender differences, physical factors (altitude) and farming systems between AEZ, (Table 5) shows expected and observed species threat score as well as species threat index calculated for both genders, between

communities living in the different physical landscape of the same agroecology and between different agroecologies.

Scores for Species Threat Index range from 0 for least concerned status to 1 for highly endangered status of agrobiodiversity. The results show that pulled threat index ranged from 0.39 to 0.59 with mean score = 0.48 (s.d = 0.055). The species threat

between AEZ were observed to be lowest in Semi-arid, mean score = 0.46 (s.d = 0.006); followed by Coastal zone, mean score = 0.47 (s.d = 0.037); while Northern highland had the highest score, 0.51 (s.d = 0.087), see top left of figure (2). Analysis of Variance showed that the differences in means for species threat index between agroecological zones were not statistically significant ( $p$ -value = 0.39).

The impact of change in elevation within AEZ on the perception of agrobiodiversity status was also observed. In Semi-arid where the change in elevation was minimum, approximately 250 m, the mean scores were 0.46 (s.d = 0.009) in Chamwino to 0.47 (s.d = 0.005) in Ilindi; for Northern highland where the elevation difference was approximately 800 meters, the mean scores ranged from 0.48 (s.d = 0.118) in lowland Kahe to 0.56 (0.045) in uplands of Massama; while in Coastal zone having difference in elevation approximately 990 meters, the mean score ranged

from 0.49 (s.d = 0.002) in Bweni along the shores of Indian ocean to 0.45 (s.d = 0.046) in upland Amani, see top right Figure (2). Generally, species threat index was found to have moderate weak positive correlation with elevation ( $R= 0.37$ ,  $p$ -value = 0.472), the bottom right of figure (2) b is the heat map showing the differences in threat index score at different elevations.

The influence of gender on perception of status of agrobiodiversity conservation and utilisation showed that generally, women perceived their agrobiodiversity to under threat with mean scored index 0.48 (s.d = 0.065) compared to men, 0.47 (0.049) see bottom left of Figure 2.2 below, however, two sample t-tests showed the difference was not of statistical significance ( $t = 0.286$ ,  $p$ -value = 0.781), for women the lowest score was scored, 0.39 in Kahe and highest score, 0.59 in Massama; for men, the lowest score was 0.41 in Bweni and highest score 0.56 in Kahe.

**Table 5**

*Expected, observed, and threat index scored by different genders in varying topography and different AEZs*

AEZ	Ward	Elevation (aver. MASL)	Gender	Expected Threat	Observed Threat	Threat Index
Coastal zone	Amani	1000	Women	175	84	0.48
			Men	135	56	0.41
	Bweni	10	Women	215	106	0.49
			Men	375	184	0.49
Northern highland	Kahe	700	Women	275	107	0.39
			Men	230	128	0.56
	Massama	1500	Women	210	123	0.59
			Men	140	73	0.52
Semi-arid	Chamwino	1050	Women	195	88	0.45
			Men	185	86	0.46
	Ilindi	800	Women	260	119	0.46
			Men	260	121	0.47

***Cell placement of predominant species and reasons provided in each AEZ***

Participants mentioned the reasons for placement of species in respective cells, the reasons were collectively agreed by participants, using the

frequency of reasons mentioned by the farmer across focus group discussions in an AEZs the dominant reasons were determined and presented in (Table 6).

**Table 6***Predominant species in each cell and reasons for placement by each gender*

AEZ	Cell	Species	Reasons
Coastal zone	1	<i>Zea mays, Amaranthus graecizans, Corchorus orustrilocularis, Panicum miliaceum, Pennisetum glaucum, Sorghum bicolor, Amaranthus graecizans. Arachis hypogaea</i>	Staple, drought tolerance, cultural importance
	2	<i>Sesamum indicum, Sus scrofa domesticus, Manihot esculenta, Ipomoea batatas, Cajanus cajan</i>	Cash crop
	3	<i>Vigna unguiculata, Vitis vinifera, Bos taurus, Mangifera indica,</i>	Labour intensive, production cost, men's crop
	4	<i>Dracaena trifasciata, Equus asinus, Madoqua kirkii</i>	Unavailable, highly seasonal
Northern highland	1	<i>Gallus gallus domesticus, Zea mays, Coffea Arabica, Phaseolus vulgaris</i>	Staple crop, cash crop
	2	<i>Allium cepa, Oryza sativa, Capra aegagrus hircus</i>	Cash crop
	3	<i>Acacia albida, Bos Taurus, Helianthus annuus, Persea Americana, Cordia Africana, Curcubit maxima, Saccharum officinarum</i>	Land scarcity, low price,
	4	<i>Cairina moschata, Tilapia sparmanii,</i>	Scarce, Protected species
Semi-arid	1	<i>Gallus gallus domesticus, Palaemon elegans, Zingiber officinale, Cajanus cajan, Cocos nucifera, Panulirus species, Rastrineobola argentea, Amaranthus species</i>	Cash and staple crops
	2	<i>Oryza sativa, Vigna radiate, Rastrineobola argentea, Helianthus annuus,</i>	Staple crop
	3	<i>Abelmoschuc esculentus, Cinnamomum verum, Elettaria cardamomum, Mangifera indica, Musa species, Hodotermes mossambicus</i>	Land scarcity

- 4 *Cavia porcellus*, *Clarias gariepinus*, *Corchorus orustrilocularis*, *Oreochromis niloticus*, *Sus scrofa domesticus* Scarce, Protected species
-

## Discussion

### *Agrobiodiversity Status in Tanzanian Agricultural Landscapes*

Results of diversity indices showed Semi-arid had lowest species richness (S) and Shannon- Wiener index (H) Score followed by Northern highland while Coastal zone had highest score. Semi-arid is characterized by exacting growing conditions for crop and animal production, unreliable rainfall and dryland renders number and kinds of crops and animals that can be cultivated to be limited. Ideally, only crops and animal species that can tolerate such conditions are cultivated for household subsistence. Regardless, Semi-arid was rich in wild and semi-cultivated species utilised by households compared to other AEZs. This was because the AEZ has relatively large area that is not used for agricultural production. The Northern highland had moderate S and H between the three AEZs, farmers were able to identify many species available in their agricultural landscapes ranging from cultivated to wildness. Despite having fertile lands and reliable rainfall, agricultural landscapes were highly affected by land scarcity and intensive farming practice rendering diminishing agrobiodiversity. Ranging from the coastline of Indian ocean to the East Usambara mountain range Coastal zone scored highest S and H. This is because it encompasses rich marine biodiversity; fertile land and reliable annual rainfall which are fairly well distributed throughout the year support wide range of crops and animals that can be cultivated thus widen agricultural biodiversity. Jaccard similarity coefficient showed more or less similarity in species composition across study areas in the three AEZs. The Semi-arid and Coastal zone AEZs shared most species, this is because in the two AEZs farming is done mainly for subsistence, coupled with topography, edaphic and hydrological factors similarity resulting in more or less similar habitat. Semi-arid and Northern highland had distant similarity in species composition because of environmental and socioeconomic dissimilarity making both species habitat and farmer's preferences to differ substantially. The Northern highland and Coastal zone had moderate similarity because upland area have similar elevation features thus temperature which favours similar crops while on

the lowland Kahe and Bweni are along the river Pangani therefore similar type of agricultural production maybe conducted in addition to uniformity in species habitat.

Duelli (1997) proposed use of landscape heterogeneity and habitat diversity as structural parameters for biodiversity evaluation. Landscape heterogeneity has two components; composition and configuration (Duflot *et al.*, 2015). Composition is the proportion of different types of land cover types and configuration is the arrangement, proximity and transition between patches of land cover (Redhead *et al.*, 2020). Composition bring about pool of biodiversity and configuration facilitates movement of species across the landscape (Estrada-Carmona *et al.*, 2022). Traditionally, agricultural communities manage biodiversity at various scales, creating dynamic landscape composition (Mijatović *et al.*, 2013). Landscape configuration in semi-natural landscape such as an agroecosystem is an important concept because it enables understanding of the dynamic of species composition therefore ways to optimise spatial configuration (Urrutia *et al.*, 2020). Habitat heterogeneity; increasing heterogeneity of non-crop habitats comes at the expense of agricultural production (Hiron *et al.*, 2015), on the other hand, increasing crop heterogeneity could mitigate the negative effects of intensification on biodiversity while maintaining high production levels. Habitat diversity; totality of species that exist in a natural or semi-natural ecosystems such as agricultural landscape (Kallimanis *et al.*, 2008). Agricultural intensification poses threat to biodiversity by decreasing habitat diversity (Hendrickx *et al.*, 2007). Habitat diversity is crucial parameter in assessment of potential for increasing biodiversity in agricultural landscape management practices of agroecosystems for ecological sustainability (Duelli, 1997).

Humanity demands heavily on agricultural landscapes, from food, ecosystem services and biodiversity conservation (Frei *et al.*, 2020). The potential of biodiversity conservation in agro ecosystem is a characteristic of agricultural landscapes with higher species diversity and richness (Munishi *et al.*, 2008). Burel *et al.* (1998) argue that agricultural intensification does not necessarily lead to a decrease in species richness

but functional responses, replacement of species or loss of species have been observed. Estrada-Carmona *et al.*, (2022) acknowledged the importance of agricultural land in conservation of biodiversity and argue for synergistically management of agriculture to halt biodiversity loss and sustainable production.

#### ***Influence of Farming Systems on Agrobiodiversity Status***

Agroecological zones are designated area with more or less distinctive environmental features, these features prompt adoption of distinctive farming practices in order to sustain household livelihood. Three AEZs; Semi-arid, Northern highland and Coastal zone having different predominant farming systems were studied to determine farmer's perception on agrobiodiversity status. Predominant farming systems observed were mixed farming in Semi-arid; intensive farming in Northern highland; and agroforestry and artisanal fishing in Coastal zone. Results on species threat index score showed on average, farmers in Northern highland perceived their agrobiodiversity was at risk compared to other AEZs. Msuya, (2013) defined farming system as in-depth description of agricultural practice. They are distinctive characteristics of agroecological zones resulting from varying constraints and having different resources endowment which farmers have to compensate judiciously (Asante *et al.*, 2019). They are therefore, a precursor for human decision-making in a quest to meet livelihood (Tittonell, 2014). Many people rely on farming systems that draws and build from nature for their subsistence and income (Milheiras *et al.*, 2022a). The relationship between farming systems and agrobiodiversity is the social-ecological system that (Fischer *et al.*, 2015) vividly explained that humanity depends on, exert influence upon and have obligation towards.

#### **4.3 Impact of Topography on Agrobiodiversity Status**

Agricultural landscapes were observed to vary along topography resulting to differences in composition and richness of agrobiodiversity managed and utilised. The agricultural landscape in the lowland areas such as Bweni and Kahe had higher diversity of species compared to upland areas Amani and Massama, this is because the agricultural landscape in upland areas where

adjacent to natural and conserved landscapes such as the Eastern Usambara mountain range and the Mount Kilimanjaro national park in Coastal zone and Northern highland respectively. Presence of conserved natural landscapes next to agricultural-based communities render agricultural land scarce thus impact local agrobiodiversity depended by farming communities (Baul *et al.*, 2015), also the microclimates associated with difference in altitude example temperatures influence the type and composition of species (Opedal *et al.*, 2015) and the perceived cultural importance to the society (Tarolli and Straffelini, 2020). Lowland areas had higher species richness because they intensively grow food crops as well as horticultural crops for commercial production especially in Northern highland but also rich marine agrobiodiversity in Coastal zone. The trend of decreasing agrobiodiversity as you ascend from lowland to upland for the two AEZs should have been consistent with the trend in farmer's perception scored using species threat index. However, farmers in the two AEZs showed different perception such that farmers in highlands of Northern highland perceived high threat compared to those in lowland while farmers in uplands of Coastal zone perceived their agrobiodiversity as more secure compared to those in lowland.

The perception of farmers along the landscape gradient being inconsistency with the trend of species richness elicits agroecosystem services as possible explanation to deliberate. That, the perception of status of agrobiodiversity might actually be influenced by totality of outputs derived from the agroecosystem services farmers enjoy from the agroecosystem regardless of the degree of environmental instability (Peterson *et al.*, 2018), for example in this study, despite the similar situation of land scarcity, farmers in the highlands of Coastal zone seemed to enjoy the setup of their agroecosystem while those in highland of Northern highland seemed unsatisfied. Contrariwise, farmers in lowland of Northern highland seemed assertive with the benefits derived agrobiodiversity while in lowland of Coastal zone were uncertain.

Agroecosystem services impacts community well-being in myriad ways both directly and indirectly, this is because it is an ecosystem that is highly manipulated by human activities

(anthropized) (Zabala *et al.*, 2021). Farmers perceive these services perhaps more in socioeconomic perspective because it is provisioning service. Lescourret *et al.* (2015) argued that it is important to understand the dynamic links existing between ecosystem and the social system in agricultural landscapes in order to drive multiple ecosystem services. Li *et al.* (2021) proposed that, although conservation management practices of agricultural landscape are preferred for maintaining or increasing ecosystem services, farmers need to factor in the socioeconomic aspects in decision making. Nevertheless, the importance of maintaining traditionally managed agricultural landscape in the anthropogenic laden agroecosystem is essential for biodiversity conservation (Eriksson, 2021).

#### ***Influence of Gender Roles on Agrobiodiversity Status***

Women scored a relatively wider range of species threat index across all three agroecological zones and higher mean threat index compared to men despite the statistical insignificance. This is because conservation and management of agrobiodiversity involve activities typically divided between genders as roles and responsibilities characteristic of a particular farming system (Khanal *et al.*, 2021). Division of labour in farming activities results in differences in interaction, perception, and knowledge about the patterns and use of local agrobiodiversity between men and women in varying degrees. The study by Lambrou and Laub, (2007) found that women and men hold very specific local knowledge regarding agrobiodiversity they manage. In sub-Saharan Africa for example, women are generally inclined to on-farm management of crops used for household food security and dietary requirements (Assefa *et al.*, 2022) while men are considered producer of cash crop (Fischer *et al.*, 2018). The gender-specific roles along species value chain results to difference in gender-specific traits desired of the species between men and women (Tchokponhoué *et al.*, 2021), this determine types and number of species or varieties of species a man or woman is likely to manage. Also, women tend to be more knowledgeable more on diversity of semi-cultivated and wild plant species compared to men (Zimmerer *et al.*, 2015a; Gbedomon *et al.*, 2017). Traditional inequities such as patrilineal

land tenure practices also limit women's activities in agriculture and type of species diversity they can manage (Powell *et al.*, 2017) thus likely affects their perception of agrobiodiversity. On the other hand, off-farm sources of income play equally important role in sustaining household livelihoods (Abdelali-Martini *et al.*, 2008a), men tend to indulging in such activities thus reduces type and number crops they manage (Assefa *et al.*, 2022).

#### **Conclusion**

In conclusion, examining farmers' perceptions of agricultural biodiversity offers real-time insights into its richness and community dependence. Over time, assessing changes in agrobiodiversity composition informs conservation efforts, addressing inherent and anthropogenic drivers. Understanding these factors helps conserve rich agrobiodiversity, slow deterioration, and rescue endangered elements. Policies must consider the environmental and socio-economic context, recognizing that agrobiodiversity's value lies in societal benefits. Participatory techniques like farmers' perceptions are crucial for measuring agrobiodiversity status.

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