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Full Length Research Paper

Contributions of Mount Cameroon National Park (MCNP) activities to livelihood of the local people, South West Region Cameroon

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The survival of Protected Areas (PAs) in Cameroon is very much dependent on alternative economic benefits derived by local people living around these areas. This study was set out to assess the contributions of Mount Cameroon National Park (MCNP) activities to livelihood of the local people. To achieve this, a household survey was conducted using simple random sampling technic where each household was given equal opportunity of being selected to take part in the survey. Line transects questionnaires and a selection of some Participatory Rural Appraisal (PRA) tools were used to source information. A total of 600 questionnaires were administered in 10 villages. The results showed no significant contribution of MCNP activities to livelihood of the local people. Implemented innovative income programs had not yet attained optimum production level. Household income level was perceived to have increased slightly. Previous income activities that impacted negatively conservation such as small-scale logging and shifting cultivation have been abandoned and replaced mainly by innovative income programs such as agroforestry farming, mixed crop farming and sustainable debarking of *Prunus africana*. However, the sustainability of the innovative income activities would require a more practical match making approach for management.

Key words: Protected areas, management, participatory rural appraisal, household income level.

INTRODUCTION

The growing loss of biodiversity and forest cover across the globe is threatening the daily benefits nature provides to billions of people in the world today (IPBES, 2019). This threat now causes many countries to drift towards Protected Areas (PAs). These PAs occupy over 15% of land surface and 7% of the oceans (WDPA, 2018). This is alleged to be the most adapted strategy for conservation of biodiversity. In some countries, many political acts of conservation are misinterpreted by policy makers who then impose ineffectual measures (Holmes, 2007). However, PA management contributions to local people livelihood are debated especially on socioeconomic perspective tropical countries rich in biodiversity (Raven et al., 2020). The general practice in

the management of PA is the restrictions on access to forest in most cases and this can inflict high negative socioeconomic impacts on the local people (Curtis, 2014, Oldekop et al., 2016). In Sub Sahara, there is huge rural population highly dependent on natural resources for subsistence and revenue (Ndenecho and Mbue 2010; Schwartz et al., 2012; Maurice et al., 2022). As such, Cameroon has been rapidly expanding and evolving its PA creation and management system over the last two decades in order to preserve these high-value and unique ecosystems (Takem and Lebga, 2020). The Cameroonian government created several National Parks across the country and additionally established other types of PAs amongst which was the Mount Cameroon, Korup, Takamanda, Bakossi national parks and the Banyang Mbo Wildlife Sanctuary found in the South West Region (Takem et al., 2010; Takem and Aloysious, 2020). In the management of these PAs, the Programme for the Sustainable Management of Natural Resources (PSMNR) was conceived. Its main objective is to support sustainable forest management on the one hand and on the other hand to foster the effective management of PAs through community participation and involvement foreseen in the legal instruments guiding both the creation and management (Nvenakeng and Rob, 2016). The PSMNR is implemented by the Regional Delegation of the Ministry of Forestry and Wildlife (MINFOF) South West. The Mount Cameroon National Park (MCNP) was amongst the recently created PAs during the last two decades and prior to 2011, the MCNP was managed area under the IUCN categories I, II and IV (IUCN, 1994), in which poaching and collection of non-timber forest products (NTFPs) were forbidden. The collaborative management approach introduced in the MCNP combines strict protection and protection with limited access (IUCN categories III, V and VI) based on land use planning with specific micro zoning that allows the continuation of ecotourism and sustainable collection of NTFPS especially *Prunus africana* based on the CITES regulations (Tchouto et al., 2014). The added value of the collaborative management approach is its complex nature of balancing biodiversity conservation cultural heritage while providing alternative livelihood activities even though the voice of the local people is not heard when making decisions (Nvenakeng and Rob, 2018). The local people around the MCNP have diverse rural livelihood production, subsistence agriculture, livestock, small scale timber and firewood exploitation, bush meat offtakes, harvesting of NTFPs, fishing, and cash crops farming. Changes in the dependence on forest-based livelihood activities such as poaching and unsustainable debarking of *Prunus africana* (Tchouto, 1996) is a common approach of dealing with vulnerability and risk (Gardner et al., 2013). The local people have now adopted sustainable debarking of *Prunus africana* due to the implementation of the collaborative management approach (Tchouto et al., 2014). However, the extent to which the local implement such sustainable practices varies because livelihood options depend on a complex suite of economic and cultural influences. Such influences can include income generation activity practiced by the individual, traditional perception on resource, proximity to the forest and household demography and seasonality of agricultural activities (Aditi and Kamaljit, 2002; Ward et al., 2018). Understanding the contributions of MCNP management to livelihood activities of the local people is essential for community participation in the management of the PA. The collection and marketing of forest resources provides a substantial revenue to many local people around the PA but in most cases has negative impacts on the biodiversity and therefore poses a significant challenge for the management of the PA in areas where local people rely heavily on natural resources for their livelihood (Cavendish, 1999; Sunderlin et al., 2008; Madhu et al., 2010; Nkembi et al., 2022). Considering the population growth rates of 2.6% per annum in Cameroon (World Bank Report, 2022) and that most remaining forests have been incorporated into the country expanded PA system that occupies 30% of the entire territory of Cameroon should be made permanent forest (MINFOF, 2013). The need to reconcile conservation with the livelihood needs of local people will be essential for local people participation in PA management (RoC, 1994; MINEF, 1996; (MINFOF, 2015). Ideally, an understanding of local socioecological systems and resource use should be developed prior to PA establishment, in order to plan and mitigate for future changes resulting from management (Urech et al., 2015). Here, the study aims to understand contributions of MCNP activities to the livelihood of the local people to inform on the impacts PA management on wellbeing of the local people that will determine the effectiveness of the MCNP management. This is particularly important as the understanding on the contributions of MCNP activities to local livelihood may be perceived differently by the local people, conservation practitioners and forest policy makers considering the perceptions on the value of forest by each stakeholder (Cavendish, 2003; Endamana et al., 2018). The study had as objective to identify the activities of the MCNP (collaborative management activities), find out the associated innovative livelihood programs that have been set up by MCNP management for the local people, assess the management of each livelihood program and examine revenue differences generated by each livelihood program into the household income.

MATERIALS AND METHODS

Location of the study area

The MCNP is located in the Fako and Meme Divisions, South West Region of Cameroon along the Gulf of Guinea. Geographically, it is between Latitude 4.055° – 4.378° N and Longitude 9.031° - 9.291° E covering a total surface area of 58,178 hectares. The PA shares
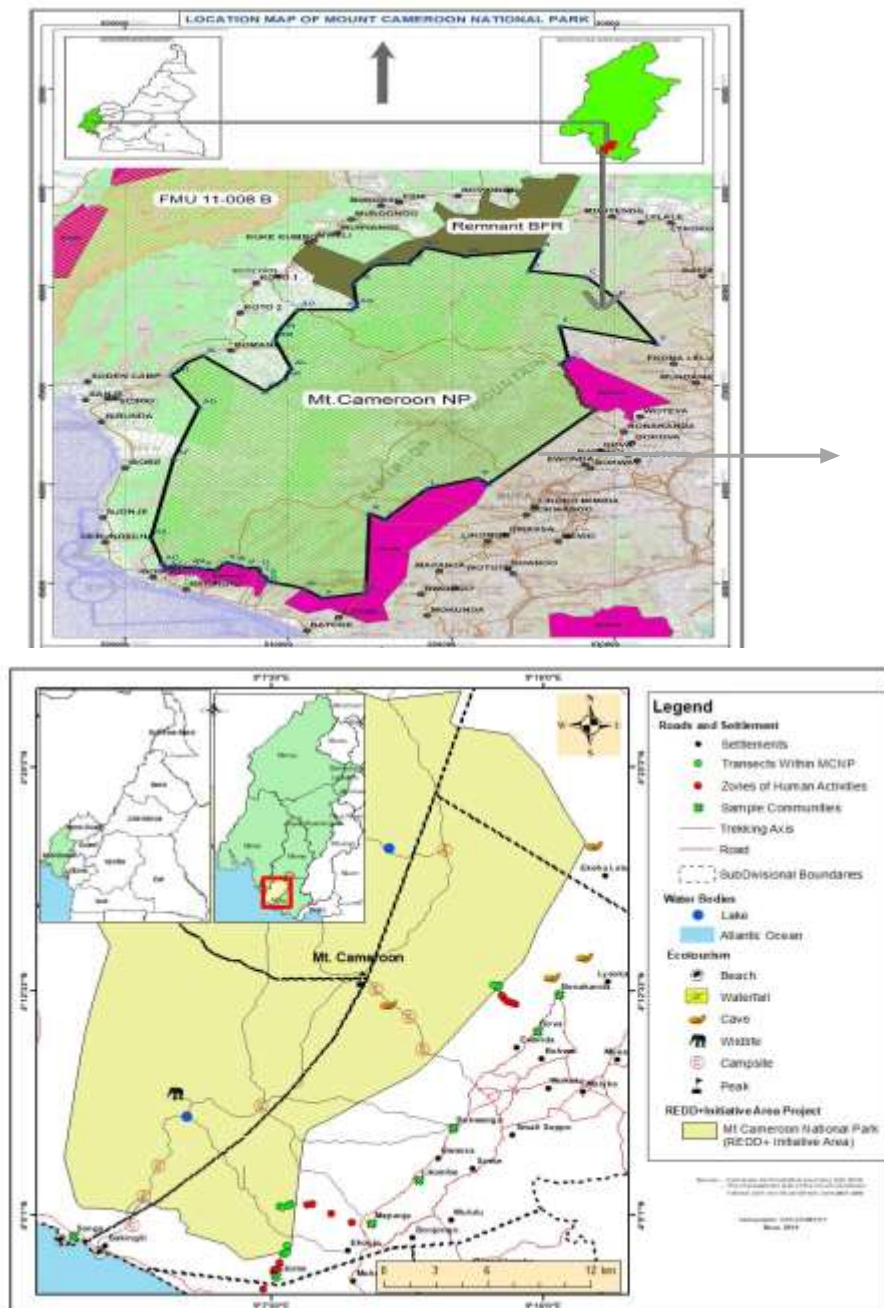
Figure 1. Map of study areas.
Source: Authors.

an external boundary of 128.73 km in length with five Sub divisions: Buea and Limbe II (46.79 km), Muyuka (19.81 km), Idenau (24 km) and Mbonge (38km). It was created as Bomboko Native Authority Forest Reserve in 1939 and finally classified as a National Park in 2009 following a Prime Ministerial decree No.2009/2272/PM of 18th December 2009 (MCNP MP, 2004). The area has a distinctly season of rainfall related to the north- south movement of the Inter-tropical Convergence Zone (ITCZ). There is a period of heavy rains occurring between the months of June and October and a dry period extending from November to May. At lower altitude, the annual rainfall ranges from over 10,000 mm at Cape Debundscha

(second wettest place in the world) to less than 2,000 mm in the north-east of the massif around Munyenge Metombe. Mean annual rainfall decreases with altitude to approximately 4,000 mm at 1,000 m and less than 3,000 mm above 2,000 m (Payton, 1993). This has influenced the selection of innovative income generating programs adapted to this climatic condition that generates substantial revenue that support livelihood of the local people (Figure 1). The MCNP management involves 41 peripheral villages grouped into six geographical clusters (Buea 1, Buea II, Bomboko I, Bomboko II, Muyuka and West Coast) based on natural boundaries, cultural and livelihood differences to facilitate park management. This Study

Table 1. Choice of clusters and number of villages.

S/N	Cluster	No. of villages	Villages in zone A	Villages in zone B	Selected villages
1	Buea 1	8	4	4	5
2	Buea II	5	0	5	2
3	West coast	6	0	6	3

Source: Authors.

was conducted in ten villages (Bova I, Bova II, Bokwango, Bonakanda, Likoko Membea, Likombe, Bakingili, Etome, Mapanja and Sanje) found in three clusters (Buea 1, Buea II and West Coast) as shown in Figure 1 that were secured and accessible during the sociopolitical crisis period. A combination of purposive and stratified random sampling methods was used to select the sample. First, a purposive sampling of the cluster was done due to the sociopolitical crisis of the English-speaking areas of the country that made accessibility of three clusters impossible due to the insecurity. In the selected clusters, random sampling was done using proximity to the park boundary as a criterion for selection and classification. Villages sharing a common land boundary with the park were classified in zone "A" and those not sharing a common boundary were classified under category "B" as indicated in Table 1. The selected villages were made up of all segments of the population that depend on the forest for their livelihood.

Methodology

The study made use of biological and socioeconomic assessment techniques (purposive sampling, some selected and a triangulation of Participatory Rural Appraisal (PRA) tools; questionnaires, visual assessments, and key-informants) for the collection of data (Buckland et al., 2010). The questionnaires were divided into four sections according to the objectives of the study and developed using secondary data on local livelihood systems around protected area during desk top review of the study. These questionnaires were later tested in the field during the first reconnaissance survey and missing elements on MCNP support systems of livelihood improvement were collected and integrated into the different sections of the questionnaires.

Sampling method

Site selection

The study area was divided into two zones (A and B) based on accessibility for data collection as follows: Zone A consisted of villages that shared a common boundary with the MCNP and were accessible by road. Zone B were villages that did not share a common boundary with the MCNP and were not accessible by road. In each of the zones, five villages were selected randomly where a total of 10 out of 19 villages were selected for the study. In each of the 10 villages, 60 questionnaires were administered giving a total of about 300 questionnaires per zone and 600 questionnaires in all with a sampling intensity of 33.4%.

Selection of respondents and socio-economic data collection

Respondents were randomly selected from three main actors involving the local communities, the civil society organizations and

forestry administration (that is those of the park service and the regional delegation intervening in the area). Over 5 - 7 days were spent in each community and a combination of household interviews, key informant interviews and focus group discussions were employed. Key respondents were the forestry administration, civil society organizations, local leaders, Forest User groups (FUG) and Village Forest Management Committees (VMFCs). This enabled an overview of livelihood activities, resource use and resource management in each village before and after park creation, while household interviews provided more in-depth information about a particular livelihood activity. A random household-based sampling was done because the Forest User Groups were found to be members of all households within the study area. Secondly, the opportunity for local people to participate in the implementation of MCNP activities was not discriminatory as per the collaborative management agreements signed between the park services and the local people (MCNP MP, 2014). Socioeconomic data were collected using purposeful and random sampling methods as described by Fimbel et al. (2000). Two sets of questionnaires divided into five sections (A to E) were used for data collection. A (identification of respondent, income generating activities and associated population structure, B (identifying collaborative management activities), C (sourcing information related to innovative livelihood programs, D (gathering information on the management of each livelihood program) and E (source data on revenue differences generated by each livelihood program into the household income). Set one was administered to local community village chiefs, Village traditional council members, cluster facilitators, Village Forest Management Committee (VFMC), Cluster Platform Members (CPM), poachers and farmers. Set two was administered to the MCNP government staff (conservator, collaborative management technician conservation development officer), the forestry staff of the regional delegation (Delegate, chief of service for wildlife, chief of service for transformation and chief of service for forestry) and PSMNR partners (Coordinator of GFA, Forestry expert of GFA, Collaborative management Expert of GFA, Wildlife conservation coordinator, WWF coordinator, GIZ technical advisors). Focused group discussions, ranking, seasonal calendars, resource mapping and scale balances were also employed for the collection of data on the type and occurrence of activities and impacts to the local people in the study area.

Transect establishment

To complement the socioeconomic data collected on the identified collaborative management activities and associated livelihood programs, line transect technique was employed. In each of the selected villages in the two zones, two 3 km transects perpendicular to the main access road into and out of the village were established. Along each of the transect that covered three main community used areas (most used, less used and least used), on a range of 100 m on one side, a 50 by 50-m plot was established. The plots were later subdivided into 25m by 25m subplots and on adjacent sides, a 100% inventory of all non-timber
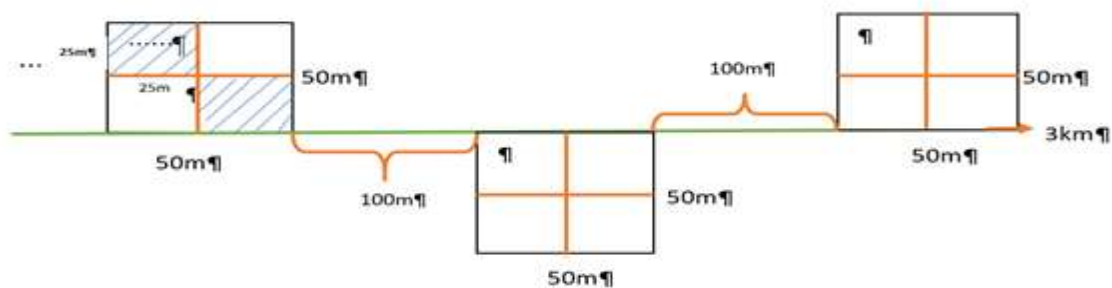
Figure 2. Transect design adapted from Thomas et al. (2007).
Source: Authors.

forest species were identified and enumerated (Thomas et al., 2007, Buckland et al., 2006) (Figure 2).

Analytical procedure

After the collection of data, the questionnaires were cleaned, sorted, coded, inputted and analyzed using the Statistical Package for Social Sciences (SPSS version 16). Descriptive statistics, parametric and non-parametric analysis (ANOVA and T-test) were used for the establishment of significant differences on the number of individuals involved in the different activities and corresponding income generated. Multiple linear regressions were used to determine income levels and data was summarized in the form of frequency distribution, measures of central tendency and variation. Cross tabulations were used to determine the association between variables. Additionally, graphical depictions of results through graphical use interface were used.

RESULTS AND DISCUSSION

Park management activities for livelihood improvement

The MCNP is managed through a collaborative approach and six main park management activities were identified to be implemented amongst which were village development, innovative green income generating programs, cluster facilitation, park protection, capacity development and users' access rights implementation as showed in Figure 3. A majority (45%) of the sampled population were involved in the implementation of the innovative green income generating programs while the least proportion (5%) was involved in capacity building. Those involved in park protection constituted 20% ranking the second while those involved in village development made up 15% ranking the third with regards to the sampled population. Those involved in the implementation of user's rights and cluster facilitation constituted 7.5% respectively from the sampled population. The highest proportion of the local people involved in the innovative green income generating

programs was realized to be forest dependent and the innovative programs were merely improved system of farming using improved seedlings and sustainable methods of collection of NTFPs. It emerged from the study that these new practices of improved farming system and sustainable collection of NTFPs was gradually replacing poaching, unsustainable methods of NTFPs collection and old farming systems of shifting cultivation. It is important to note that the innovative programs bring individual gains to the household and this has been the main motivation behind the increase in number of local people involved in its implementation. These results were similar to that of Nkembi et al. (2022) who indicated that the rural poor tend to be disproportionately dependent on forest resources and rally behind any forest related income generating activity that secure individual household income, especially in the forest areas. The relationship between gender and conservation activities is presented in Table 2. A Pearson chi-square value of 118.9, df = 5 ($p < 0.05$) showed that there is a statistical association between gender of the respondents and conservation activities. Most of the activities were gender oriented with more males involved in park protection activities that included biological monitoring survey, demarcation of park boundary, encroachment survey and more women involved in users' and access rights, village development while other activities such as innovative green income generating programs recorded both male and female involvement that showed an even balance. A significant proportion of the local people were found participating in park protection activities for purposes of income generation and ownership of the protected area. A smaller proportion involved in the implementation of user and access right, capacity building on forest management, village development and cluster facilitation, indicated an interest of creating a conducive atmosphere for collaboration by the local people that enabled smooth exchanges between the MCNP managers and the local people. These energized the local people to take ownership and see the
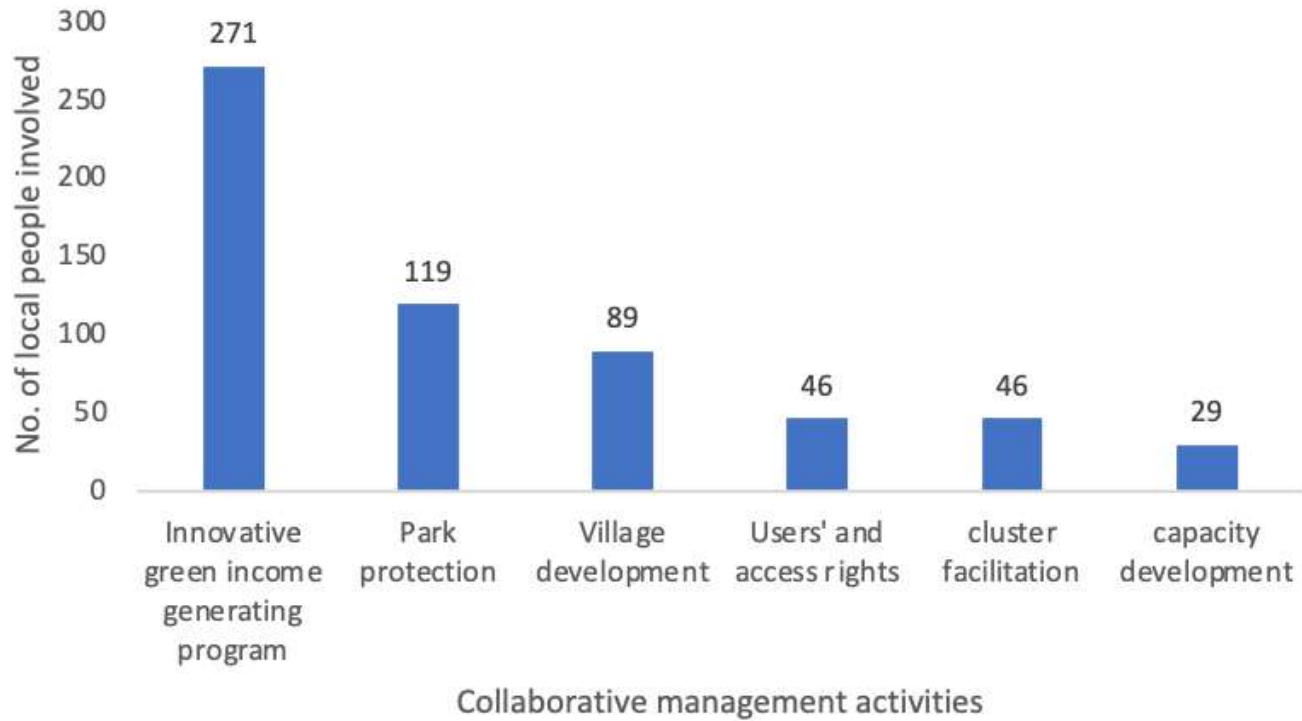
Figure 3. Percentage representation of local people implementing collaborative management activities.
Source: Authors.

Table 2. Chi-square Tests on the relationship between gender and conservation activities.

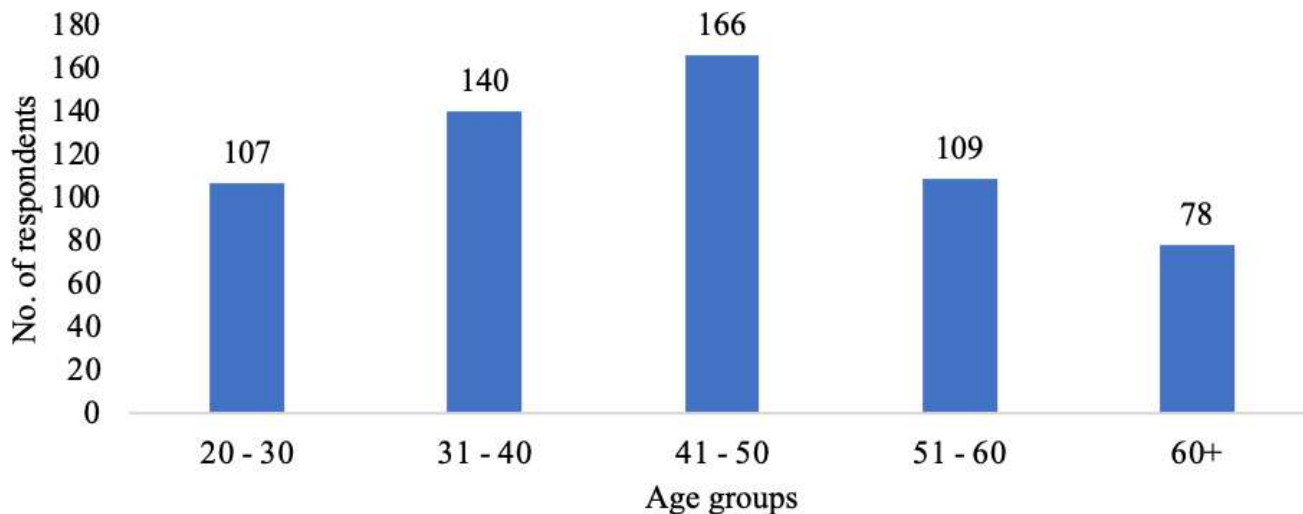| Variable	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	118.973[a]	5	0.000
Likelihood Ratio	139.424	5	0.000
N of Valid Cases	600		
[a]Zero cells (0.0%) have expected count less than 5. The minimum expected count is 9.81.			

Source: Authors.

MCNP as an investment for their unborn children. These results confirmed Ute (2000) who stipulated that restriction of access policy for PA management kept local people further away from PA management. Furthermore, the perception that the further away people are from a resource, the better they can conserve it only created conflicts between managers of PA and local people.

Characterization of park management activities with regards to local participation

Local people involved in the implementation of the MCNP management activities in the sampled villages were found to be distributed into five age groups (Figure 4). The highest (27.7%) proportion of the local people participating in these activities were those between the ages of 41 and 50-year and those above the age of 60 formed the least (13%) proportion of the local people. Those between the ages 31 and 40 represented 23.3%, ages of 51 and 60 constituted 18.1%, whereas those between 20 and 30 represented 17.8% of the local population. The determination of an age group to participate in the MCNP management activities was time and energy spent as well as financial benefits earned. A statistically significant Pearson chi-square value of 332.7, df = 20 ($p < 0.05$) showed that there is a statistical association between age of the respondents and park management activities as most of the respondents involved in park protection and capacity development were between the ages 20 to 30 whereas those between the ages 30 to 40 were involved innovative income generating activities and cluster facilitation while those between 51 to 60 were mostly involved in village

Figure 4. Proportion of age groups involved in the implementation of collaborative management activities.
Source: Authors.

**Table 3.** Relationship between age and park management activities.

Variable	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	332.752[a]	20	0.000
Likelihood Ratio	347.715	20	0.000
N of Valid Cases	600		
[a] One cell (3.3%) had an expected count less than 5. The minimum expected count is 3.77.			

Source: Authors.

development and access and user rights as presented in Table 3. The significant distribution of activities with regards to age was basically due to the labour force needed, immediate cash payments and ownership. The aging class was drifting towards more less labour driven activities which provided a possibility of ownership whereas the young were more involved in labour intensive activities with immediate cash payments. The young people between the ages of 20 and 30 years and those between 31 and 40 years rallied, and were motivated to participate in park protection and capacity building activities because compensation in terms of remuneration was immediate. As indicated in a relative study by Nkembi et al. (2022), these segments of the population were those constituting the highest proportion of local people involved in the collection of forest products for livelihood. Even though this situation is different from the collection of forest resources for livelihood purposes, the factor that brought similarities is the aspect of immediate revenue generated. Engaging these segments in park management and capacity building on forest management has a direct positive impact on conservation of the MCNP. This is also in line

with the saying of an old man in Botswana who expressed some relativity of conservation priority when he said "when we are compensated we forget our old practices of hunting, when we are neglected we go back to our ancestral practice" (Kgathi and Motsholapheko, 2011). Those between the ages of 41 and 50 were more involved in activities oriented towards permanent investments through a permanent relationship between the local people and the park services based on consultations and negotiations. The elderly that belonged to the ages 51 and above ensured that management respected their cultural and traditional rights through village development, user's and access rights. These findings fall in line with Ndenacho (2007) who indicated that participation of local people in PA management depended on monetary benefits derived from these areas. Park protection and capacity development were identified as part of management activities implemented by the MCNP. Results of local people participation in this activity indicated that those between the ages of 20 and 30 years had the highest 52.1% proportion that participated in park protection and a proportion of 75.9% that participated in capacity development. Those of ages

Park protection

Capacity development
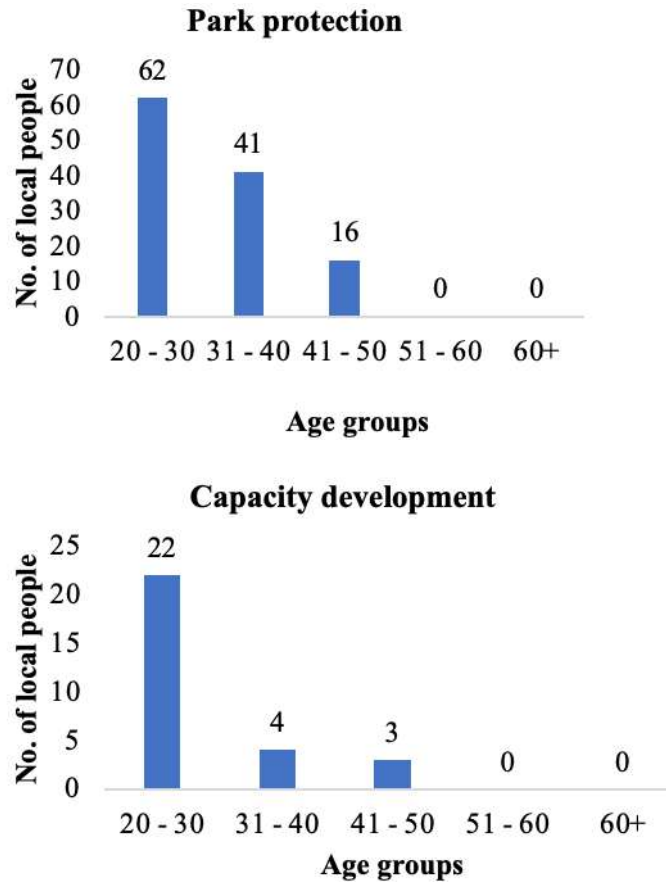
Figure 5. Proportion of Local people participating in park protection and capacity development.
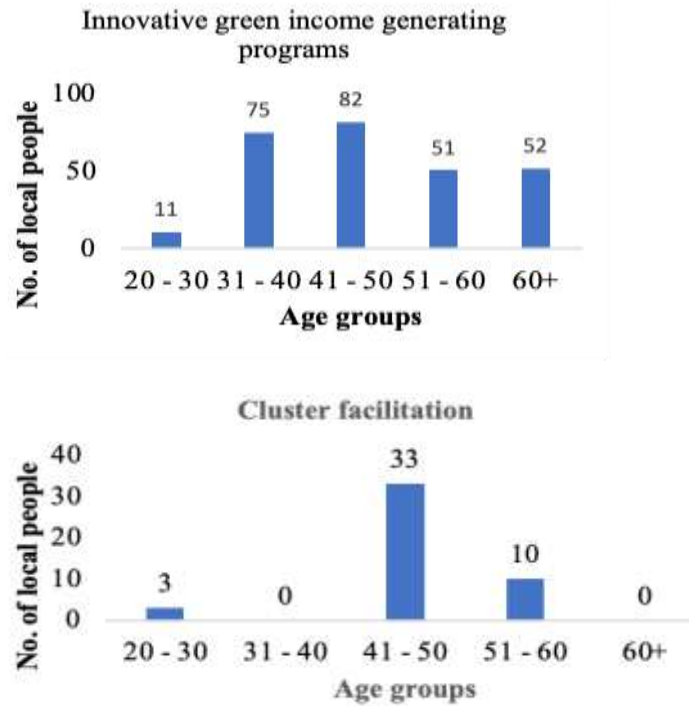Source: Authors

above 50 years were found completely absent in these activities (Figure 5).

Park protection included activities such as biomonitoring survey, joint anti-poaching patrols, encroachment survey, boundary and tourists' trails opening and boundary surveillance. The nature of these activities required ₤ tedious and long hours of trekking in the forest which could not often been supported by the elderly people. This was a clear indication that the more energetic class of people who constituted the young was the most suitable. This group was the most represented, deriving their living directly from the forest through hunting, farming, collection of NTFPs, exploitation of medicinal plants, small scale logging and search for firewood. This group saw park protection as an alternative source of revenue considering the collection of these forest resources were all regulated by the law following the new status of the area. These results were in line with Ndenecho (2007), who indicated that these age groups are the most active when it comes to sourcing of forest products for their livelihood.

The innovative green income generating programs and cluster facilitation were realized to be more attractive to those between the ages of 41 and 50 years as shown in Figure 6. Results showed that a majority (30.3%) of those participating in the implementation of this activity were made up of local people between the ages of 41 and 50 years. This same age group also had the highest percentage (71.7%) of local people involved in cluster facilitation. Local people between the ages 20 and 30 constituted the least (10.2%) proportion participating in the innovative green whereas those of ages 31 and 40 were the least with a zero percent represented in cluster facilitation as shown in Figure 7. Innovative green programs constituted alternative income source and identified activities included agroforestry and sustainable collection of non-timber forest products (NTFPs) program, ecotourism, improved food crops mixed farming, improved beekeeping, improved livestock farming and community forestry. A Pearson chi-square value of 1086.2, df = 24, ($p < 0.05$) showed that there is statistical association between age of the local people and the innovative income generating program and cluster facilitation as the middle aged (41 – 50 years)

Figure 6. Proportion of local people participating in innovative green programs and cluster facilitation.
Source: Authors
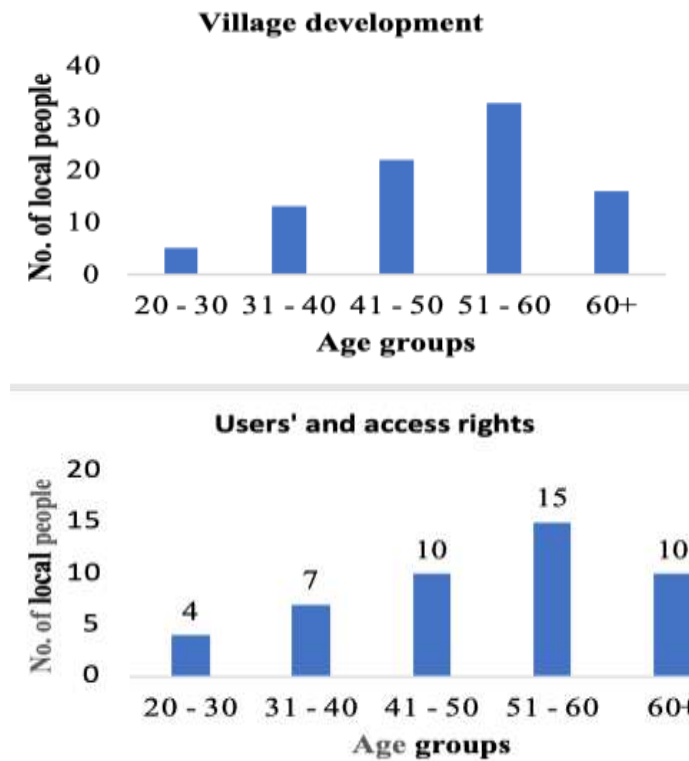
Figure 7. Proportion of local people participating in village development and user's and access rights.
Source: Authors.

Table 4. Relation between age and innovative income generating activities.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1086.720[a]	24	0.000
Likelihood Ratio	864.337	24	0.000
N of Valid Cases	600		
[a] 17 cells (48.6%) have an expected count less than 5. The minimum expected count is 1.69.			

Source: Authors.

respondents played a major role in activities related to agroforestry and sustainable collection of non-timber forest products (NTFPs) and improved food crops mixed farming while in cluster facilitation, the ages 41 – 50 year played a key role in decision making while those above the age 60 were dominantly into livestock rearing as indicated in Table 4. Local people between the ages of 41 and 50 were found to be the most active because match making conditions jointly agreed between local people and the park service were generally met by this age group. The match making was basically the provision of space in terms of land where the program needed to be implemented. They represented the highest proportion of the local people who were involved in household and village decision making. They championed the implementation of agreed decision with regards to these programs and this resulted in a significant reduction in cutting down of the forest because the other age groups depended on this age group for decision making since they constituted the leaders of the communities. A greater proportion of this age group maintained their farm sizes because they were targeted for all trainings on the implementation of innovative green programs development, use of improved seedlings and improved farming method. The practicing of improved farming method has increased quality and quantity of food produced by the locals based on income generated from the sales of farm products recorded during this study.

Cluster facilitation consisted of community mobilization and preparing grounds for consultations and negotiations with local people on the implementation of MCNP management activities. Considering this age group constituted the main decision makers both at household and village level, their acceptance and willingness to participate in cluster facilitation created smooth collaboration between the local people and the park service. These results contradicted those of Holmes (2007) who indicated that land use conflicts in PA are on a rise due to bias negotiations between local people and PA service on the implementation of PA management activities.

In village development and the user's and access rights programs, the highest (37.1%) proportion of participants were those between the age of 51 and 60 years of the sampled population for village development and 32.6% for users' and access rights implementation. Those between the ages of 20 and 30 were the least represented on a percentage of 4.6 and 3.7 participating in village development and users' and access rights (Table 7).

Village development constituted the village hygiene, construction of village conference hall, purchase of chairs and converting village land into roads financed by the MCNP services and the local people; whereas, users' and access rights consisted of exercising rights in the PA through the collection of forest products for subsistence purposes. Participation of local people in village development was structured following family heads with specific financial contributions attached to each village development project. This limited the direct participation of the young people as they constituted a minority of the family representatives even though they provided the labour force and financial contribution in all development projects. The implementation of users' and access rights was of lesser economic interest to all the age groups. Those above the age of 50 years were mainly involved in the traditional uses of some forest resources. The local representation on both programs provides for a direct commitment of the local people because representatives are family heads who are responsible for family coordination. The financial and material contribution of the MCNP on village development encouraged local people to respect the conservation of the MCNP because such benefits are enjoyed by every member of the community. The respect of the users' and access rights had a significant positive impact on conservation of the MCNP because local people only collect for subsistence and medicinal small quantities accepted by the park services. Such collection is done only in the peripherical zone of the MCNP. These results were in line with the World Bank Annual Report (2022) that confirmed that many conservation bodies committed to the conservation of natural resources have become engaged in a sequence of required measures tailored to the needs of the affected people.

Livelihood Innovative programs

Agroforestry and sustainable non-timber forest products collection

Agroforestry and non-timber forest products production were carried out by over 18.7% of the entire population of
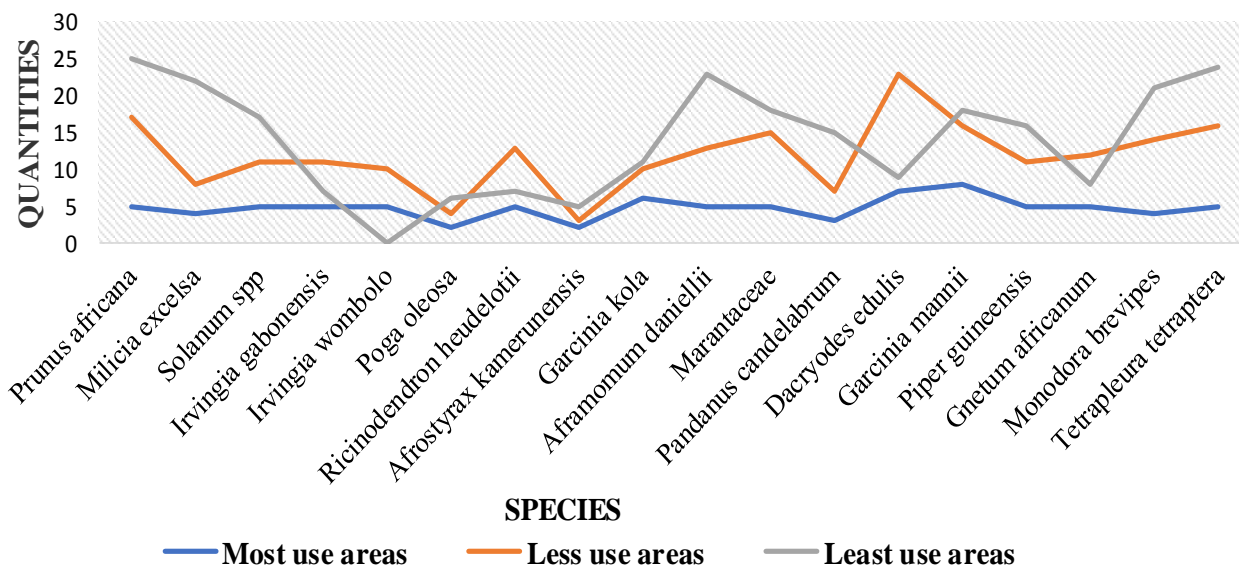
**Figure 8.** NTFPs presence in the different used areas.
Source: Authors

the study area. Plots allocated for agroforestry varied between 1.5 to 2 hectares. Identified agroforestry species products were NTFPs and fruit trees. The proportion of species representation in agroforestry farms were 54% NTFPs and 46% of domestic fruit trees. The main recorded species of NTFPs planted were *Prunus africana*, Sweet bush mango (*Irvingia gabonensis*), Bitter bush mango (*Irvingia wombolo*), Njansanga (*Ricinodendron heudelotii*), Ngongo leaves (*Megaphrynium macrostachyum*) a species in the family Marantaceae, Bitter Kola (*Garcinia kola*), Four corner (*Tetrapleura tetraptera*), and Mbongo (*Aframomum danielli*). Domestic fruit trees used were oranges (*Citrus sinensis),* avocado *(Persea americana*) and guava *(Psidium guajava)*. The distribution of the NTFPs found in the least, less and most used areas (Figure 8) represented of (47%) recorded in the Least Used Areas (LUA) and the abundance declined as one moved from this area to the Less Used Areas (38%) to the Most Used Areas (15%). A proportion of 86% of NTFPs and 96% of the domestic fruit trees were collected during their various production seasons for commercialization and household consumption. The yearly household income generated from the sales of NTFPs varied between 50,000 – 301,000XAF and between 50,000 – 301,000XAF as well for fruits collected. The highest proportion of the respondents (40%) earned between 151,000 – 200,000XAF from the sales of NTFPs while the least (1.7%) earned 50,000XAF – 150,000 XAF (Figure 9). Those collecting fruits made an annual income between 50,000XAF and 301,000XAF from sales. Over 46% of the households earned between 201,000 – 250,000XAF income from the sales of fruits; while (4%) of

households made between 50,000XAF to 100,000XAF from fruits sales (Figure 10). Both seedlings and fruits are sold for both species during the wet season. The finding of this study was in line with other studies about the importance of NTFPs in supporting household income and ensuring food security especially in the tropical areas where most people depend on the forest for their livelihood (Nkembi et al*.,* 2022). NTFPs are sustainably collected including *Prunus africana* based on used of training knowledge provided by the MCNP service to collectors. These results were in line with (MINFOF, 2009) which prescribe directives for *Prunus africana* management. Same results are contrary to Sinha and Bawa (2002) who indicated that in most parts of south India, local people are still collecting NTFPs through harmful harvesting methods that threatens the very existence of these products despite their high economic value. The sustainable debarking of *Prunus africana* in the MCNP area was confirmed by the lifting of the CITES band that was placed on *Prunus africana* harvesting in 2007 (Tchouto et al*.,* 2014).

The production of NTFPs in the study area takes two forms, collection of fruits, roots, leaves barks and the propagation of species in nurseries for subsistence and commercial purposes to be planted by local people into their cocoa and palms farms. New species of NTFPs (*Irvingia wombolo*) has been introduced and propagation techniques adapted to the production of most species by the park management has increased market demand for propagated species into new communities within the area. The extension of the market system has increased both the demand and opportunity for increased cash revenue as many rural farmers move towards the
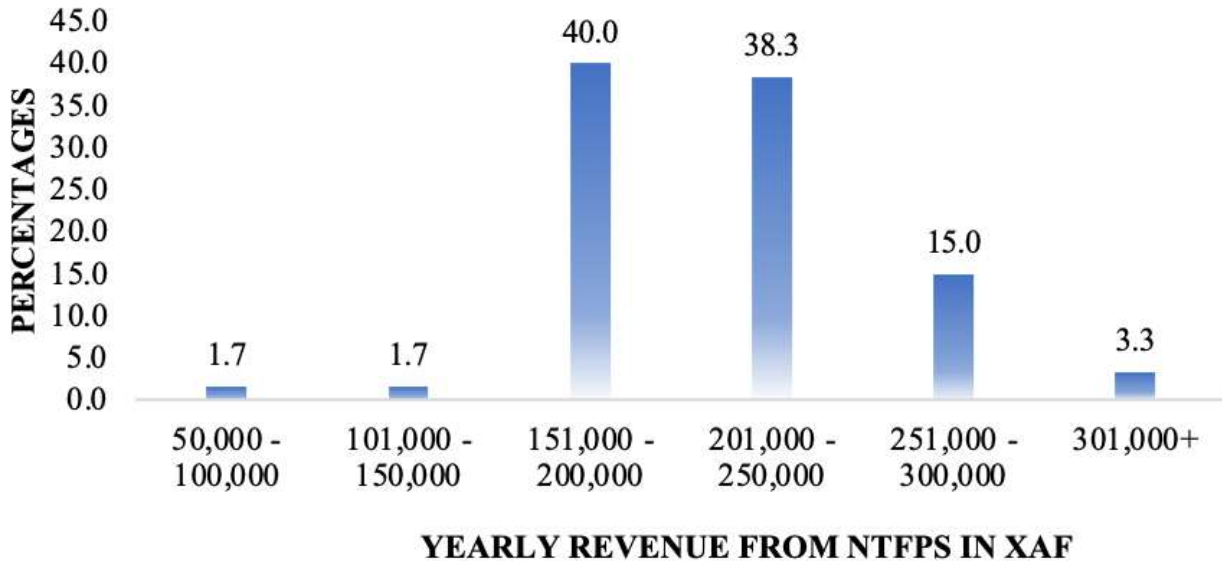
Figure 9. Yearly revenue from the sales of NTFPs per respondent.
Source: Authors
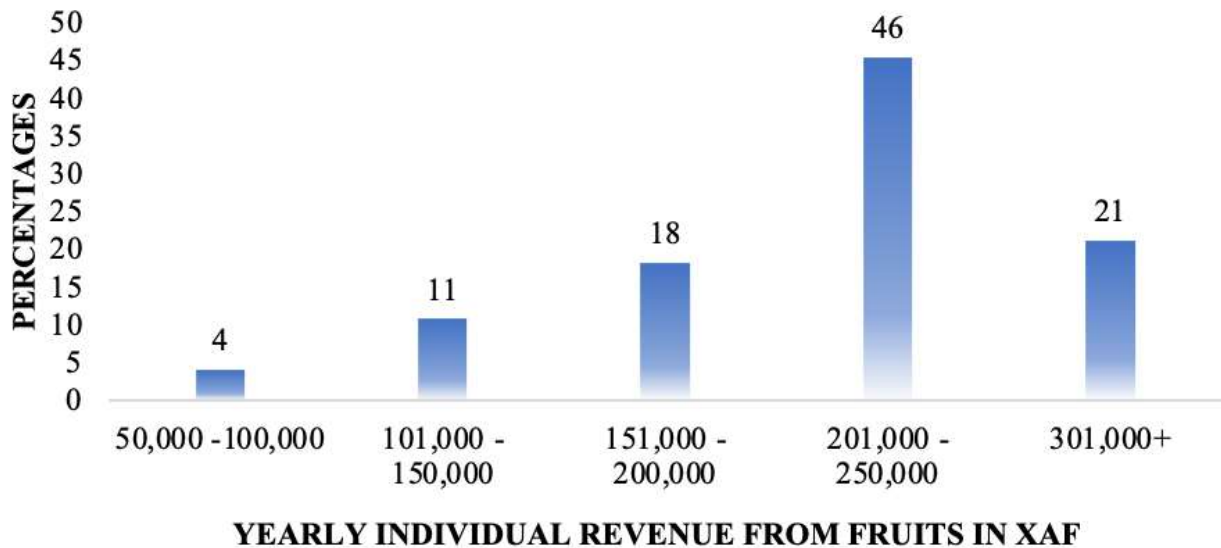
Figure 10. Yearly revenue from the sales of fruits per respondent.
Source: Authors.

multipurpose nursery established by communities around the park to buy directly from the park communities to introduce in the cocoa farms. Still the majority of propagated products are sold in small quantities and for relatively low prices. These results were similar to those of Apurba et al. (2017) who showed that now-a-days it is vital to cultivate or to domesticate wild species and practice their sustainable use to increase demand of medicinal plant and other NTFPs. Though small, this adds up to the sales of NTFPs collected in the ready

market that enables a stable revenue source that provides considerable subsistence support to livelihoods through handy cash that eases the acquisition of basic needs. It is important to note that energy and time that would have been wasted during poaching and illegal hunting that in most cases runs local people into trouble with the forestry administration is been used for legal NTFPs production. The concentration of local people in NTFPs propagation and harvesting added up on food provision, medicines and plants of socio-cultural

Figure 11. Average revenue in XAF per month.
Source: Authors.

importance The sales of these products provides a direct cash benefits and subsidiary means of income to the local people as indicated by Nkwatoh et al. (2019), which this study agrees to.

Ecotourism program

Ecotourism was recorded as a seasonal income generating activity implemented by the local people on through direct and indirect recruitment by the services of the tour operators. The proportional representation showed 56% of porters, 29% of tourists' guides and 15% of administrators in the tour operators' organizations. Those permanently recruited represented 15% of the proportion of the local people involved in ecotourism program and earned an individual average income of 75,000 – 100,000XAF, those temporally recruited constituted 85% and earned an average individual income of 126,000 – 150,000XAF per month (Figure 11). The participation of local people into ecotourism activities varied based on the seasons corresponding to the wet and dry seasons, respectively. The local people consider ecotourism as one of their main seasonal activity, which is carried by most youths occasionally when the need arises and a minority as main source of livelihood. In the MCNP area, ecotourism activities included porting, tourists guide, and administrative operations implemented by tour operators' organization that constituted mainly of the local people These results fall in line with those of Spenceley and Snyman (2017) who indicated that ecotourism in PAs remains a subsidiary income activity for local people living around PAs and especially those around the Congo basin.

Improved food crop mixed faming program

Mixed crop farming is an important livelihood activity that

ensures regular supply of food stuff in the household and revenue Improved farming system has been adopted by84% of the sampled population and species cultivated were mainly improved species of plantains, yam, cocoyam, and cassava. Improved seedlings of plantains were preferred because local people had acquire adequate knowledge on seed multiplication while cassava stems were gotten from nearby Agricultural Research Institute for Development (IRAD) following a partnership agreement signed between MCNP service and the institution. Farm sizes were generally small with a majority (72%) having farms less than 2 ha on average. A majority (92%) of the local people had on average one to two farms. Very few local people (7%) had 3 farms and a small proportion (0.1%) had more than 4 different farms (Table 5). The use of improved species and farming methods played an important role in the reduction of farm sizes, quantity and periodicity of crop production that enhanced the availability of food crops for household consumption and the market. Household with limited farmland can produce adequate food for their families and for the ready market and this made reliability on forest resources for livelihood to reduce. These results were in line with those of Apurba et al. (2017) who confirmed that improvements to agriculture were perceived to be promising strategies for reducing forest-dependence, a landscape approach to conservation necessary in order to promote sustainability of livelihoods and to reduce overall pressures on forest resources.

Improved beekeeping

Improved beekeeping was found to be one of the most valued programs accepted by the local people with a12.5% proportion of the sampled population involved. The introduced Kenyan top bar hives were used by 60.5% of the beekeepers while 33.5% used a mixture of

Table 5. Farm sizes and number of farms owned by local people.

Farm sizes in ha	% of local people	Number of farms	% of local people
0.5 - 2	72	1.1 - 2.0	92
2.5 - 4	22	3	7
4.5 - 6	4	4	0.9
6+	2	5	0.1

Source: Authors.
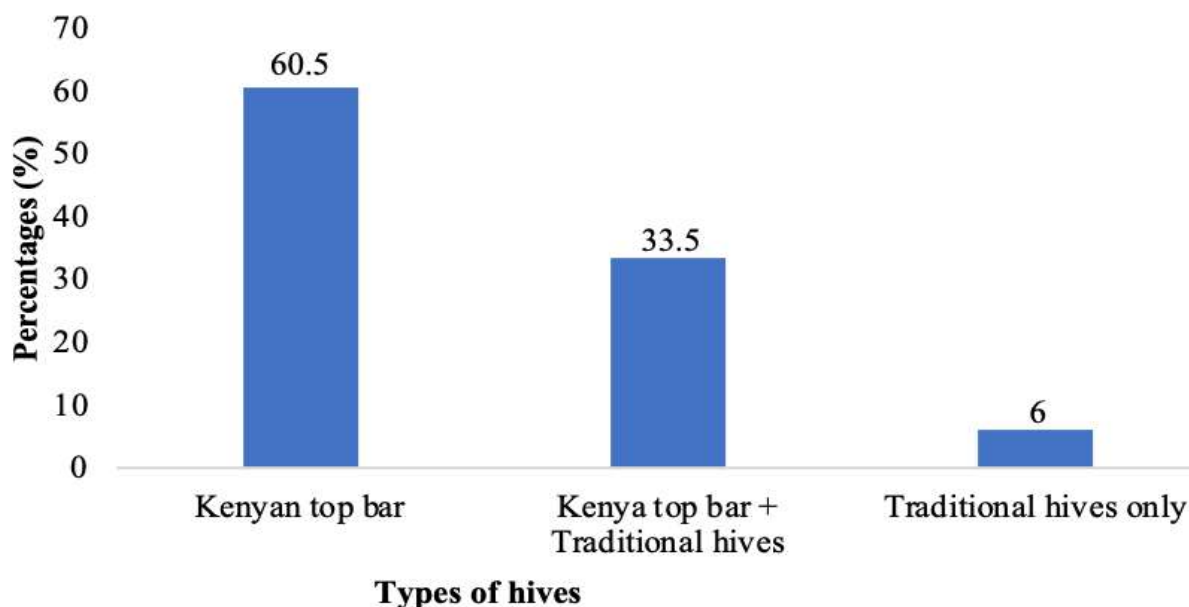
Figure 12. Types of hives and proportion of local people using them.
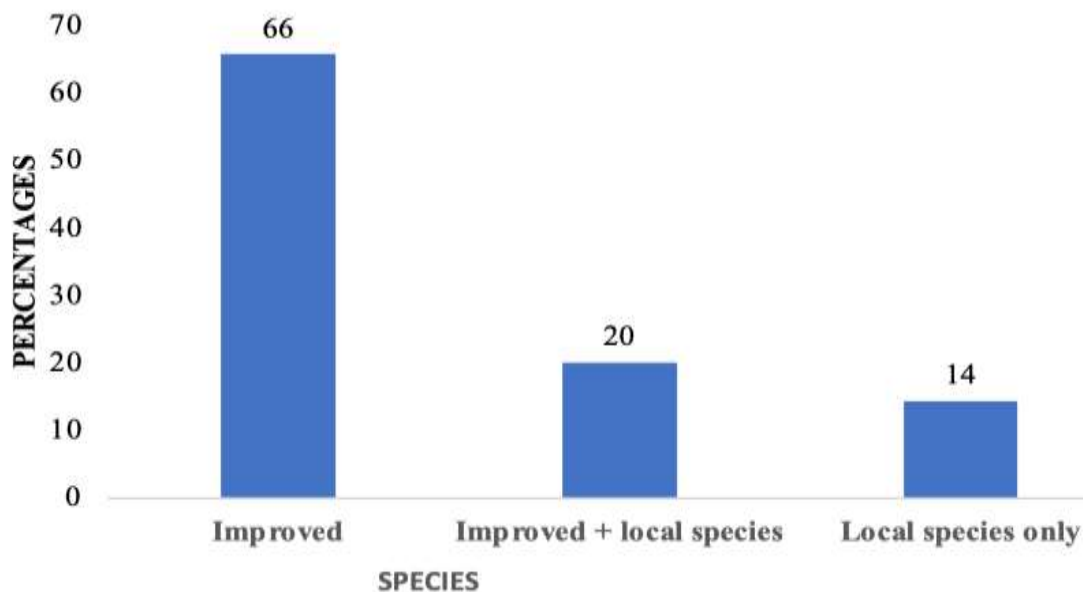Source: Authors

Kenyan top bar and the traditional hives, and 6% used only the traditional hives (Figure 12). Both hives were installed on agroforestry farms and only the Kenyan top bar had average distance of 0.5 -1 km along the park boundary periphery. The average quantity of honey produced by the Kenyan top bar installed in the agroforestry farms varied between 10 and 11 l, 5 and 6 l produced by traditional hives. The Kenya top bar installed around the park boundary produced averagely 12 -14 l of honey. These results were similar to that of Tarekegn and Ayele, (2020), which indicated that the type of beehive used and the proximity to the available forest has a significant and positive effect on honey production. An average of 55% of the beekeepers generated annual income of 230,000 and 245,000XAF from the sales of honey and honey products while 45% generated annual income of 155,000 – 220,000XAF. The local people consider improved beekeeping as one of their main secondary local activity carried out by many for livelihood fortitude. These results fall in line with that of Gallmann and Thomas, (2012) who found out that honey production provides a secondary source of income for smallholder farmers, who traditionally also grow cereals, pulses, oil seeds, and other perennial crops. It is believed that in the tropical world, many forest people who were born and raised in around this area use honey products for food and medicine and this fortifies the need to continue honey production. Beekeeping was realized to be a good income-generating activity for resource-poor people and is completely environmentally friendly and sustainable with no outside resources required. Besides, in most African countries there is already a market for honey.

Improved livestock farming

Over 12% of the sampled population in the study area was realized to be involved in improved farming. Out of this proportion, a majority (66%) of the household used improved breeds of livestock 20% reared improved and local breeds, while 14% of the livestock farming households reared the local breeds' species only (Figure

Figure 13. Proportion of pig farms and species farmed.
Source: Authors.

13). Domestic animal rearing was understood to be a traditional activity that was meant for household consumption but with the creation and management of the MCNP, improved domestication was particularly focused to piggery which now resulted in the supply of meat protein for subsistence and commercial needs of the local people. These results are in line with that of Matache (2016) who confirmed that pig farming represents a very important subsidiary economic activity for local people and Manese et al. (2021) noted pig farming contributed over 40% of household income in the Tenga subdistrict of Indonesia. In the past around the MCNP area, pigs were allowed to stray within the community and this practice was not accepted by a lot of local people in the area. The innovative system of confiding, breeding on a single stand with the use of required feed composition, 66.7% of pig farmers generated an annual income of 200,000 to 400,000XAF from the sales of piglets and pork meat while 33.3% generated between 500,000 and 750,000XAF. The local people consider pig farming as one of their main activities, which remained partly artisanal and partly modern based on the species of pig reared and types of feeds used in growing up the piglets that depended on the financial capacity of the household.

Community forestry program

Community forestry was found to be one of the major innovative programs where over 13.3% of the sampled population participated in its classification and management. A total of 7,746 hectares distributed in three sites of Etinde (4,976 ha), Bakingili (905 ha) and Woteva (1,865 ha) have been placed under the management of the three communities. The proportion of users showed that 76% of the sampled population was using community forest for the collection of NTFPs, 20.7% fetch firewood and 3.3% do poaching expeditions (Figure 14). The intensity of use of the community forest varied from one community to another. The highest proportion (73.2%) of local people using community forest was noticed in Woteva, and a relative lower proportion in Bakingili (43%) and Etindi (32%). The use of the community forests in the area was linked to limited forest livelihood alternatives. The relative difference in the proportion of local people involved in the use of the community forest can be explained by the differences in livelihood opportunities present in the different communities as presented in Table 6. A Pearson chi-square value of 89.5, df = 15 ($p < 0.05$) showed that there is a statistical association between household size and community forest management. The results indicated a larger proportion of the respondents were involved in community forest management originating from household sizes of between 4 to 6 members which is dominant in the study area. In Woteva where forest use was high, community forest activities constituted the major livelihood activities. In Bakingili where the community forest use was relatively moderate, a significant proportion of the local people were involved in artisanal fishing and trade. Increased opportunities for fishing, farming, petty trading and other paid employment in the urban and per-urban localities of Limbe, account for the relatively low community forest use in Etindi. The interest in the local people to exploit the community forest
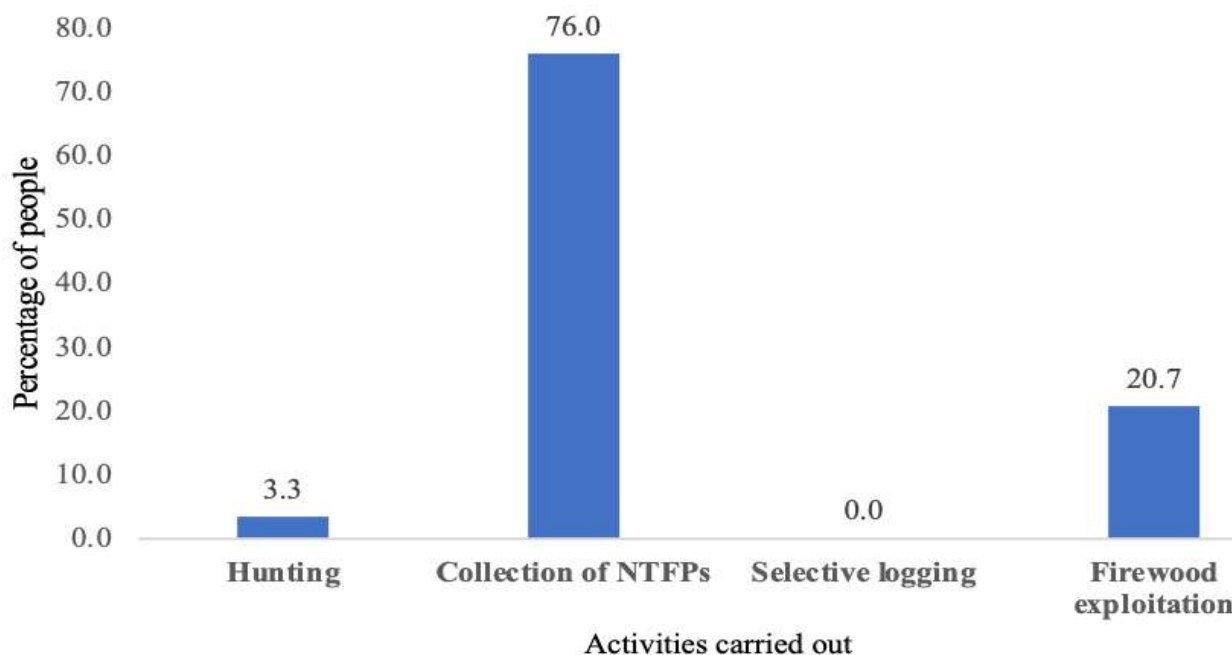
Figure 14. Different uses of community forest in the MCNP area.
Source: Authors.

Table 6. Proportion of local people involved in community forest management.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	89.449[a]	15	0.000
Likelihood Ratio	100.896	15	0.000
N of Valid Cases	600		
[a] 6 cells (25.0%) have expected count less than 5. The minimum expected count is .15.			

Source: Authors.

reduces pressure that would have been on the PA considering a large proportion of the local people around the MCNP still depend on the forest resources for their livelihood. This type of structural difference in the use of community forest, was also observed by Rossi (2007) across several communities in Andhra Pradash in a joint study on community-based forest management in India. The creation of community forests in the MCNP area was for timber provision to the local markets, secure areas for NTFPs collection and purposeful hunting for traditional needs. Selective logging was yet to start. This means that most of the local people depending on forest resources for their livelihood are concentrating more in the utilization of the community forest, making it to fulfil the purpose for which it was created. These findings are aligned with that of Beauchamp and Ingram (2011) who confirmed that community forests is an alternative role in the supply of forest products that were supposed to have been fetched from PAs.

Management of innovative livelihood programs

Local governance structure involved in management

The highest (84.4%) proportion of the local people were involved in the management of the livelihood programs through the VFMCs, a smaller (9.5%) were involved through the cluster platform (CPF), while the least (6.3%) were engaged in management through the cluster executive (CE) (Table 7). Three local management structures were identified to be directly involved in the implementation of the innovative livelihood programs amongst which were the village forest management committee (VFMCs), the cluster platform and the cluster executive. The VFMCs is composed of (8) to nine (9) elected members with a mandate of three years in each village. All ten communities were found to have one VFMCs. Three cluster platforms were identified and were in three clusters in which the study was carried out. Each

Table 7. Proportion of local community members involved in the local governance structures.

Local governance structure	No. of persons involved	Percentage representation
Village Forest Management Committee	80	84.2
Cluster Platform	9	9.5
Cluster Executive	6	6.3

Source: Authors.
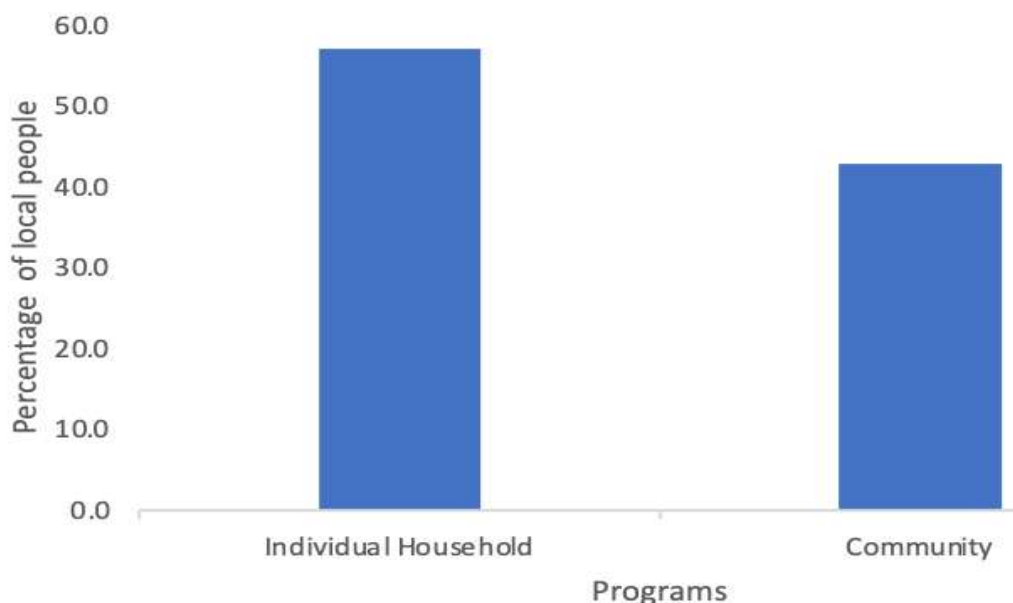
Figure 15. Proportion of stakeholders that owned innovative income generating programs.
Source: Authors.

cluster platform constituted three elected representatives from the VFMCs. The cluster executive was made of two (2) to three (3) elected members of the cluster platform and each cluster was represented by one member.

Ownership of innovative projects

Two main stakeholders were identified to own the innovative programs. These structures were the households and the community. Over 57.1% of the programs were owned by individual households, while 42.9% were owned by the community (Figure 15). Agroforestry and sustainable NTFPs collection program, improved food crops mixed farming, improved beekeeping and improved livestock farming programs were owned by the household while community forest, multipurpose nursery and ecotourism programs were owned by the entire community. The number of programs owned by individual households varied between one and four. Over 63% of the households owned two programs, 19% owned three programs while 18% owned all four

programs. With regards to number and distribution of the community owned programs, three (3) community forests; namely, Woteva, Bakingili and Etindi were identified and located all in the West coast cluster, the Ecotourism program had a head office in the Buea 1 cluster with antennas in the other two clusters and three multipurpose nurseries were identified distributed one each in the clusters. In each of the clusters, a group of 10 persons were identified as cluster nursery supervisors responsible for the running of the nursery. Their main role was the implementation of decisions taken by the community, on sites for program establishment, preparation of the site, planting of crops, maintenance and monitoring. The decision on household ownership as expressed by some local people will encourage long term exploitation and provision of sustainable income that will enhance livelihood. This expression is consistent to results presented by Nkembi et al. (2022) that states that adequate conservation management strategies take into consideration adapted livelihood activities of the local people who are very instrumental for the improvement of biodiversity within protected areas.
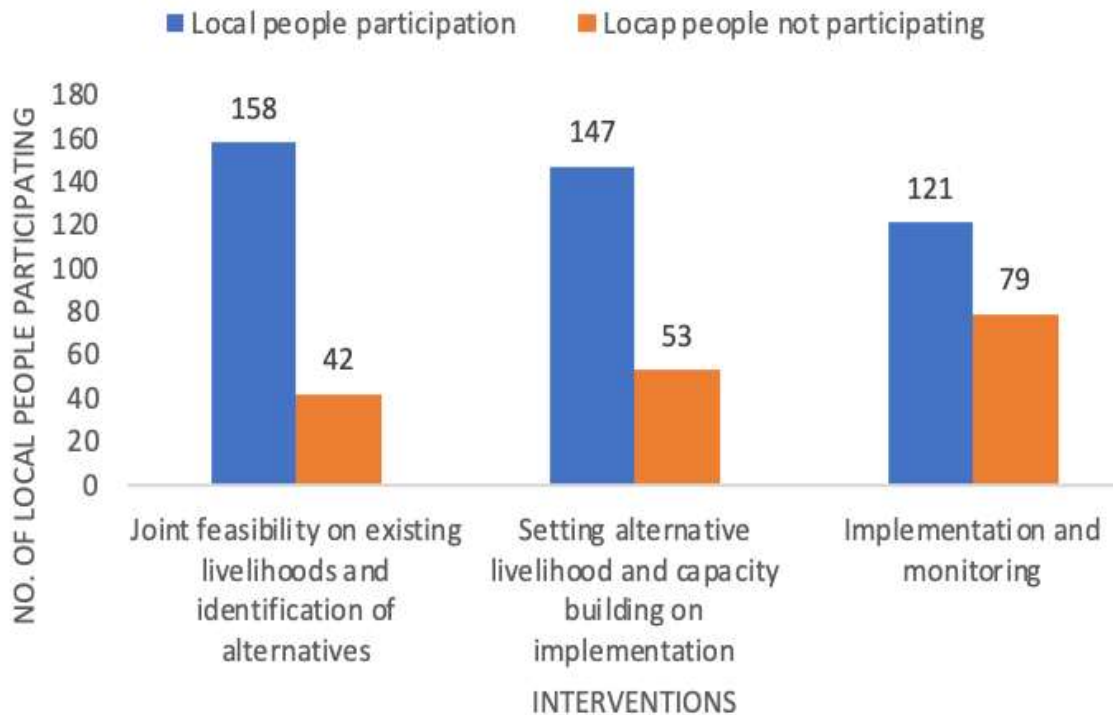
Figure 16. Proportion of local people involved in the identification and implementation of livelihood activities.
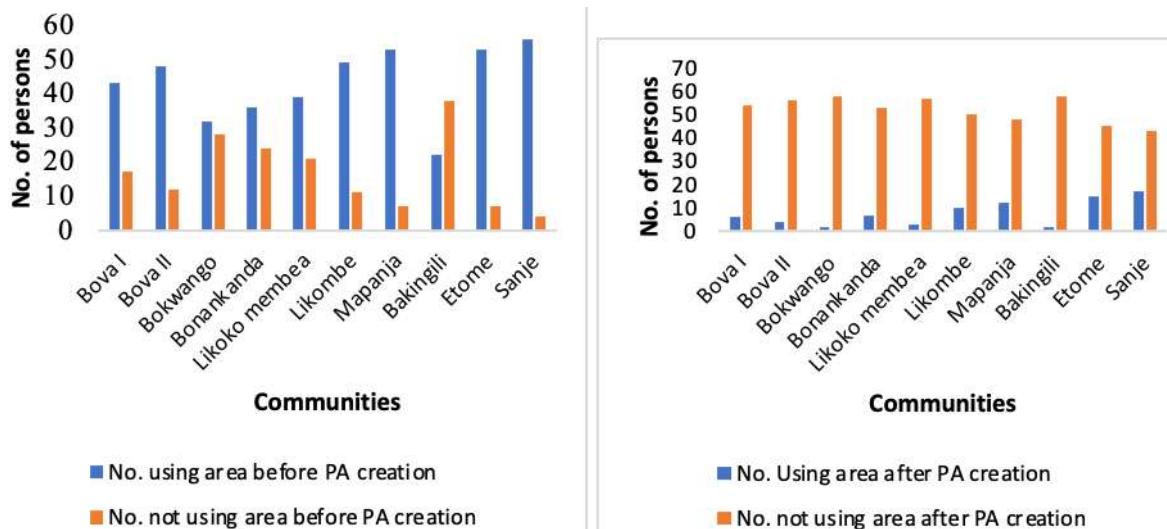Source: Authors

Management process

It was observed that the creation and management of the innovative livelihood programs underwent three main steps that included joint feasibilities on livelihood activities and identification of alternative income sources, establishment of alternatives that support forest conservation and capacity building on implementation, activity implementation and monitoring following natural, physical, human, financial and social capitals. A majority (71%) of the local people participated in all three phases of management, while a minority (29%) was not participating. The proportion of local people participating in the different phases were 26.3% on joint feasibilities, 24.5% on establishment of alternatives that support forest conservation and capacity building on implementation and 20.2% on activity implementation and monitoring following natural, physical, human, financial and social capitals, while 13.2% were not participating (Figure 16). Out of the three management structures, just one was legal in terms of Cameroon forestry legislation through decision No. 1354/D/MINEF/CAB of November 1999 that fixes the procedure of classifying permanent forest estates in Cameroon. The main role of the VFMC indicated by the decision was to facilitate the efforts for sustainable natural resource management at community level. The other two structures (cluster platform and the cluster executive) were realized to be created by the

MCNP services, which were noticed to be widely accepted by the local people. This was a clear indication of interest in participating in decision making that will reverse income of conservation. These results were partly in line with those of Serrat (2008) who indicated that to set up sustainable livelihood programs that alternatively replaces usual human livelihood activities in PAs, the basis is a combination of natural, physical, human, financial and social capitals. The involvement of local people into management was a significant source of investments that constituted the required decision.

Variations in access before and after PA creation

Over 71.8% of the sampled population of the local people was found to be using the forest around the Mount Cameroon area before park creation (Tchouto et al., 1999) and a proportion of 13% were still realized to be using the PA as a major source of livelihood (Figure 17) after PA creation. is mostly used for the search of medicinal plants meant for subsistence purposes. Such access was realized to be monitored by the VFMCs jointly set up by the communities and the park services based on the provisions of the laws and text of application on protected area management in Cameroon. The decrease in the proportion of users could be justified by the introduction of the sustainable alternative income

Figure 17. Variations in access of local people in PA before and after creation.
Source: Authors.

generating green innovative projects to the local people through a consultative process that led to the park services and the local communities in the collaborative management approach. The Sanje community was found to have the highest (13%) number of individuals still depending on the PA for their livelihood, while Bakingili (2%) was the least amongst the sampled villages. This disparity could be explained by the alternative income generating opportunities present in the different communities and the distance of the communities from the PA. The interest of the Sanje community with the highest proportion still using the park is due to their proximity to the park areas and the far distances from peri-urban and urban areas that provide multiple job opportunities. Bakingili happened to be closer to the Cameroon Development Cooperative Plantation sites and the peri-urban and urban areas of Limbe which present multiple job opportunities. Park protection, cluster facilitation and the implementation of green innovative projects implemented by 86% of the sampled household were found to be the main income generating activities introduced by the MCNP management as farming, hunting, debarking of *Prunus africana* barks/NTFPs collection and fetching of firewood were previously done by the local people before the PA was established. These finding were similar partially to that of Ndenecho and Mbue (2010) who confirmed park protection is a major remunerated activity carried out jointly by park management and local communities.

Income generated before and after PA creation

Households of 1 to 3 persons generated a yearly income of 500,000 and 900,000XAF, households of 4 to 6

persons generated 1,500,000 and 1,700,000XAF, while those of above 7 persons generated 2,000,000 and 2,400,000XAF from farming, hunting, debarking of *Prunus africana* barks/NTFPs collection and fetching of firewood. After the park establishment the same household of 1 - 3 individuals generated a yearly income of 500,000 and 800,000XAF, those of 4 - 6 individuals generated 1,500,000 and 1,800,000XAF, while those of 7 and above individuals generated 2,000,000 and 2,500,000XAF from the implementation of park protection, innovative green projects and cluster facilitation (Figure 18). Over 64% of the households constituted 4 to 6 persons, while the least (15%) were made up of household above seven persons. The difference in the level of revenue is greatly related to the number of individuals in the household that provided needed labour. Revenue for households of 1 – 3 individuals decreased by an average of 100,000XAF per annum, which represented 7.1% of average annual revenue following restriction on debarking of *Prunus africana* by CITES regulations, which mostly made up the main income generation source for the youths and young married people. Those of 4 – 6 and 7 plus households were noted to have an average annual increase of 3.03% and 2.2%. When compared to previous revenue earned by local people before the creation of the MCNP, there is a slight drop in the income rates of households of 1-3 individuals and a slight increase for households of 4 – 6 and households of 7 persons. The results indicated no significant difference between household income before and after park establishment as the pair sample t-test showed that the household income before and after park establishment had no significant increase with (Mean 666.67, SD = 708677.877) to (Mean = 1736824.67, SD = 854172.788); $t = -.295$, $p > .796$, $d = 2$. It was realized that
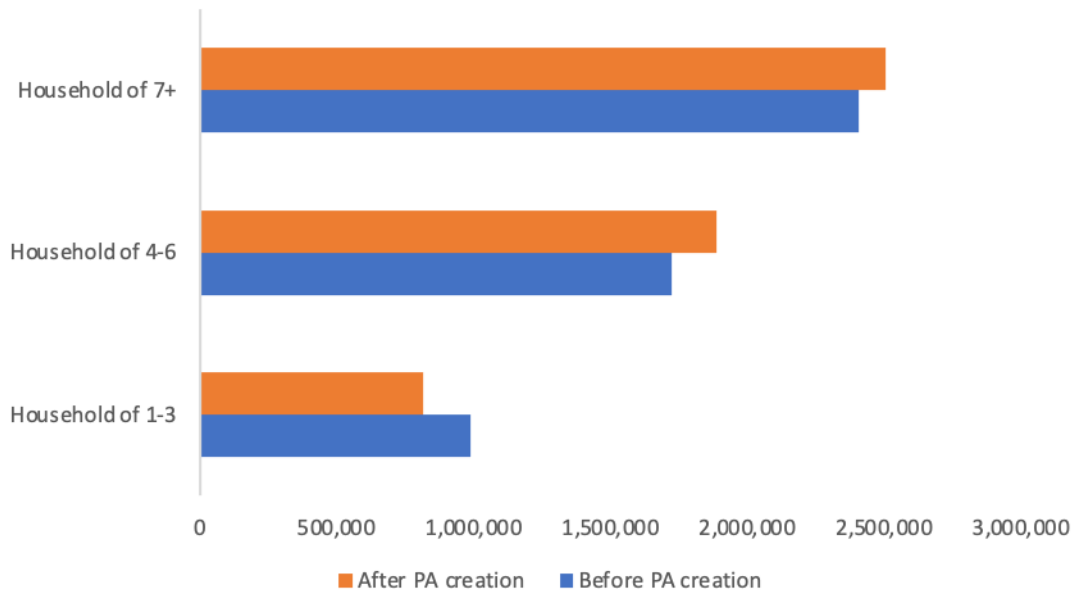
Figure 18. Proportion of yearly income generated by different households.
Source: Authors.

there has been a swap of activities from forest dependent prohibited activities to legal forest dependent activities. Even though no significant difference in income levels, the main drivers of economic development around the MCNP was partly direct employment and indirect employment based on the household interest to participate in the conservation of biodiversity through taking part in the implementation of innovative programs introduced in the area by the park service. Multiple regression was conducted, with age, gender (0=male, 1 = female), and household income as the predictors, with income generating activities as the dependent variable. Overall, the results showed the utility of the predictive model was significant, f (3,596) = 200.79, r = 0.709, (p < .005). Predictors explained a large amount of the variance between the variables. The results showed that age and household income of the local people were not significant positive predictors of income generating activities (β =.07, t = 1.395, p (.164) >.05, and β = -.002, t = -.070, p (0.944) >.05, respectively. The results showed that gender (β = .651, t = 13.056, (p < .005) was a significant positive predictor of income generating activities.

These results are similar to those presented by Ward et al. (2018) in protected areas of Madagascar where gender-oriented trainings and provision of agricultural inputs are main drivers. The contribution of local people in the decision-making process is not fully considered the park service as recorded by Nvenakeng and Marchant (2016) but in the implementation of innovative income generating projects within the area as recorded by this study, the MCNP management system has provided for

provisions that has enabled the setting up of processes that facilitate local people to decide on which project to participate and eventually own them. Although Nkembi et al. (2022) disclosed that most community people living around PA exert high pressure on the PA through unsustainable practices in NTFPs collection, this differs with the results of this study because local people around MCNP are using sustainable practices in the collection of NTFPs such as *Prunus africana* where debarking was very detrimental to the resource in the past. The MCNP experiences lesser pressure on the collection of NTFPs in the PA due to trainings acquired by local people on the integration of NTFPs into their food, cash crops farms in the perspective of agroforestry. The pressure on illegal hunting and gathering coming from the young people, the rare employment opportunities and missing access to market in the Dzanga Sangha complex PA as indicated by Ngbo-Ngbangbo et al. (2010) does not apply in the case of the MCNP. The management of the MCNP has introduced strategies to accompany local people to vocational trainings that provide opportunity for the young people to be competitive in the job market and provide them with avenues to create their own proper businesses. Villages have been disenclaved to enable the local people to evacuate farm products easily to the nearby agglomeration for sale. Participative management in the Dzanga Sangha complex PA focuses only on two communities leaving out other communities surrounding the complex PA as recorded by Ngbo-Ngbangbo et al. (2010), which differs with situation in the MCNP. A collaborative management approach is used in the management of the MCNP, giving an opportunity for the

local people and the government park management staff to negotiate and agree amongst themselves a fair sharing of the management functions, entitlements and responsibilities of the park. The implementation of the collaborative management approach provides an opportunity for the local people around the MCNP to acquire direct financial benefits such as conservation bonus paid directly into the community account as compensation for monitoring the PA and reporting any ongoing or spontaneous illegal activity. However, this is not the case with Dzanga Sangha complex PA for the participative management does not give avenues for the management to provide financial support to the local people (Ngbo-Ngbangbo et al., 2010).

Conclusion

The results showed that the MCNP activities had no significant economic effect on the livelihood of the local people. Although a slight increase in the income level of the household was perceived, the percentage increase was far below to influence the level of significance. The age group had a major role to play on the implementation of MCNP activities. The young people were more in park protection activities which was more labour intensive and periodical while the middle age and the elderly were involved in sustainable income activities such as innovative green programs. The middle age constituted the highest proportion of the population involved in decision making at the village level, and played a leading role in negotiating green income programs with the park service. Most of the local people accepted the innovative programs because of restriction of access to PA. Options on forest dependency were replaced with trainings that provided knowledge on investment without forest destruction. The introduction of innovative income programs serves as the widest opportunity and option for local people to generate revenue that could improve livelihood, sustenance an investment in livelihood-based interventions, gain capability on forest management and support PA management that was doubtful in the past. To create ownership of existing livelihood activities, there is a need for further research on match-making in the provision of livelihood and proposal of management options within the framework of protected area management.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Traditional knowledge on wild edible vegetables consumed by communities around Serengeti ecosystem, northern Tanzania

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Globally traditional knowledge on wild edible vegetables (WEVs) exists in most communities, but this information is limited and incomplete in the Serengeti ecosystem. This study employed face to face interviews using semi-structured questionnaires to about 180 households to acquire the required information on the WEVs species they consume in their area. After analysis of the collected data, the results indicated that a total of 10 WEVs species mostly herbaceous plants belonging to 10 genera and 9 families were used mainly for domestic (92.8%) and partly commercial (7.2%) purposes. Women (50.8%) were more knowledgeable on the WEVs they use than men in their area. Also, households with lower income (n = 161) represented more of women who were more knowledgeable on the WEVs they consume because they are the ones who most frequently harvested and cooked them. Additionally, majority of the households (86.6%) reported that the WEVs were decreasing in supply and difficult in accessing them and again were aware that WEVs were improving their livelihood and healthy status in the area. Therefore, we call for urgent measures to protect and conserve WEVs in Serengeti ecosystem.

Key words: Wild edible vegetables, traditional knowledge, communities, ethnobotany, Serengeti ecosystem.

INTRODUCTION

Wild edible vegetables (WEVs) are defined as those plants with edible parts that grow naturally on farm land, and on fallow or uncultivated land (Khakurel et al., 2021). They are the fresh and edible parts of herbaceous plants (Satter et al., 2016). According to Satter et al. (2016), WEVs may include roots, stems, leaves, fruits or seeds of the plants that can be eaten as raw and/or cooked form. They have played a significant role in different geographical regions of the world throughout human history (Duguma, 2020). They are a major part of daily food intake by humans with their main dishes all over the world and the cheapest and most readily available source

of foods that can contribute significantly to human nutrition and health in rural as well as in urban areas, especially among the poor and marginalized communities (Satter et al., 2016; Duguma, 2020).

Globally, it is estimated that species of higher plants range between 300,000 and 500,000, of which at least 250,000 have been identified and documented, 30,000 edible and 7000 collected or cultivated at some point for human consumption (Bvenura and Sivakumar, 2017). About 30 major crops feed the world, providing 95% of dietary energy/calories or protein, while minor and underutilized species including wild fruits and vegetables play a key and significant role both nutritionally and culturally in many societies. Moreover, according to Naik et al. (2017), there are 45,000 species of wild plants out of which 9, 500 species are ethno-botanically important species. Among these, 7,500 species are in medicinal use for indigenous health practices and 3,900 plant species are used as tribal food; out of which, 145 species comprise root and tuber as food, and all totaled, there are 521 species of WEVs (Naik et al., 2017). Therefore, the consumption of wild plants persists in many communities, especially among indigenous people for whom wild food plants are part of their traditional food systems (Nath, 2015; Berihun and Molla, 2017; Punchay et al., 2020). Indigenous people often experience food insecurity and malnutrition, yet local communities often possess traditional knowledge that can help them to alleviate these problems through harvesting, hunting, and gathering of wild plants (Punchay et al., 2020). It has previously been found that the collection and consumption of WEVs has been a way of life to supplement dietary requirements for many rural populations (Berihun and Molla, 2017; Naik et al., 2017). In addition, previous studies have shown that humans have a tremendous influence on WEVs, even before civilization because of their high nutritional value as well as medicinal importance (Berihun and Molla, 2017; Naik et al., 2017). These plants play an important role in the livelihoods of rural households and forest inhabitants and provide an integral part of the subsistence strategy of people in many developing countries (Powell et al., 2014; Berihun and Molla, 2017; Naik et al., 2017). Therefore, the history of gathering WEVs for food from the wild, not only in Africa but the world at large, cannot be overemphasized. In Africa, for example according to Bvenura and Sivakumar (2017), this history can be back to the pre-Bantu migration era and can be found on the rock art of the Sahara and southern parts of the continent. It has been found that till today, women and children usually predominate the practice of gathering these essential foods (Bvenura and Sivakumar, 2017). However, Bvenura and Sivakumar (2017) pointed out that this tradition has drastically declined over time due to several factors such as forest degradation, agriculture,

and urbanization.

Nonetheless, WEVs are still widely consumed in the daily diet of the local people and also serve as a source of income. However, they have received little attention in research studies concerning their biodiversity conservation and sustainable management; and many are largely ignored, remain unexplored or undocumented, especially those found in the Serengeti ecosystem. Therefore, the present study was carried out to document traditional knowledge on wild edible vegetables consumed by communities around the Serengeti ecosystem, northern Tanzania. Firstly, we hypothesized that women would have more knowledge on WEV's identity and their usage than men in the Serengeti ecosystem because they are the ones who most frequently harvested and cooked them. Secondly, that local people with lower income would be more knowledgeable of WEVs they use than those with higher income because they are the ones who most frequently use them in the area. Thirdly, more herbaceous than woody WEVs species would be used by the people because they are abundant and mostly frequently encountered in the area.

MATERIALS AND METHODS

Study area

The Serengeti ecosystem is approximately 25,000 km^2, centered on Serengeti National Park (SNP) (14,763 km^2) which is a World Heritage Site, Biosphere Reserve, and forms the heart of the Serengeti Maasai-Mara Migratory Ecosystem of north-western Tanzania and south-western Kenya (Mfunda and Røskaft, 2011) (Figure 1) and lies between 1° and 2°S; 34° and 36°E. The park itself is situated on the north western edge of Lake Victoria and up to the border with Masai Mara national reserve (Bugwesa et al., 2009). It borders the Ngorongoro Conservation Area, a multiple land use area, Ikorongo, Grumeti and Maswa Game Reserves, Ikona Wildlife Management Area (WMA) and Loliondo Game Controlled Area (Roskaft et al., 2012). The national park contains high diversity and concentrations of ungulates, large carnivores, and birds (Sinclair and Arcese, 1995). Also, the Serengeti ecosystem supports the largest herds of migratory species including wildebeest (*Connochaetes taurinus*), zebra (*Equus burchelli*) and Thomson gazelle (*Gazella thomsoni*) (Sinclair and Arcese, 1995; Thirgood et al., 2004). The land use type consists of a wildlife conservation area, human settlements, and agricultural and grazing lands. Topography of the area is characterized by a series of hills and valleys extending to an extensive gentle and flat area. Altitudes vary from 1280 to 2540 m above sea level, and the climate is described as having annual rainfall ranges from 600 to 1,200 mm and an average temperature of 26°C (Herlocker, 1974). The annual migration of over a million wildebeest defines the ecosystem (Schmitt, 2010) following seasonal variations in rainfall and the availability of grazing across the ecosystem (Walelign et al., 2019). According to Schmitt (2010), the ecosystem has more than a hundred villages located along the outside of the game reserves and park and within the game controlled area, or the NCA. These villages are home to over two million people inhabiting seven districts (Walelign et al., 2019). Many people in the ecosystem have been around since before the parks inception in 1959, having their
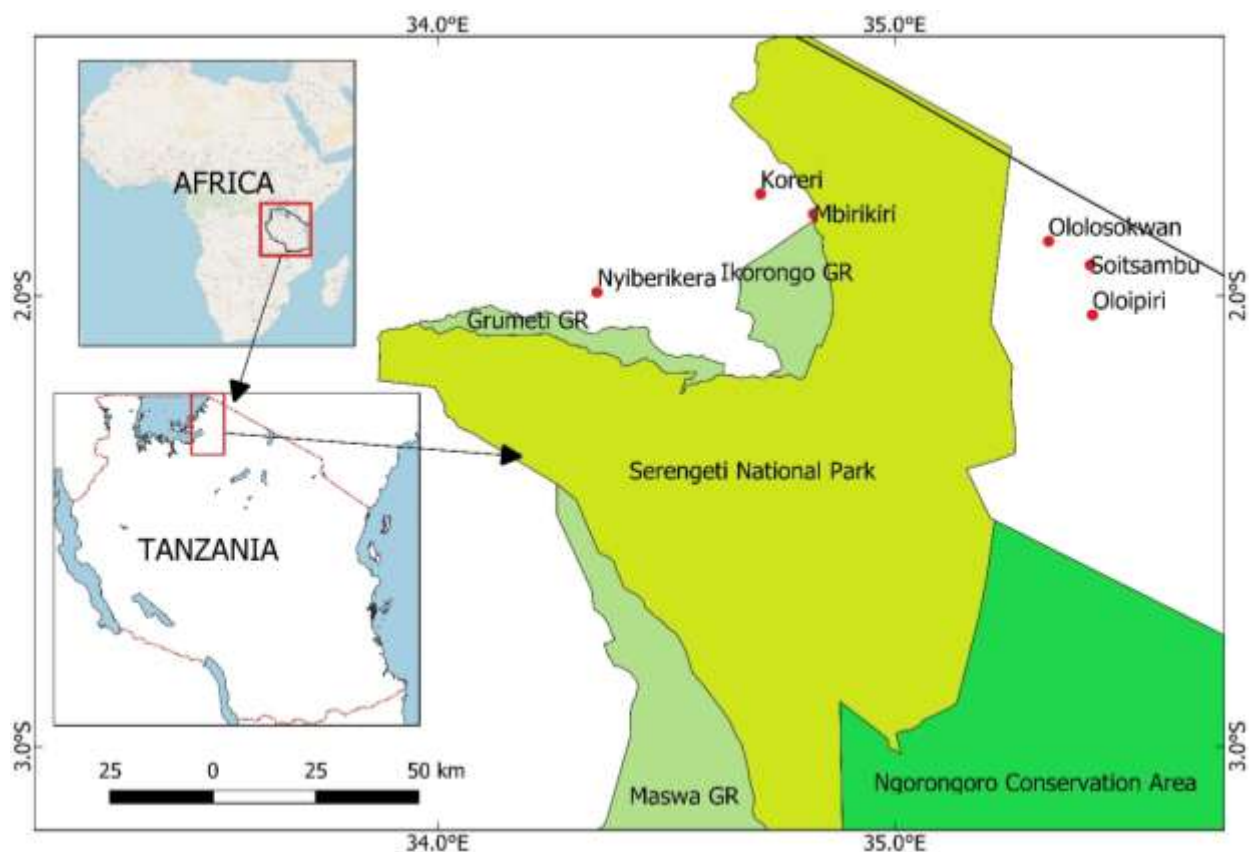
Figure 1. Map of Serengeti Ecosystem showing the study villages in red dots.
Source: Authors

traditional grazing lands taken away by the establishment of the park (Schmitt, 2010). However, immigration into the area is common and thus many people and groups are new to the ecosystem (Schmitt, 2010). However, the western side of Serengeti is mainly inhabited by multi-ethnic agro-pastoral communities mostly engaged in peasant agriculture (Mfunda and Røskaft, 2011). The ethnic communities in this part include the Kurya, Isenye, Natta and Sukuma, who mainly grow cotton, sorghum, millet, maize and cassava as dual crops and sell forest products such as fuel wood and building poles (Mfunda and Røskaft, 2011). On the contrary, the region East of SNP is inhabited by the Maasai pastoralists and Sonjo agro-pastoralists (Mfunda and Røskaft, 2011). The Sonjo are agro pastoralists who have specialized more in agriculture than the Maasai, and they mainly grow maize, beans, sorghum and millet. Maasai are mainly pastoralists, with livestock being central to their way of life, a style viewed as being compatible with sustainable conservation (McCabe, 2003).

Data collection

The data for this study were collected between January and May, 2018 because it was the time when the budget for the field work was available. Our survey encompassed 180 households who were chosen purposively, that is, 30 respondents from six randomly selected villages using a lottery method. The villages were

Ololosokwani, Soitsambu, Oloipiri from Ngrongoro district and Mbirikiri, Koreri, Nyibererekera from Serengeti district. This criterion was used to understand and obtain maximum information as possible on WEVs available in each area. In each village, 30 households were purposively selected for the interview because based on the literature, a sample of at least 30 households is enough for statistical analysis (Acharya et al., 2013). No prior notice was given to the interviewees to reduce possible misrepresentations during the data collection process, although the village chairman was first informed about the study purposes; and his permission was secured to carry out interviews in the area. The respondents were chosen based on their ages (15 - 95 years) and gender (male, female). Then, the face-to-face interview using a semi-structured questionnaire was administered by the researchers with the help of the translator to acquire the required information. The method employed in this study was designed for collecting baseline information on the diversity and usage of WEVs by communities of the Serengeti ecosystem. The questions were prepared in English but asked in ''Swahili'' language and then translated to the respective languages by the help of a tribe translator. From this method, we were able to record the required information on the uses of WEVs from each respondent in the area. Data collected included: village name, age of the respondent, age class (youth, adults, elders), gender (males, females), GPS location of the respondent household, education level (no education, primary, secondary), level of income (small, large), accessibility of

Table 1. The WEV species and their frequency of use by local communities among different families in the Serengeti ecosystem.

Species	Family	Frequency	Percent
Gynadropsis gynandra	Capparaceae	68	37.6
Amaranthus hybridus	Amaranthaceae	38	21.0
Solanum nigrum	Solanaceae	13	7.2
Corchorus tridens	Tiliaceae	32	17.7
Oxygonum sinuatum	Polygonaceae	2	1.1
Brassica oleracea var. *acephala*	Brassicaceae	1	0.6
Vigna unguiculata	Fabaceae	5	2.8
Agaricus bisporus	Agaricaceae	1	0.6
Portulaca quadrifolia	Portulacaceae	19	10.5
Capparis tumentosa	Capparaceae	2	1.1
Total		181	100.0

Source: Authors

WEVs (easy, moderate, difficult), WEVs availability (deceasing, increasing, stable), harvesting area (open area, game controlled area, game reserve, national park) and whether WEVs have contributed to improve their livelihood in the area.

Data analysis

Statistical Package for Social Science (SPSS, version 16.0) software was used for analyzing the data (http://www.spss.com) (Kirkpatrick and Feeney, 2010). The data were analyzed using descriptive statistics to determine the frequencies among different variables and the Pearson's Chi-square goodness-of-fit test using Exact Tests with Monte Carlo confidence level (two-sided significance). The Exact Tests enabled us to make reliable inferences because our data were small, sparse, heavily tied, or unbalanced and poorly distributed. Also, Exact Tests enabled us to obtain an accurate p value without relying on assumptions that may not be met by our data. Therefore, Pearson's Chi-square goodness-of-fit test using Exact Tests with Monte Carlo confidence level (two-sided sig.) were used to determine whether the distribution of cases (e.g., wild edible vegetable species) in a single categorical variable. These variables included the following: Gender (consisting of two groups: men and women), Income category (consisting of two groups: small income and large income), Taxonomic category of WEV group (consisting of two groups: family and genus), Frequency of the WEVs use (consisting of four groups: daily, weekly, monthly and annually, Accessibility of WEVs (consisting of three groups: easy, moderate and difficult), WEVs availability (consisting of three groups: deceasing, increasing and stable), Harvesting area (consisting of four groups: open area, game controlled area, game reserve and national park), and Whether WEVs have contributed to improve their livelihood in the area (consisting of two groups: "Yes" and "No").

In addition, a linear regression analysis was used with response to the question "Which WEVs species are you using in your area?" as the dependent variable; and the following independent variables: age classes (youth, adults, elders), gender (men, women), education level (no education, primary, secondary education), income level (small, large), frequency of use (daily, weekly, monthly, annually), reasons for use (domestic, commercial), harvesting location (open area, game controlled area, game

reserve, national park), availability status (stable, decreasing, increasing) and WEVs forms (herb, shrub). This method was used to determine which independent variables or factors explained the existing variation in traditional knowledge of WEVs use among the communities in the area. Since all the independent variables used were all continuous, therefore no assumptions about their distributions were made. For all tests, p ≤ 0.05 was considered significant.

RESULTS

In the present study, a total of 10 WEV species belonging to 10 genera and 9 families (Table 1) were documented and used mainly for domestic (92.8%, diet) and partly commercial purposes (7.2%, source of income). Of these species, 179 were herbs (98.9 %) while others were shrubs (1.1 %). Among these, the most represented were Capparaceae (38.1%), Amaranthaceae (21.5%) and Tiliaceae (17.7%); exemplified by the following species: *Gynadropsis gynandra* (37.6%), *Amaranthus hybridus* (21.0%), and *Corchorus tridens* (17.7%), respectively (Table 1).

Traditional knowledge about WEVs differed significantly among villages (χ^2 = 58.98, df = 11, P < 0.001). Households from Koreri (21.5%), Mosongo (21.0%) and Maburi (17.7%) villages were more knowledgeable on WEVS they use than other villages such as Nyiberekera (3.3%), Nyamirama (2.8%), Mbirikiri (3.9%), Ololosokwani (6.1%), Oloipiri (1.7%), Enguserosambu (3.3%), Maaloni (9.9%), Losoito (2.2%), and Digodigo (7.2%). Those households reported that they use more *G. gynadra* (n = 68), *A. hybridus* (n = 38) and *C. tridens* (n = 32) compared to other WEVs species in the area.

Traditional knowledge on WEVs differed significantly among households' ages as well as age classes (p <0.001), with more youths (n = 65, 35.9%) and elders (n

Table 2. Differences between men and women in terms of knowledge about WEV uses in the Serengeti ecosystem.

WEV Species	Men		Women		Total	
	n	%	n	%	N	%
Gynadropsis gynandra	39	57.4	29	42.6	68	100.0
Amaranthus hybridus	27	71.1	11	28.9	38	100.0
Solanum nigrum	10	76.9	3	23.1	13	100.0
Corchorus tridens	7	21.9	25	78.1	32	100.0
Oxygonum sinuatum	2	100.0	0	0.0	2	100.0
Brassica oleraceae var. *acephala*	1	100.0	0	0.0	1	100.0
Vigna unguiculata	1	20.0	4	80.0	5	100.0
Agaricus bisporus	1	100.0	0	0.0	1	100.0
Portulaca quadrifolia	1	5.3	18	94.7	19	100.0
Capparis tumentosa	0	0.0	2	100.0	2	100.0
Total	89	49.2	92	50.8	181	100.0

Source: Authors

= 62, 34.3%) who expressed more knowledge on WEVs than adults (n = 54, 29.8%) in the area. Moreover, traditional knowledge on WEVs differed significantly among education levels (x^2 = 33.45, df = 18, P = 0.015) with households with primary education (60.2%) being more knowledgeable than those without any education (23.2%) and those with secondary education (16.6%) in the area.

Also, WEVs were found to differ significantly from where they were found (P < 0.001). A majority of the households reported that more WEVs were found in open areas (n = 149, 82.3%) and game controlled areas (n = 19, 10.5%) than in a National parks (n = 9, 5.0%) or in Open areas and Game controlled areas (n = 3, 1.7%) and open areas and national parks (n = 1, 0.5%) within the area.

Most of the respondents mentioned that the frequency of the WEV's use was mostly annually (30.6%), daily (27.4%), weekly (25.5%) and monthly (16.6%), respectively. Some of which were often collected from open areas, game controlled areas or a national park. Herbaceous plants made up the highest proportion of edible plants and leaves were the dominant edible parts consumed through cooked food.

Moreover, women (n = 92, 50.8%) possessed more traditional knowledge on WEVs identity and usage than men did (n = 89, 49.2%) (x^2 = 45.1, df = 9, P < 0.001; Table 2) with the 99% confidence interval for p = (0.001, 0.001). The Monte Carlo estimate of 0.000 for the exact p value was based on 10,000 random samples from the reference set, using a starting seed of 475,497,203. Also, youths (35.9%) and elders (34.3%) were more knowledgeable on identifying WEV's use than adults (29.8%) in their area, and this difference is statistically significant (x^2 = 70.495, df = 18, P < 0.001, Table 3) with

the 99% confidence interval for p = (0.001, 0.001). The Monte Carlo estimate of 0.000 for the exact p value was based on 10,000 random samples from the reference set, using a starting seed of 624,387,341. Women elders (n = 41, 44.3%) were more knowledgeable on the WEVs they use in their area especially on using *Portulaca quadrifolia* (n = 18, 94.7%) and *C. tridens* (n = 25, 78.1%) compared to adult men (n = 19, 20.7%) and youths (n = 32, 34.8%), as well as to their counterpart men elders (n = 21, 23.6%), adults (n = 35, 39.3%) and youths (n = 33, 37.1%) who reported mostly specifically *A. hybridus* (n = 27, 71.1%) and *G. gynandra* (n = 39, 57.4%) and their differences were statistically significant (x^2 = 45.07, df = 9, P < 0.001) with the 99% confidence interval for p = (0.001, 0.001). The Monte Carlo estimate of 0.000 for the exact p value was based on 10,000 random samples from the reference set, using a starting seed of 2,000,000. Whereas, there were also statistically significant differences with level of household income (n = 161, small income) and (n = 20, large income) regarding the traditional knowledge on WEV uses (x^2 = 2.42, df = 9, P < 0.001; Table 4) the former being more knowledgeable than the latter in the area, with the 99% confidence interval for p = (0.001, 0.001). The Monte Carlo estimate of 0.000 for the exact p value was based on 10,000 random samples from the reference set, using a starting seed of 2,000,000. Women (n = 82, 50.9%) had lower income compared to men (n = 79, 49.1%); though their differences were not statistically significant (P = 0.937).

In addition, majority of the local household (86.6%) reported that the WEVs decreased more in supply than either increasing (7.8%) or remaining stable (5.6%) and their differences were statistically significant (x^2 = 16.72, df = 2, P < 0.001) with the 99% confidence interval for p =

Table 3. Differences between household's age classes in terms of WEV use knowledge in the Serengeti ecosystem.

Species name	Age Classes			Total
	Youths	Adults	Elders	
Gynadropsis gynandra	26 (38.2)	28 (41.2)	14 (20.6)	68 (100.0)
Amaranthus hybridus	19 (50.0)	13 (34.2)	6 (15.8)	38 (100.0)
Solanum nigrum	7 (53.8)	0 (0.0)	6 (46.2)	13 (100.0)
Corchorus tridens	6 (18.8)	10 (31.2)	16 (50.0)	32 (100.0)
Oxygonum sinuatum	2 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)
Brassica oleracea var. *acephala*	1 (100.0)	0 (0.0)	0 (0.0)	1 (100.0)
Vigna unguiculata	4 (80.0)	1 (20.0)	0 (0.0)	5 (100.0)
Agaricus bisporus	0 (0.0)	1 (100.0)	0 (0.0)	1 (100.0)
Portulaca quadrifolia	0 (0.0)	1 (5.3)	18 (94.7)	19 (100.0)
Capparis tumentosa	0 (0.0)	0 (0.0)	2 (100.0)	2 (100.0)
Total	65 (35.9)	54 (29.8)	62 (34.3)	181 (100.0)

Source: Authors

Table 4. Differences between households with different levels of income in terms of knowledge about WEV uses in the Serengeti ecosystem.

Species name	Level of income		Total
	Small income	Large income	
Gynadropsis gynandra	52 (76.5)	16 (23.5)	68 (100.0)
Amaranthus hybridus	38 (100.0)	0 (0.0%)	38 (100.0)
Solanum nigrum	9 (69.2)	4 (30.8)	13 (100.0)
Corchorus tridens	32 (100.0)	0 (0.0)	32 (100.0)
Oxygonum sinuatum	2 (100.0)	0 (0.0)	2 (100.0)
Brassica oleracea var. *acephala*	1 (100.0)	0 (0.0)	1 (100.0)
Vigna unguiculata	5 (100.0)	0 (0.0)	5 (100.0)
Agaricus bisporus	1 (100.0)	0 (0.0)	1 (100.0)
Portulaca quadrifolia	19 (100.0)	0 (0.0)	19 (100.0)
Capparis tumentosa	2 (100.0)	0 (0.0)	2 (100.0)
Total	161 (89.0)	20 (11.0)	181 (100.0)

Source: Authors

(0.001, 0.001). The Monte Carlo estimate of 0.000 for the exact p value was based on 10,000 random samples from the reference set, using a starting seed of 2,110,151,063; and also, there was more difficulty in accessing them (42.0%). Also, a majority of the households (n = 181, 100%) agreed that the WEVs were improving their livelihood in the area.

Furthermore, a linear regression analysis where the dependent variable was "which WEVs species are you using in your area" and independent variables as: age classes, gender, education level, income level, frequency of use, reasons for use, harvesting location, availability status and WEVs, with the method entered being significant (F = 9.1, r² = 0.389, P < 0.001). Here, the slope

coefficients of the regression line for age classes (B = 1.09, t_4 = 4.85, P < 0.001), gender (B = 1.46, t_4 = 4.17, P < 0.001), income levels (B = 2.69, t_4 = 4.86, P < 0.001) and WEV's form (B = 5.26, t_4 = 3.12, P = 0.002) explained the variation significantly; while the education level, frequency of use, reasons for use, harvesting location, and availability status did not.

DISCUSSION

The present study revealed that a total of 10 WEV species of herbaceous plants, belonging to 10 genera and 9 families, were known and used by the majority of

the households mainly for domestic and partly commercial purposes in the area. Our findings support reports that Wild Edible Vegetables (WEVs) are an important component of traditional food systems with higher nutritional values around the world (Powell et al., 2014; Konsam et al., 2016; Khakurel et al., 2021). This is because they have used WEVs from time immemorial to contribute to their food security and health as well as having nutrient value (Thakur et al., 2017). In addition, WEVs are also important to communities of the area, probably because they are a source of vitamins, fibers, minerals, fatty acids and sometimes they have medicinal values (Duguma, 2020). In most cases, communities consumed those plants or plant parts after either boiling or frying or preparing curry or chutneys or raw vegetables. Also, a study by Duguma (2020) revealed that WEVs are relevant to household food security and nutrition in some rural areas and are relied on to supplement the staple food, to fill seasonal food shortages, and to serve as emergency food during famine. Again, communities around the Serengeti ecosystem use these WEVs such as *G. gynandra*, *A. hybridus* and *C. tridens* as an accompaniment for their staple cereal-based diets food crops that include maize (*Zea mays*), rice (*Oryza sativa*), wheat (*Triticum aestivum*), potato (*Solanum tuberosum*), soybean (*Glycine max*), and cassava (*Manihot esculenta*). These are grown in their areas to add diversity to their diets; thus, making their diets healthier and more interesting. In addition, Konsam et al. (2016) reported that the use of wild plants as food is an integral part of the culture and tradition of many indigenous communities around the world. Similarly, Devarkar et al. (2010) revealed that although nowadays, human vegetable consumption is based on rather very limited number of crops (12-15 species); however, in many parts of the world, the use of wild plants is very common. Moreover, previous studies also revealed that a large section of the rural population, such as those of the Serengeti ecosystem, meets their nutritional requirement through unconventional means, by consuming various wild plants and animal resources (Konsam et al., 2016).

However, besides nutritional value obtained from the WEVs in the Serengeti ecosystem, some of the communities used WEVs partly for commercial purposes. This corroborates with the finding of Duguma (2020) who reported that benefits such as income and employment can be obtained from the sale of WEVs. This is in support of the study by Konsam et al. (2016) who reported that millions of people, mostly in developing countries, derive a substantial part of their subsistence and income from wild plant products. In addition, although WEVs provide staple food for indigenous people and serve as complementary food for non-indigenous people, they also offer an alternative source of income (Konsam et al., 2016).

The finding also revealed that *Agaricus bisporus* was among the WEVs used by people in the area. This plant is an edible basidiomycete mushroom native to grasslands in Europe and North America. However, it was found to be used by the people of the Serengeti area because during the rainy season, wild edible mushrooms such as *A. bisporus* grow naturally in most parts of Tanzania and members of various communities, especially women and children, gather mushrooms to be used as relish (Mamiro et al., 2010). Additionally, the wild edible mushrooms are reported to be seasonal and the seasonality is determined by moisture availability (Mamiro et al., 2010). According to Mamiro et al. (2010) their availability is controlled by moisture availability in particularly that found in the Serengeti ecosystem.

The findings also showed that elder women households in the Serengeti ecosystem possessed more traditional knowledge on WEVs, including their identity and usage, because probably they predominately use the practice of gathering and cooking of these essential foods (Bvenura and Sivakumar, 2017); and therefore this supports our first predisposition. In addition, it is because knowledge of WEVs is part of their traditional knowledge, which is usually transmitted by elders to young ones and also by participation of individuals in collection of vegetable plants (Devarkar et al., 2010). Also, the study by Konsam et al. (2016) observed that women (>40 years old) of a household possessed more traditional knowledge about leafy vegetables, including the identity of the species, as well as the usage and mode of preparation. This could be due to their association with household chores, such as cooking, marketing, and their home nurturing qualities (Konsam et al., 2016). This is in support of the finding from the study by Powell et al. (2014) who claimed that everywhere, women had very clear knowledge about specific preparation practices needed to make different species palatable. In addition, Powell et al. (2014) pointed out that some women claimed that people prefer WEVs to cultivated/imported vegetables because they taste better and/or have medicinal properties.

The finding also revealed that traditional knowledge on WEVs differed significantly between education levels and those households that have been to school are more knowledgeable than those who have not in the area. This is because, according to Gartaula et al. (2020), those who have been to school have already experienced the interface between formal knowledge at school and informal knowledge at home with respect to their own food and nutrition and therefore are self-motivated to learn from both knowledge systems. Moreover, it had been found that a food literacy that is predominantly shaped by both informal and formal food knowledge in most communities to enhance the overall food literacy and community food security of current and future

generations because those that have been to school have the potential to enhance their food literacy in the schools through experiential learning (Gartaula et al., 2020).

However, majority of the local household reported that the WEVs were decreasing in supply and difficult in accessing them probably because of increased land use change (expansion of agricultural lands), developmental activities (road construction and urbanization), habitat destruction (timber harvest, fuelwood collection, and wildfire), drought, overharvesting and overgrazing (Bvenura and Sivakumar, 2017; Duguma, 2020). Also, according to Powell et al. (2014), decreased availability of WEVs is probably due to biodiversity loss and changes in agricultural practice, government and development policies that ignore WEVs; loss of knowledge needed for gathering and preparation; and a general loss of cultural value for WEVs.

In this study it was found that households with lower income were more knowledgeable on WEVs they use than those with higher income in the area. This is in support of our second prediction and the finding by Duguma (2020) who reported that WEVs have played a significant role in supplying food and nutritional requirements and increasing the health status of poor communities in many rural parts of the world. In addition, according to Duguma (2020), WEVs have always been an essential and widespread food source for food-insecure families living in poverty in developing countries. Moreover, WEVs are also important for many communities in rural villages and even those in urban areas, especially among the poor and marginalized (Duguma, 2020).

The finding also indicated that youths and elders households possessed more traditional knowledge on WEVs species they use than adults in their area. This finding is consistent with a study by Konsam et al. (2016), which revealed that traditional knowledge of WEVs should be transmitted to future generations to obtain inexpensive food resource and improve their healthy status as previously had been reported that WEVs knowledge is gained early in life and increases with age.

Again, majority of the local households reported that the WEVs improved their livelihood in the area. This is because WEVs are known to make important contributions to food baskets and livelihoods in the smallholder and subsistence farming communities of sub-Saharan Africa (Shumsky et al., 2014). Also, this finding supports the findings of Ju et al. (2013) who reported that locally harvested wild edible plants (WEPs) provide food as well as cash income for indigenous people, and are of great importance in ensuring global food security and they improve the nutrition in the diets of many people in developing countries. Additionally, some also play a significant role in maintaining the productivity and stability of traditional agro-ecosystems (Ju et al., 2013).

CONCLUSION AND RECOMMENDATIONS

This study concludes that majority of the households were knowledgeable on the WEVs species they use in their area. Most of the WEVs species used were herbaceous plants and were used mostly for domestic and partly commercial purposes. Elder women were more knowledgeable than men of all ages on the WEVs they use in their area. Households with lower income more represented by women were more knowledgeable on the WEVs they consume because they are the ones who most frequently harvested and cooked them. Additionally, majority of the households were aware that the WEVs were decreasing in supply and difficult in accessing them probably because of their over harvesting as well as improving their livelihood and healthy status in the area. We therefore call for further research into WEVs nutritional components to understand their potential as a source of future food and nutritional security as well as for urgent measures to protect and conserve WEVs in Serengeti ecosystem.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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