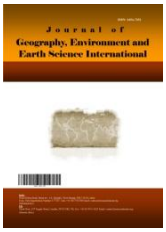

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Environmental Challenges of Tree Nursery, Reforestation and its Impacts in the Limbe Municipality, South West Region, Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

With the increasing rate of global warming and climate change in the world and Limbe municipality in particular, tree nursery in the Limbe Botanic Garden and reforestation is of great importance to combat the negative environmental impacts. There are frequent landslides, flooding, rapid deforestation, and destruction of animal habitats leading to climate change and global warming in the town of Limbe. This study is focus on exploiting the challenges of tree nursery, reforestation and its impacts in order to reduce the increasing rate of carbon dioxide and other environmental disasters brought about by rapid deforestation. A community based cross-sectional survey was conducted from February to August 2021 using quantitative and qualitative approaches. With the use of a simple random sampling method, 400 questionnaires were administered. Focus group discussion (FGD) was held with tree growers, the chief of forest conservator in the Limbe Botanic Garden and also with the local population in charge of forest exploitation. The results obtained from the questionnaires indicated that 57% of the challenges of tree nursery and reforestation were as a result of limited species of trees being nursed and transplanted. In contrast, 24% and 19% of the respondents also indicated that the difficulty faced in the maintenance of Limbe Botanic Garden

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(LBG) is the fact that there is limited renovation strategies employed. And that the causes of deforestation in Limbe, is brought about by rapid exploitation of the forest for timber purposes. To overcome these challenges, a joint effort of government and stakeholder's participation, together with the local population is urgently needed in order to achieve sustainable tree nursery and reforestation in the municipality.

Keywords: Tree nursery; reforestation; limbe botanic garden; environmental challenges and joint effort.

1. INTRODUCTION

Nowadays, with the increasing rate of global warming brought about by the malpractices of man in our environment mostly by the actions of deforestation without reforestation, has resulted to many environmental disastrous consequences. The Limbe municipality is also facing this same situation where there is inadequate tree nursery and reforestation, and limited renovation strategies at the Limbe Botanic Garden. With the increasing rate of exploiting its forest for timber purposes and many other uses; there is need to urgently embark on rapid nursing of all types of tree seedlings and replanting them in areas of deforestation. By so doing, the increasing environmental disasters will be greatly reduced without allowing it to reach its highest stage of causing havoc to many.

Population growth has been found the principal cause of deforestation globally, and including Cameroon [1,2]. Wide scale deforestation has been responsible for food insecurity, water scarcity and increase in atmospheric carbon dioxide in Sub-Saharan Africa (SSA), and Cameroon in particular [3]. To reverse this situation, many communities, governments, donor organizations and non-governmental organizations (NGOs) in many parts of the world, including in Cameroon, have resorted to regreening or revegetating the landscape through tree planting projects.

Most academic studies on reforestation in Africa and Latin America are either simplistic or generalized such that they are speculative and fail to examine the particular causes of the problem [4]. And the study of reforestation is made even more complicated in that appropriate solutions vary between regions due to intricate environmental, cultural, political, economic and socio-cultural differences.

Cameroon's forest resources are estimated to be about 22 million hectares. The forest contains an estimated 1.5 billion m3 of timber. Unfortunately, about 200,000 hectares are lost annually and over 40 species of wildlife are threatened with extinction [5]. The pressure exerted on natural resources by high populations and growing poverty has had effects that go beyond those natural resources. Deforestation is accompanied by soil erosion, crop destruction, water and fuel-wood shortages observed on a small scale and the risk of climate change on a larger scale [6]. There is an urgent need to mobilize maximum efforts and resources to halt and avoid future negative consequences for the forest ecosystem in Cameroon and Limbe municipality in particular.

In the 1970s and 80s, large central nurseries managed by governments, research institutes, NGOs or in some cases individuals, were the only sources of tree planting material. However, these central nurseries have not succeeded in promoting tree planting materials as was expected, because their offer most often did not match smallholder needs in terms of species' diversity and field adaptability, but was rather determined by national and international priorities [7,8]. As a result, the total number of tree seedlings produced was often below expectations, in spite of considerable investments. This same situation is true in Limbe municipality with its current challenges faced in tree nursing and reforestation.

Many of these problems can be attributed to insufficient involvement of local communities from the beginning of the project when tree species for reforestation were selected through to planting and care of the trees on community or individual land. One of the alternatives would be to build farmers' capacities to produce their own planting material. For example, Nyoka et al. [9] found that more than 90 % of the documented agroforestry tree seed distributed to farmers in Malawi was produced by smallholder farmers and collected mainly from scattered farmland trees. This situation is a reverse in the Limbe municipality as the small-scale farmers and the government officials involved in tree nursing do not pay attention in producing many tree seedlings.

In Cameroon, few studies have examined distribution channels for tree planting materials, and basically none examined agroforestry tree species or their supply in rural areas [10]. And in the town of Limbe, south west region of Cameroon, tree nursery and reforestation remains a greater problem to be tackle with the growing climate change in the municipality. The Limbe Botanic Garden found in a gentle sloppy low land area with its nursery section lacks the necessary expert needed to improve on tree nursing and replanting and renovating the Limbe Botanic Garden in the municipality. The major cause is an increasing deforestation leading to the destruction of habitats in prominent areas of Bimbia, Debundscha and Idenau found in Limbe municipality. Also, landslide and flooding equally creates negative environmental impacts in the town leading to climate change. Therefore sustainable nursing and replanting of trees in all parts of the town can go a long way to reduce the negative environmental consequences in the Limbe municipality. This study is focus on exploiting the challenges of tree nursery, reforestation and its impacts in order to reduce the increasing rate of carbon dioxide and other environmental disasters brought about by rapid deforestation.

2. MATERIALS AND METHODS

2.1 The Study Area

Limbe a town in Fako Division, South West Region of Cameroon, is located in an active dynamic coastal zone. Situated between longitude 90^0 and 130^o east and latitude 40^o and 90^o north of the equator with a surface area of about 674km^2 (Limbe Town Planning Office, 2000). With an elevation of 150m at the foot of Mount Cameroon, Limbe is bounded to the West by Limbe II settlement up to Debundscha and the Atlantic Ocean to the South West. To the north, it is bounded by Moliwe, East by Tiko Sub-Division and South East by confines of Limbe III Municipality. It is also located within the coastal lowlands of Cameroon with an estimated population of 118210 (Limbe council, 2020). Limbe is made up of 3 sub - division namely; Limbe 1, Limbe 2, and Limbe 3. The main settlements here include; Mbende, Limbe Camp, Unity Quarter, Animal Farm, Church Street, Motowoh, Limbe 2 and 3. From the 3 sub - divisions in Limbe, we randomly selected three forest areas where deforestation takes place as follows; Bimbia forest, Debunscha forest, and Idenau forest areas. Our study on tree nursery was based in Limbe Botanic Garden found in Limbe town where tree nursing and reforestation takes place. Climatically it has two seasons, the dry and rainy season with moderate temperatures of about 20 to 28^0c, and with high rainfall of about 3000 to 5000mm [11]. The vegetation is generally green almost throughout the year having the Limbe Botanic Garden, with a tropical forest on the slope of Mount Cameroon, having several water sources currently more or less exploited [11]. Fig. 1.

2.2 Socio - Economic Characteristics of Limbe

Data obtained from Limbe Municipal Council on June 6th 2021 shows that the population of Limbe is estimated to about 118210 inhabitants. It has one of Cameroon's largest companies known as Cameroon Development Corporation (CDC) occupying vast hectares of land and has contributed to deforestation in the area. The head office is at Bota, Limbe, the only oil refinery company SONARA is also found in Limbe with a non-operational natural sea port. Limbe has several tourist attractions such as Limbe wildlife center, the Limbe Botanic Garden and private beaches. There are several small inns and hotels, including the LK Hotel, Musango Beach Hotel, Atlantic Beach Hotel, Guest House, Savoy Palms and First International Inn as was observed from the field. However, the respondents equally indicated that there are only a few educational and health facilities with limited numbers of qualified staff. Also, about 51% of the settlements are connected to the national electricity grid with frequent blackout and pipe-born water is available in 57% of the villages. Still, the standard is very low [13]. As observed from the field, the town is facing a lot of deforestation, nursing and replanting of trees along the roadside and all over the town will go a long way to reduce the increasing temperatures and carbon dioxide in the environment.

2.3 Study Design

This study design involved both quantitative and qualitative (Focus Group Discussions and In-Depth Interviews) approaches. We randomly selected 4 localities that is the Limbe Botanic Garden, Bimbia forest, Debundscha and Idenau forest areas in the Limbe municipality. We observed the nursery section in the Garden and the forest areas and then held focus group discussions (FGDs) and In-depth Interviews with the stakeholders involved in the tree nursery, reforestation and in guarding the Limbe forests.

Fig. 1. Map of Limbe city showing the settlement and study area adapted from Melle Ekane Maurice [12]

2.4 Data Collection

A check list was used for data collection with the following challenges that were observed on tree nursery, reforestation and in deforestation areas. We equally observed the tools and old equipment used in tree nursing and reforestation found in the nursery factory. Deep findings were equally carried out on the causes of rapid deforestation taking place in the municipality. We then used these results to assess the challenges of tree nursery, reforestation and the causes of deforestation in Limbe using an adapted semi quantitative approach and possible control measures (mitigation). We used a FGD and an IDI guides for qualitative data. We conducted four FGDs - each lasting 45 minutes. Group 1 was conducted in the Limbe Botanic Garden among the chief of forest conservator with stakeholders involved in forest management and group 2 at Bimbia forest; group 3 was at Debunscha forest and group 4 at the Idenau forest area with the forest guard and those involved in forest exploitation. During the FGD with stakeholders involved in tree nursery, reforestation and in forest management, we probed on awareness of the rapid deforestation rate, its implications and mitigation strategies.

2.5 The Study Approach

The environmental challenges of tree nursery and reforestation were conceptualized through literature review and preliminary field investigation. A questionnaire was prepared following the objectives of the study. The questionnaire focused on people's perceptions on tree nursery, reforestation and its impact on the environment. Using a random sampling method, four hundred questionnaires were administered in the Limbe Botanic Garden, Bimbia forest, Debundscha and Idenau forest areas where rapid deforestation takes place without reforestation. And also in the Limbe Botanic Garden where tree nursing and reforestation takes place to know the challenges

of tree nursery, reforestation and the consequences of deforestation on the environment of Limbe municipality. The questionnaires used for collecting data were divided into sections. Section (A) targeted the challenges faced in tree nursery and reforestation (B) was based on the challenges faced in the maintenance of Limbe Botanic Garden. Also, section (C) of the questionnaire indicated the causes of rapid deforestation in Limbe municipality and (D) targeted the impact of tree nursery and reforestation.

2.6 Data Analysis

We made used of both the primary and secondary data. Primary data obtained from the field using a questionnaire survey were analyzed scrupulously by a research team of porters, facilitators, moderators, and a statistician. And data from the field survey were coded and entered into a Microsoft Office Excel version 2016. Analysis was done using the statistical package for social sciences (SPSS) version 16. Secondary data obtained from the literature review have also been reported in the results.

3. RESULTS

Of the 400 questionnaires distributed in these localities of Limbe municipality, a total response rate of 100% was recorded. The data obtained were represented in tables, figures, pie charts, line graphs, and text. Results of data analysis are presented sequentially, accompanied by discussion to facilitate coherency and understanding.

3.1 Challenges Faced in Tree Nursery and Reforestation in the Limbe Botanic Garden

After administering the 400 questionnaires, the following results were obtained as the major challenges of tree nursery and reforestation.

Forty five percent (45%) of the data obtained from the field shows that only few species of tree seedling are nurse and transplanted mostly within the Limbe Botanic Garden. This shows that little effort is being made in transplanting trees seedling in areas like Bimbia and the Idenau forests where deforestation mostly takes place. 21% of the respondents in the garden stated that some of the nursed seedlings are hardly transplanted. That is most of the nursed species grow past the stage of transplanting in the garden. Also 19% and 15% of the respondents indicated that there is the lack of irrigation schemes needed to facilitate the watering of nursed tree seedlings. And only few fruit tree seedlings are nursed in the Limbe Botanic Garden because of inadequate trained workers employed, Fig. 2.

Besides, below is the nature of Limbe Botanic Garden showing how the nursery structure look like, Fig. 2.

More so, the nursed seedlings are hardly remove from the nursery sector and transplanted from deserted areas. Most of the nursed seedlings grow past the age of replanted because of inadequate trained person needed to follow the nursing and replanting procedures, Fig. 3.

3.1.1 Challenges faced in the maintenance of the Limbe botanic garden

Data obtained from the field indicated that there is a lot of challenges faced in the maintenance of the Limbe Botanic Garden especially in terms of renovation Fig. 4.

As concern the maintenance of the botanic garden, 56% of the respondents indicated that no renovation is done in the garden. In terms of changing the pipes, watering cans, buckets, nursing trays, and propagators are old and need to be renewed. More so, 31% and 13% of the respondents stated that no proper cleaning is done in the nursery factory and the municipality depends on one botanic garden having only a single nursing factory.

Table 1. Challenges faced in tree nursery and reforestation

Challenges faced in tree nursing	Percentages
Few species are nursed and transplanted	45
Some of the nursed seedlings are hardly transplanted	21
Inadequate irrigation schemes in the garden	19
Only few fruit trees are nursed in the garden	15

Fig. 2. The nature of the nursery structure of the Limbe Botanic Garden

Fig. 3. Over grown seedlings that need to be transplanted in the Limbe Botanic Garden

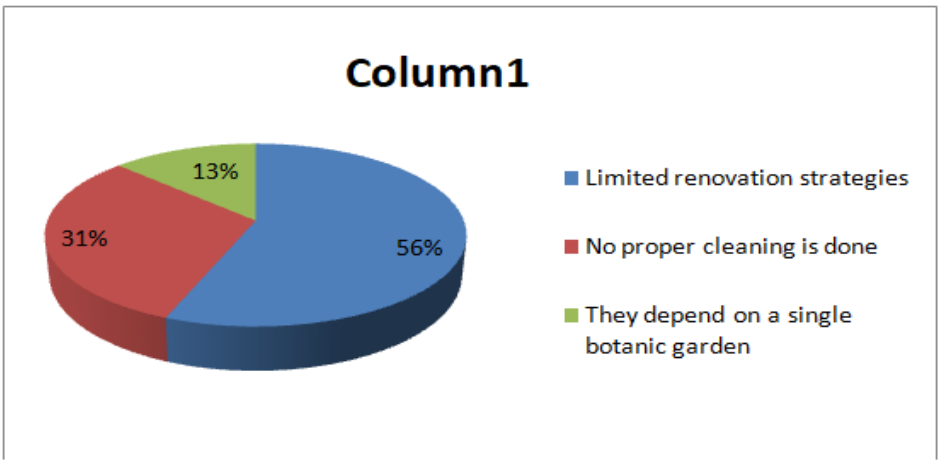

Fig. 4. Challenges faced in the maintenance of the Limbe botanic garden

3.1.2 Causes of rapid deforestation in Limbe municipality

Causes here means something or people's actions leading to rapid deforestation in the municipality. While the effects are the changes brought about by the causes. Furthermore, information obtained from the field also stated that rapid deforestation in the municipality is as a result of the major causes like, primitive methods employed by the local population in exploiting forest resources. They fell down even younger trees without replanting back for timber, plantation and for construction purposes, Fig. 5.

Concerning the causes of rapid deforestation, 48% of the respondents indicated that the major cause of deforestation in the municipality is rapid exploitation of the forest for timber purposes. That is, mostly primitive method is carried out by illegalized individuals in felling trees for timber purposes. With the use of engine sow and cutlasses, the forests of Bimbia, Debundscha and Idenau in Limbe are rapidly fell down with huge logs of wood removed from the forest and exported every year as well as some are sold within the country. Meanwhile 41% and 11% of the respondents were of the opinion that the cultivation of plantation farms and the destruction of forested areas for construction purposes are other causes of deforestation in the Limbe municipality. Also, it was observed that deforestation in the municipality is not only caused by plantation farmers, but by peasant and primitive subsistent farmers who cultivate one piece of land to another in search of fertile soils.

4. DISCUSSION

The data collecting through a questionnaire survey using random sampling methods, and the results were analyzed. Also, the discussions are assessed in the following subsections;

4.1 Assessment of the Challenges Faced in Tree Nursery and Reforestation in Limbe Municipality

After analyzing the 400 questionnaires and results to obtained reliable data about the challenges of tree nursery, reforestation and its impacts in the Limbe municipality. This study revealed that only few species of trees are nursed and transplanted mainly within the Limbe Botanic Garden. According to Epule et al, [3], to reverse this situation, many communities, governments, donor organizations and non-governmental organizations (NGOs) in many parts of the world, including in Cameroon, have resorted to regreening or revegetating the landscape through tree planting projects. This situation is not true as attention has not been given in creating many nursery factories and nursing many species of trees all over the country. The lone nursery factory in south west region of Cameroon, found in Limbe municipality lacks even the necessary irrigation schemes. Few species of fruit trees are nursed and completely ignoring the importance of fruit trees and trees as a whole to man and its environment. As the trees nursed are mostly replanted in one garden, other area like the Bimbia and Debunscha forests where there is increasing rate of deforestation remains without any iota of reforestation. With the increasing rate of intensive heat in the municipality and global warming as a whole, nursing and replanting of trees along the town streets, compounds, resting places and in deforested areas is urgently needed.

4.1.1 Assessment of the challenges faced in the maintenance of the Limbe Botanic Garden

In the same spirit, proper management and maintenance in the botanic garden and nursery factory is another major challenge as renovating the area remains another problem difficult to overcome. According to Food and Agricultural Organization in 2010 (FAO), little evaluation of the success of tree planting projects in public spaces has been undertaken in Cameroon. This is true in that, little evaluation is being done even in renovating the nursery factory in Limbe, no proper cleaning and they depends on a single botanic garden. That is all tree nursing and replanting often takes place mainly within the Limbe Botanic Garden ignoring the other areas like Bimbia, Debundscha and Idenau forest areas facing increasing deforestation. Besides, in order to stabilize the environmental challenges of tree nursery and reforestation in the municipality, evaluating the success of tree planting projects in public spaces need to be encourage at all levels.

4.1.2 Assessment of the causes of rapid deforestation in Limbe municipality

Data obtained from the field showed that there is rapid exploitation of the forest in the municipality for timber purposes without putting into consideration the management strategies involved. Between 2000 and 2010, the net

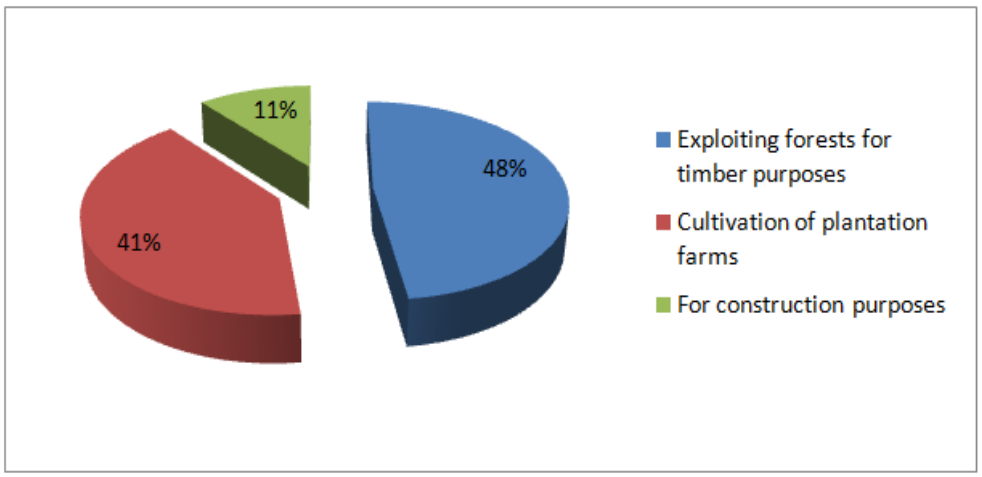

Fig. 5. Causes of rapid deforestation in Limbe municipality

annual loss of forest in Africa stemming fromdeforestation averaged 3.4M/ha [14]. This rate is lower than what was experienced in Latin America, which lost 4.0 M/ha per year during the same period. This same situation is witnessed in Limbe municipality with increasing annual loss of forests as the local population and some of the non-governmental organizations involved in forest exploitation in Limbe do not see themselves as part of the process for managing the resource and as such they do so without any precaution. In some forest areas of Bimbia and Idenau in Limbe, many conflicts often arise between the Cameroon forest guards and the local population. The local population frequently disrespects the laws and continues to exploit the forest without replanting. As such, there is an increasing intensity of sunshine, carbon dioxide, landslides and global warming in the municipality.

Besides, according to FAO in [15], those involved in the forest sector in Cameroon have different and conflicting interests. For the state and large corporations, the forest is a source of private accumulation of economic interest regardless of the interest of the indigenous population. For the local population, on the other hand, the forest is the ultimate source of survival. Therefore violations of forest reserve boundaries and the encroachments of the farming population into the reserves are common. Corrupt forest guards allow individuals to fell trees and timber from reserved forest areas with impunity. The farming population both the local and plantation farmers frequently encroach into forest reserved areas without any given permission. This routine disobedient is leading to increasing and random deforestation without reforestation is leading to many negative environmental consequences in the municipality.

Most academic studies on reforestation in Africa and Latin America are either simplistic or generalized such that they are speculative and fail to examine the particular causes of the problem [4]. Also, little evaluation of the success of tree planting projects in public spaces has been undertaken in Cameroon and most of the public spaces are used for construction purposes. This situation is true in that increasing population in Limbe municipality has equally increases the deforestation rate as many people fell down the forest areas both the public spaces for construction purposes. Building of houses in the Bimbia, Debundscha and Idenau forest areas of Limbe has becomes a rampart thing that need to be address and control in order to encourage tree nursing and reforestation.

4.1.3 The importance of tree nursery and reforestation in order to reduce increasing deforestation rate and climate change in the environment of Limbe Municipality

The following importance will help to reduce the deforestation rate in the municipality if taken into consideration;

Tree nursery and reforestation help to cool the streets and the city. A town like Limbe with increasing rate of deforestation and intensive heat needs reforestation. Replanting of trees in areas of deforestation and along the streets will help reduce the rate of deforestation in the municipality.

Also, trees help to conserve energy. Replanting of these trees in areas of deforestation and in any compound, streets and in resting places will help to conserve energy that we can easily use up during periods of intensive sunshine.

Trees provide oxygen. The increasing rate of carbon dioxides in the environment of Limbe can only be reduced by planting many trees in the municipality. Through a process called photosynthesis, leaves pull in carbon dioxide and water and use the energy of the sun to convert this into chemical compounds such as sugars that feed the tree.

Trees help to combat climate change. Sustainable management of the forest requires a holistic approach including everyone in nursing and replanting trees. As trees grow, they help stop climate change by removing carbon dioxide from the air, storing carbon in the trees and soil, and releasing oxygen.

Besides, trees help to save our natural water. Reducing soil erosion which prevents sediment from entering storm drains and streams, as such the rise in fresh water search can be easily be combat by planting many trees around natural streams. Trapping debris and contaminants in the decaying organic matter that is present in the root zone when water percolates through, below the soil surface will equally natural ground water purity.

Trees help to prevent soil erosion. Trees protect our environment and prevent soil erosion in many ways. They reduce the amount of water in soil through transpiration. Their roots bind soil to sloping ground. They also break the wind and prevent it from blowing soil away.

More to that, trees help to shield children from ultraviolet rays. Tree shade reduces ultraviolet ray's exposure by about 50 percent. That is a statistic we like. Trees provide the most coverage from ultraviolet rays during the middle of the day. In the same light, trees help to provide us with food and heal. Trees provide shelter from the weather and from enemies. Trees provide food in the form of fruits, nuts, leaves, bark, and roots. Even dead trees provide shelter and food for many insects. Furthermore, trees provide a canopy and habitat for wildlife. That is, broad leaves species such as Oak, beech, and maple have larger surface area leaves which generates more photosynthesis. Many animals' lives under the trees as well as some dig their homes underground roots of trees.

5. CONCLUSIONS

Access to improving on the environmental challenges of tree nursery, reforestation and its importance in the Limbe municipality, and in some African countries like Burundi, Sudan and Nigeria facing severe deforestation rates remains a greater task. These challenges can only be reduced by managing our forests in a sustainable development way. By supporting and encouraging both the government and local community nursery factories. Also, encouraging reforestation and setting up a team that would monitor and ensure that replanting of trees is being done in areas of deforestation. Creating many educational facilities to teach and train workers on how to manage nursery factories. And also creating irrigation schemes near the nursery factories and improving on renovating them to ensure proper nursing of seedlings. Sustainable management of the forest requires a holistic approach that includes everybody.

To overcome these challenges, a joint effort of government and stakeholder's participation, together with the local population is urgently needed in order to achieve sustainable tree nursery and reforestation in the municipality.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

QUESTIONNAIRE

Dear respondents,

I am BUH EMMANUEL NONG, a graduate student of the Department of Environmental Science, Faculty of Science, University of Buea. We are conducting a study entitled, Environmental Challenges of Tree Nursery, Reforestation and its Impacts in the Limbe Municipality, South West Region, Cameroon. The purpose of this study is to identify the issues plaguing tree nursery and reforestation in this municipality.

Thank you again for accepting to participate in the study. As an inhabitant of the Limbe municipality, your opinion on this topic is very important. Please, kindly provide your honest opinion only. Your responses shall be treated confidentially and used only for the purpose of this study.

SECTION A: Challenges faced in tree nursery and reforestation in Limbe Botanic Garden (LBG).

1) What in your opinion are the challenges faced in tree nursery and reforestation in Limbe? ---------

2) In your opinion, why do some of the nursed seedlings grow and past the stage of transplanting in the Garden? ----------

3) What do you think are the reasons for inadequate irrigation schemes in the garden? ----------

4) According to you, why are few fruit trees nursed and transplanted in the garden? ----------

SECTION B: Challenges faced in the maintenance of the LBG

5) What do you think are the reasons for the limited renovation strategies in the LBG? ----------

6) Please, comment on the level of cleanliness in the garden ----------

7) In your view, why does this municipality depend only on a single Botanic Garden? ----------

SECTION C: Causes of rapid deforestation in Limbe municipality

8) Why in your views is there rapid deforestation in the Limbe forest areas? ----------

Thank you for your time and for sharing your opinions!

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