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Research Article

Beekeeping Practice as a Sustainability Approach to Promote Climate Change Adaptation for Income Generation in Gambian Villages

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Abstract

This study examines Beekeeping Practice as a sustainable approach to promote climate change adaptation and income generation. By examining the multi-dimensional benefits of beekeeping, this research highlights its potential to enhance environmental resilience, support biodiversity, and provide economic opportunities for communities. The findings underscore the importance of creating enabling conditions to enhance community participation in combating climate change menaces on sustainable basis, while improving the economic status of households. The approach integrates traditional and modern beekeeping practices to create sustainable strategic approach to beekeeping to adapt and build resilience to climate change. Furthermore, the study provides recommendations for policymakers, practitioners, and stakeholders to create an enabling environment, for promoting beekeeping initiatives in the communities.

Introduction

Climate change is the most challenging issue in recent times, impacting negatively on ecosystems, economies, and livelihood systems worldwide particularly in Africa, the Gambia inclusive. As global temperatures rise and weather patterns become increasingly erratic, the need to sustainable adaptation practices becomes obvious.

Traditional beekeeping, as has been practiced in many parts of the world, the Gambia inclusive has proven its efficacy in supporting biodiversity and enhancing environmental restoration and resilience [1]. The integration of modern beekeeping practices with traditional methods can address both ecological and socio-economic dimensions of climate change. Bees play a crucial role in pollination, which is vital for maintaining healthy ecosystems, improving biodiversity and agricultural productivity. By nurturing healthy bee populations, communities can strengthen their local environments and improve food security.

Moreover, beekeeping provides significant economic opportunities, especially in rural areas where alternative sources of income may be limited. A study by Smith et al. [2] demonstrated that beekeeping can substantially increase household incomes and contribute to poverty alleviation. The sale of honey and other biproducts e.g. wax, offers a sustainable income stream, empowering communities to invest in further climate adaptation measures. By creating enabling conditions for community participation and integrating beekeeping into broader climate adaptation strategies, policymakers and stakeholders can enhance sustainable adaptation and resilience to climate change in the communities. This approach not only mitigates the adverse effects of climate change but also enhances the economic status of households, reinforcing the importance of beekeeping as a multi-dimensional adaptation practice.

In summary, this case highlights the potential of beekeeping to promote climate change adaptation and income generation. By leveraging the benefits of beekeeping and fostering an enabling environment, we can develop sustainable strategies to combat climate change and support the resilience of affected communities.

Problem Description

The Gambia amongst other African countries is adversely affected by Climate Change. The erratic weather conditions as captioned above drastically affected the Gambia many ways in the past years with rainfall patterns declining to only 3 months of rain (July- September) year after year. This coupled with intermittent draught spells lasting 8 to 14 days had a significant impact on crop production and productivity. With more than 65% of the population depending on agriculture as livelihood means, people's attitude began to focus on harvesting the available environment (Forest Resources) by drastically cutting down trees for timber, fuelwood and charcoal burning to supplement income from low agricultural products. This practice has adversely challenged the environment and its related existing biodiversity which has impacted traditional and modern beekeeping opportunities. In view of these circumstances, beekeeping amongst other adaptive methods emerged as a promising climate change adaptation, offering a holistic approach to environmental restoration, resilience building and enhancing economic stability in rural farming communities.

Beekeeping addresses several critical problems associated with climate change and economic instability, especially in vulnerable regions like sub–Saharan Africa where the Gambia falls. Climate change disrupts ecosystems, affecting pollination and food security. This practice supports biodiversity by promoting healthy bee populations essential for pollination, thus maintaining healthy ecosystems and enhancing agricultural productivity. Furthermore, beekeeping provides a sustainable income source, particularly in rural communities with limited economic opportunities. The sale of honey and its biproducts increases household incomes, allowing them to reinvest in climate adaptation measures. By promoting community participation and integrating beekeeping into broader adaptation strategies, the approach not only mitigates the adverse effects of climate change but also enhances economic resilience, creating strategic solutions to complex environmental and socio-economic challenges (Figures 1-3).

Figure 1: Example of Illegal Lugging in the Forest.

Figure 2: Heap of confiscated wood lugs for fuel wood.

Figure 3: Illegal charcoal burning.

Research Objectives

Revitalize beekeeping practices in 5 selected communities in the Lower River Region of the Gambia by end of 2024.'

a) Increase income of beekeeping groups in the selected communities by 10% within 2 years.
b) Reduce illegal tree cutting by 30% within 18 months through community Forest Management practices
c) Increase community awareness in beekeeping initiatives within targeted communities by one year.
d) Enhance agricultural productivity by 15% through improved pollination within 3 years.

Materials and Methods

Description of study site

Before proceeding with materials and methods, I wish to describe the location of the area where the study was conducted. Lower River Region (LRR) was amongst 3 other EbA project implementation sites in the Gambia. It is centrally located in the Gambia with its headquarters 181 Kilometers east of the capital Banjul. It is bordered by the West Coast Region in the West and Central River Region South in the east. LRR is inhabited by 144 village settlements out of which 28 villages share 25 Community Forests (CFs). Going by geographical location 6 villages had to share 3 CFs. Following the protocol development as described below, 9 of the villages actively participated in the beekeeping initiative.

Global conventional approach to beekeeping as part of efforts to combat climate change was used. The materials used in the revitalization of beekeeping practices included modern beekeeping equipment such as hives, protective clothing (gloves, boots), knives, smokers, honey extractors and buckets. Local materials such as cutlasses and rakes were also integrated to make the practice sustainable and cost-effective (Figures 4 & 5).

Figure 4: Trainers and trainees in beekeeping gears.

Figure 5: Assembling bee hives at the apiary.

Methodological Approach

Identification of beekeeping groups

By design, EbA intervention communities benefitted from the beekeeping initiative. Prior to project implementation properly, protocol development exercise was carried out in all EbA intervention communities to identify issues relating to environmental degradation, natural resources and agricultural farmlands; develop and prioritize realistic projects based on EbA options. Amongst many, Beekeeping was identified as natural resource-based adaptation activity to climate change in certain communities as shown in table 1 below.

Table 1: Priority ranking of EbA Intervention in Manduar Community.

Identify evaluation criteria to assess the feasibility of EbA options									
EbA Options	Feasibility evaluation criteria (high = 3, medium = 2, low = 1) Threshold score - 8								
	Affordability (Consider long-term cost effectiveness)	Technical feasibility	Political feasibility	Cost to maintain	Can be monitored	Flexibility can respond to feedback & learning)	Supports large number of beneficiaries	Culturally appropriate / Socially acceptable	Score
Enrichment planting	3	3	3	2	2	3	3	3	22
Woodlot	3	2	2	1	2	3	3	3	19
Beekeeping	3	2	1	2	3	3	3	2	19
Poultry	1	1	3	1	3	3	3	3	18
Borehole	1	1	3	1	3	3	3	3	18
Nursery preparation	1	1	2	1	2	3	3	3	16

This exercise further identified traditional beekeepers at community meetings led by the extension network (Focal Points). In addition, interested members were identified to reach the target of 10 beekeepers of 5 men and 5 women in each communityto enhance gender empowerment and equity. A total of 13 communities were initially targeted, while 5 actively participated in the initiative (Figure 6).

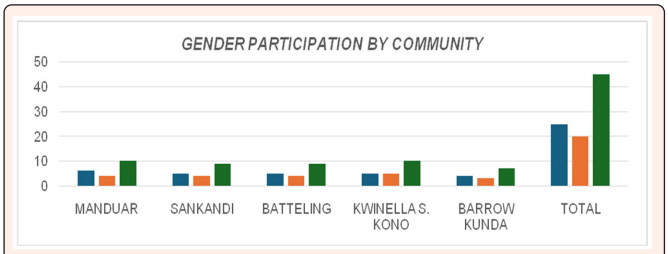

Figure 6: Gender participation by community.

The benefits of intra agency collaboration were added valuable strengths enjoyed by the beekeeping initiative project. The Market Analysis and Development (MA&D) unit of Department of Forestry spearheaded the training and capacity building process of community members in identification of forest product-based enterprises. MA&D is a framework for planning tree and forest product-based enterprises. It consists of a preliminary planning phase followed by four phases that guide entrepreneurs through a simple and clear participatory process to plan and develop their enterprises.

Training to Build Capacity

Following the ground setting the approach proceeded with several levels of training aimed at preparing both the extension network and communities for the challenge. The training process started with trainers (extension network) aimed at technically preparing them on beekeeping concept and good practices. The training equipped the trainees with technical know-how in apiary management, preparing and bedding bee hives and catcher boxes with wax to enhance colonization and effective use of beekeeping gears.

The second level of training was community-based, targeting the beekeepers where modern technologies of beekeeping theories and practices were practically imparted and demonstrated. Participants through practical and experiential learning acquired advanced skills in modern beekeeping practices. The third level was even more practical at apiaries where communities were exposed to honey harvesting processes. This was led by technical experts demonstrating how to approach and harvest honey from the colonized hives. Additionally, the project incorporated the use of indigenous knowledge and practices, which were combined with modern techniques to enhance beekeeping, increase productivity and enhance sustainability.

A great lesson learned was the use of smokers in place of traditional fire settings to disperse bees while harvesting honey. With smokers, bush fires were eliminated, bees were controlled and harvesting carried out leaving the colonies intact to continue colonizing the hives (Figures 7 & 8).

Figure 7: A cross section of participants at the community-based training session.

Figure 8: The focus group meeting to support beekeeping groups.

The extension team (Focal Points) interfaced with the communities monitored progress, collected feedback and report. To ensure sustainability and support to the beekeeping groups, a series of follow-ups were conducted at field level keeping the initiative on track.

Regional Coordination

The Regional Coordinating point which includes Regional Technical Working Group (RTWG)in collaboration with experts from "Kumu Kunda" "Bee Cause" Association provided specialized technical back-up support to the focal points and beekeeping groups. The RTWG facilitated delivery of necessary supplies, equipment and continuous education on environmental conservation good practices emphasizing the importance of bees in pollination and agriculture.

The use of materials and methods, the project boosted beekeeping practices in the communities contributing to the broader goals of income generation, community development, whilst promoting environmental conservation on sustainable bases.

Theoretical Background

Beekeeping, also known as apiculture, involves the practice of maintaining bee colonies, typically in hives, by humans. The theoretical background to beekeeping encompasses several key concepts and principles that are essential for successful practice and sustainability.

Firstly, understanding the biology and behavior of bees is crucial. Bees are social insects that live in colonies consisting of a queen, workers, and drones. Each of these has special roles to play in keeping an active bee colony. The queen, however, seems to be the nerve center of each colony. The colony operates as a single organism, working together to ensure survival and productivity. Knowledge of the bee lifecycle, including the stages of egg, larva, pupa, and adult, helps beekeepers manage the colony effectively. At certain levels of training, emphasis was made on roles of the queen bee, workers, soldiers, and drones. Understanding of the bee population psychology helps build and maintain useful and more productive colonies, as the longer a colony stays, the more productive they become over time.

Secondly, the principles of hive management are fundamental. Modern beekeeping utilizes various types of hives, such as the Langstroth hive, the Kenyan top bars which allows for efficient honey extraction and colony management. Beekeepers must be skillful and proficient in tasks like hive inspection, frame management, strategic placement and transfer of catcher boxes, and swarm control to maintain healthy and productive colonies. Environmental factors also play a significant role in beekeeping. Beekeepers must understand the impact of climate, flora, and local ecosystems on bee health and productivity. Sustainable practices, providing water containers at apiaries helps in establishing productive colonies. Other practices such as planting bee-friendly plants and avoiding pesticides and clearing apiaries to minimize predators that can feed on bees or honey are essential for keeping healthy and productive colonies.

Lastly, the economics of beekeeping cannot be overlooked. Beekeeping provides various products, including honey, beeswax, royal jelly, and propolis, which contribute to income generation and economic development. Understanding market dynamics, product quality, and value addition processes are critical factors to optimizing the economic benefits of beekeeping which also influences greater community participation, ownership hence sustainability.

Incorporating both indigenous knowledge and modern techniques enhances the economic effectiveness and sustainability of beekeeping initiatives.

The Medicinal Value of Honey

An Exploration of Honey's Healing Properties

Honey, a natural substance produced by bees from the nectar of flowers, has been valued for its medicinal properties for centuries. Its applications in traditional medicine and modern healthcare highlight its versatility and effectiveness in treating various ailments.

Antibacterial and Antimicrobial Properties

Honey is renowned for its potent antibacterial and antimicrobial qualities. Studies have shown that honey can inhibit the growth of a wide range of bacteria, including antibiotic-resistant strains. According to Al-Waili et al. [3], honey's high sugar content, low pH, and the presence of hydrogen peroxide contribute to its ability to prevent bacterial growth and infection. This makes honey an excellent topical treatment for wounds, burns, and ulcers, promoting faster healing and reducing the risk of infection.

Anti-inflammatory Effects

Honey also exhibits significant anti-inflammatory properties, which can help reduce swelling and pain. Research by Kamaratos et al. [4] demonstrated that honey's anti-inflammatory effects are beneficial in managing conditions such as sore throats, colds, and even chronic inflammatory diseases.

Antioxidant Benefits

The antioxidant properties of honey are another key aspect of its medicinal value. Honey contains a variety of antioxidants, including phenolic acids and flavonoids, which help protect the body from oxidative stress and free radical damage. A study by Ahmed et al. [5] indicated that regular consumption of honey can enhance antioxidant defenses, potentially reducing the risk of chronic diseases such as heart disease and cancer.

In conclusion, honey's medicinal value is well-supported by scientific research, making it a valuable natural remedy for a range of health issues. Its antibacterial, anti-inflammatory, and antioxidant properties underscore its importance in both traditional and modern medicine [6-10].

Results & Discussions

Beekeeping initiatives have yielded significant positive outcomes across various dimensions in the pilot communities the concept was implemented. Beekeeping was revitalized in the communities when honey was in very high demand. In past decades or so, beekeeping was fast track decline due to bad practices like deforestation, forest fires and charcoal burning. The biodiversity of bees was destroyed resulting in migration of bees to more environmentally conducive areas. However, the implementation of beekeeping as an adaptive climate change initiative, and the knowledge gained during the training motivated and encouraged community participation in beekeeping and related adaptation measures regenerate healthy and conducive biodiversity for beekeeping. It contributed to the preservation of bee populations, which are essential for pollination and agriculture. By emphasizing environmental conservation and sustainable practices, beekeepers have managed to create habitats that support healthy bee colonies, ensuring their survival and productivity [11-17].

Economically sustainable beekeeping has proven to be a viable source of income for the communities. The production of honey, beeswax, royal jelly, and propolis provided financial benefits and promoted economic diversification cultures. Communities engaged in beekeeping have experienced enhanced income generation, which in turn has supported community development efforts. This economic empowerment has fostered greater participation and ownership, ensuring the sustainability of beekeeping projects (Figures 9 & 10) (Table 2).

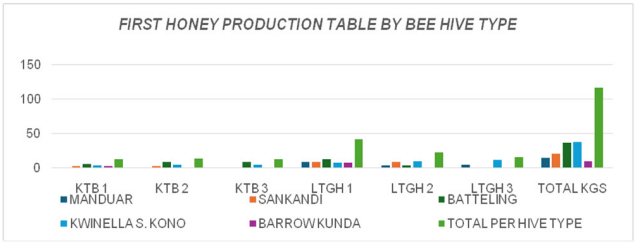

Figure 9: First honey production by bee hive type

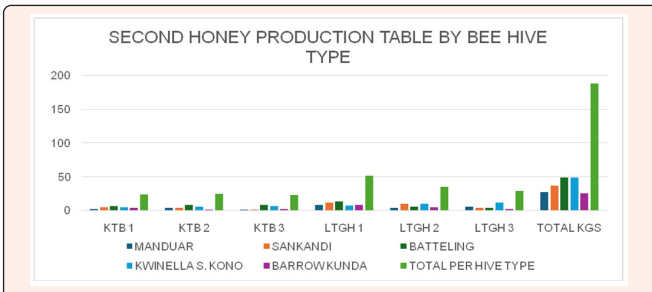

Figure 10: Second honey production by bee hive type.

Table 2: Income analysis by community.

INCOME ANALYSIS TABLE BY COMMUNITY			
COMMUNITY	FIRST SALES (kgs)	SECOND SALES (Kgs)	TOTAL (GMD)
MANDAUR	4900	9800	14700
SANKANDI	7035	12950	19985
BATTELLING	12425	17150	29575
KWINELLA S. KONO	12950	17150	30100
BARROW KUNDA	3220	9100	12320
TOTAL INCOME			106680

Moreover, sustainable beekeeping initiatives have played a crucial role in educating communities about environmental conservation. By adopting practices such as planting bee-friendly trees, avoiding harmful pesticides and minimizing forest fires, communities have learned to coexist with nature harmoniously. Using conservation methods like planting bee-friendly flowers, assisted natural regeneration, and effective community forest management has greatly helped sustain beekeeping initiatives. The knowledge gained has instilled a sense of responsibility and stewardship towards the environment, promoting long-term ecological balance.

Finally, the integration of indigenous knowledge with modern beekeeping techniques has further strengthened the effectiveness and sustainability of the initiatives. Indigenous knowledge has provided valuable insights into local ecosystems and traditional practices, while modern techniques have introduced efficiency and innovation. Combination of indigenous practices and modern knowledge has enhanced the resilience of beekeeping projects, making them adaptable to changing climatic environmental and economic conditions.

Sustainability Analysis of Beekeeping

Beekeeping is a sustainable practice in Gambian villages. Because, it is ecologically susceptible. Dense bee colony signifies environmental as well as ecological soundness in the vicinity. Beekeeping practice is a means of socialization among the farmers since they work in group. Beekeeping product, honey is a value-added product and has economic value as well. So, beekeeping practice in Gambian villages is sustainable on the basis of three pillars of sustainability: ecology, economy and society.

Recommendation

Based on the results and discussions, the following recommendations are proposed for enhancing the sustainability and effectiveness of beekeeping initiatives:

a) Promote Environmental Conservation: Encourage the planting of bee-friendly trees and flowers, avoid harmful pesticides, and minimize activities that lead to deforestation, for example forest fires. Implement community forest management practices to enhance community ownership and sustain bee habitats.

b) Integrate Indigenous and Modern Techniques: Continue to blend traditional beekeeping practices with modern knowledge and technical know-how to improve efficiency, adaptability, and resilience against changing climatic and economic conditions.

c) Educational Programs: Develop and support educational programs that emphasize the importance of environmental conservation and sustainable beekeeping practices to instill a sense of responsibility and stewardship in the communities.

d) Translate the beekeeping training manual into local languages and introduce it in adult literacy classes to learn beekeeping theories and practices.

e) Facilitate Economic Diversification: Support the production and marketing of beekeeping products such as honey, beeswax, royal jelly, and propolis. Provide training and resources to optimize product quality and value addition processes, enabling economic empowerment and community development.

f) Maximize the use of media, radios, television, face book, YouTube, Instagram and Tik Tok to adverse beekeeping productive attract wider market and economics of scale.

g) Community Engagement and Support: Foster greater community participation and ownership of beekeeping projects by providing necessary training, resources, and support. Motivate other communities to emulate successful practices and establish their beekeeping initiatives by establishing a network of beekeeper's associations.

h) Monitoring and Evaluation: Implement regular monitoring and evaluation of beekeeping projects to assess their impact, identify challenges, and make necessary adjustments. This will ensure continuous improvement and sustainability of the initiatives.

Conclusion

Beekeeping presents a viable and adaptive measure to counter the adverse effects of climate change while offering substantial opportunities for income generation. By promoting environmental conservation, integrating indigenous and modern techniques, and enhancing community engagement, beekeeping initiatives can lead to resilience against changing climatic conditions. Furthermore, by supporting other adaptation practices like planting flowering trees, enhancing assisted natural regeneration, promoting community forest management initiatives e.g. fire belt clearing, a conducive environment will be established to sustain beekeeping as an adaptation initiative to climate change. Engaging media facilities to attract and diversify market opportunities for products tantamount to economic empowerment, increase in income and sustainable development. Regular monitoring and evaluation of these projects will ensure their long-term effectiveness and adaptability, making beekeeping a practical and lucrative solution in the face of global climate and economic challenges. By creating a network of beekeeper's associations and conducting exchange visits enhances learning from each other leading to multiplier effects.

The results of sustainable beekeeping initiatives are dimensional and impactful. They encompass the conservation of bee populations, economic empowerment, environmental education, and the fusion of indigenous and modern knowledge. These outcomes reflect the holistic benefits of sustainable beekeeping, establishing it as a vital practice for both ecological and community development. In addition, the multiplier effect was evident by other communities emulating good practices from beneficiary beekeeping groups.

Acknowledgement

I wish to extend my heartfelt gratitude to all the stakeholders whose unwavering support and dedication have made this initiative a glowing success.

First and foremost, my deep appreciation goes to the Ministry of Environment, Climate Change and Natural Resources (MECCNAR) for their visionary leadership and commitment to environmental conservation. This was a rock foundation for establishing beekeeping projects in intervention villages.

To the Eba Project, management and Program Staff, for their tireless efforts, expertise, and passion have been the driving force behind the success of our beekeeping endeavors. I am immensely grateful to the focal points for the hard work and community mobilization efforts which have empowered communities and fostered a sense of responsibility towards embracing sustainable beekeeping initiative. Their contributions have been invaluable, and I am proud to have such a committed and talented team.

I extend my sincerest and deepest gratitude to the Kumu Kunda "BeeCause" Association for the excellent technical guidance and supervision. Their active participation, collaboration, and sharing of knowledge created a network of motivated and skilled beekeepers, with greater sense of ownership working towards a common goal of environmental conservation and economic empowerment.

Let me also appreciate the willful enduement and participation of the communities for sharing indigenous knowledge and experiences, creating time and space without which the endeavors would have been futile.

Lastly, I must profoundly and sincerely acknowledge the expertise guidance I enjoyed from Dr. Mohammad Shahidul Islam for his commitment, encouragement, guidance and perseverance to the journey of publishing this journal. I will end with acknowledging the tutorial team of experts of AIU creating a conducive learning environment yet still at home. Thanks to the AIU team. I look forward to continuing this journey together, with renewed vigor and determination, to ensure a brighter and more sustainable future for all.

List of Symbols

a) Example of illegal lugging in the forest
b) Confiscated lugs
c) Illegal charcoal burning
d) Display of beekeeping gear
e) Beehive assembling at apiary
f) Priority ranking table of EbA options in Manduar
g) A cross section of participants at training site.
h) Gender participation table
i) Honey production tables by beehive type
j) Revenue generated by the keeping groups

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