



Sustainable Vanilla Farming in Kilifi, Kenya: A Pathway to Biodiversity Conservation

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ABSTRACT

The article investigates how Kilifi County, Kenya's sustainable vanilla growing could contribute to both economic growth and ecological preservation. Although the region's warm, humid environment makes it ideal for growing vanilla, its ecosystems are in peril due to the intense agricultural methods. The study emphasizes the value of biodiversity and how it contributes to the preservation of ecosystem services that are essential to agricultural output. It promotes environmentally friendly methods that can boost farmers' livelihoods and biodiversity, such as integrated pest control, organic farming, and agroforestry. The lack of technical expertise, early financial investment, and the effects of climate change are among the obstacles to sustainable vanilla production that are mentioned in the article. It suggests focused interventions—such as research development, government policy, and community involvement—to deal with these issues and advance a model of ecologically sustainable vanilla production in Kilifi.

INTRODUCTION

Kilifi County, with its warm and humid climate, is well-suited for vanilla farming. As a high-value crop, vanilla has the potential to significantly contribute to the local economy. However, the intensive nature of vanilla cultivation poses risks to the region's rich biodiversity. This paper introduces the concept of sustainable vanilla

farming to enhance both economic and environmental outcomes.

Background on Vanilla Farming in Kilifi

Kilifi, a coastal region in Kenya, has seen a growing interest in vanilla farming due to its favourable climate and soil conditions. Vanilla, derived from the orchids of the genus *Vanilla*, is one of the most labour-

intensive crops, requiring specific conditions and meticulous care for successful cultivation. Traditionally, vanilla is grown in tropical regions, with major producers being Madagascar, Indonesia, and Mexico. However, Kilifi's unique microclimate, characterized by moderate temperatures, high humidity, and adequate rainfall, makes it an ideal location for vanilla farming [Mwirigi, Muthoni, & Ngari, 2019].

The surge in global demand for natural vanilla, driven by consumer preference for organic and sustainably sourced products, presents an economic opportunity for Kilifi's farmers [Mwirigi et al., 2019]. This demand is also fueled by the culinary and fragrance industries, where vanilla is a critical ingredient [Aurore, Parfait, & Fahrasmane, 2009]. As vanilla prices remain high, smallholder farmers in Kilifi are increasingly viewing vanilla cultivation as a viable economic venture, capable of significantly improving their livelihoods [Choge & Bandara, 2005].

Despite the potential benefits, vanilla farming in Kilifi is still in its nascent stages, facing numerous challenges including lack of expertise, pest and disease management, and initial high capital investment. Addressing these challenges requires a sustainable approach that not only enhances productivity but also conserves the local biodiversity [Mwirigi et al., 2019].

Importance of Biodiversity

Biodiversity refers to the variety and variability of life on Earth, encompassing different species, genetic variations, and ecosystems. It is essential for maintaining ecosystem services that support human life, such as clean water, fertile soil, and pollination of crops. In the context of agriculture, biodiversity plays a crucial role in ensuring resilience against pests and diseases, improving soil health, and maintaining ecological balance [Loubser, 2007].

In Kilifi, promoting biodiversity through sustainable vanilla farming practices can yield significant ecological benefits. Diverse ecosystems tend to be more resilient and productive, capable of withstanding environmental stressors such as climate change [Loubser, 2007]. Sustainable farming practices, such as agroforestry, intercropping, and organic farming, can help maintain and even enhance local biodiversity [Mwirigi et al., 2019].

Sustainable Vanilla Farming and Biodiversity Conservation

Sustainable vanilla farming involves practices that are ecologically sound, economically viable, and socially responsible. These practices include:

1. **Agroforestry:** Integrating vanilla plants with trees and other crops to mimic natural ecosystems. This method not only provides shade necessary

for vanilla orchids but also creates habitats for various species, thus enhancing biodiversity [Loubser, 2007].

2. **Organic Farming:** Avoiding synthetic chemicals and fertilizers, which can harm local flora and fauna. Organic methods promote soil health and create a safer environment for beneficial insects and wildlife [Mwirigi et al., 2019].
3. **Integrated Pest Management (IPM):** Using a combination of biological, physical, and chemical methods to control pests in an environmentally friendly way. This reduces reliance on harmful pesticides, protecting both the crop and surrounding ecosystems [Mwirigi et al., 2019].
4. **Water Conservation Techniques:** Implementing efficient irrigation methods to conserve water, an essential resource in maintaining ecosystem health in Kilifi [Choge & Bandara, 2005].
5. **Community Engagement and Education:** Involving local communities in sustainable practices and educating them about the importance of biodiversity. Empowered and knowledgeable farmers are more likely to adopt and sustain conservation practices [Mwirigi et al., 2019].

Challenges and Potential Solutions

The transition to sustainable vanilla farming in Kilifi faces several challenges:

1. **Lack of Technical Knowledge:** Many farmers lack the expertise required for effective vanilla cultivation and sustainable practices. Training programs and extension services can bridge this knowledge gap [Mwirigi et al., 2019].
2. **Initial Capital Investment:** The cost of setting up a vanilla farm can be prohibitive. Access to microfinance and subsidies can help smallholder farmers overcome this barrier [Choge & Bandara, 2005].
3. **Market Access:** Connecting farmers with fair trade markets can ensure they receive fair prices for their produce, incentivizing sustainable practices [Mwirigi et al., 2019].
4. **Climate Change:** Changing weather patterns can impact vanilla yields. Implementing climate-resilient farming techniques can mitigate these effects [Loubser, 2007].

By addressing these challenges through targeted interventions, Kilifi can become a model for sustainable vanilla farming, contributing to both economic development and biodiversity conservation [Mwirigi et al., 2019].

Vanilla Cultivation and Biodiversity

Vanilla Planifolia: Characteristics and Cultivation

Characteristics of Vanilla Planifolia:

Vanilla planifolia, commonly known as the Bourbon vanilla, is a tropical orchid native to Mexico. It thrives in hot, humid climates and requires a specific combination of soil types, temperature, and shade to produce high-quality vanilla pods (Bora et al., 2018). The plant is a climbing vine that needs support and a host tree to grow optimally. The flowers of vanilla are unique as they bloom for only one day and must be hand-pollinated to produce fruit (Bora et al., 2018).

Cultivation Techniques:

1. **Propagation:** Vanilla is typically propagated through cuttings, which ensures genetic consistency and maintains the desired traits of the mother plant (Bora et al., 2018).
2. **Planting:** The cuttings are usually planted at the base of support trees or structures that provide partial shade and necessary support for the climbing vines (Bora et al., 2018).
3. **Pollination:** Since natural pollinators of vanilla, such as the *Melipona* bee, are not present in most vanilla-growing regions, hand-pollination is essential. This labor-intensive process involves transferring pollen from the male part of the flower to the female part manually (Bora et al., 2018).
4. **Harvesting:** The pods are harvested when they are still green and immature. They are then cured through a process of drying, sweating, and conditioning to develop the characteristic vanilla flavor and aroma (Bora et al., 2018).

Biodiversity in Kilifi: Current State

Biodiversity Overview:

Kilifi County, located along the coast of Kenya, is known for its diverse ecosystems, which include coastal forests, mangroves, coral reefs, and terrestrial wildlife (Leakey, 2017). The region supports a variety of plant and animal species, some of which are endemic and threatened by habitat loss and degradation (Leakey, 2017).

Current Biodiversity Challenges:

1. **Deforestation:** Agricultural expansion, logging, and infrastructure development have led to significant deforestation in Kilifi, affecting both terrestrial and aquatic ecosystems (Leakey, 2017).
2. **Habitat Fragmentation:** The fragmentation of habitats due to human activities disrupts wildlife corridors and reduces the genetic diversity of species (Leakey, 2017).

3. **Climate Change:** Changing weather patterns and rising temperatures pose additional threats to the delicate balance of Kilifi's ecosystems (Leakey, 2017).

Impact of Vanilla Cultivation:

Sustainable vanilla farming has the potential to mitigate some of these biodiversity threats by promoting agroforestry practices that integrate vanilla cultivation with the conservation of native trees and plant species (Kusters & Belcher, 2004). This approach can enhance habitat connectivity and provide economic incentives for local communities to engage in conservation efforts (Kusters & Belcher, 2004).

Sustainable Farming Practices

Organic Farming Techniques

Benefits of Organic Farming:

1. **Soil Health:** Organic farming practices, such as the use of compost and green manures, improve soil structure, fertility, and microbial activity, leading to healthier plants and higher yields (FAO, 2020).
2. **Pest and Disease Management:** Organic farmers use natural pest control methods, including biological control agents, crop rotation, and intercropping, to manage pests and diseases without harmful chemicals (FAO, 2020).

Implementation in Vanilla Farming:

1. **Compost and Mulch:** Utilizing compost and organic mulches helps retain soil moisture, suppress weeds, and provide essential nutrients to vanilla plants (FAO, 2020).
2. **Natural Fertilizers:** Applying organic fertilizers, such as fish emulsion or bone meal, supports plant growth while maintaining soil health (FAO, 2020).

Soil and Water Conservation

Techniques for Soil Conservation:

1. **Contour Farming:** Planting along the natural contours of the land reduces soil erosion and water runoff (WOCAT, 2016).
2. **Cover Crops:** Growing cover crops during off-seasons protects the soil from erosion, enhances soil organic matter, and improves nutrient cycling (WOCAT, 2016).

Water Conservation Methods:

1. **Drip Irrigation:** Using drip irrigation systems ensures efficient water use by delivering water

directly to the plant roots, minimizing evaporation and runoff (WOCAT, 2016).

2. **Rainwater Harvesting:** Collecting and storing rainwater provides an additional water source during dry periods and reduces the strain on local water resources (WOCAT, 2016).

Agroforestry and Polyculture

Agroforestry Systems:

Agroforestry combines agricultural and forestry practices to create more diverse, productive, and sustainable land-use systems. In vanilla farming, incorporating shade trees not only supports the vanilla vines but also provides habitat for wildlife, improves soil health, and sequesters carbon (Leakey, 2017).

Polyculture Benefits:

1. **Biodiversity Enhancement:** Growing multiple crops together increases plant diversity, which can attract beneficial insects and birds, reduce pest outbreaks, and improve ecosystem resilience (Leakey, 2017).
2. **Resource Use Efficiency:** Polyculture systems optimize the use of sunlight, water, and nutrients by combining plants with complementary growth habits and resource needs (Leakey, 2017).

Case Studies and Examples:

1. **Kilifi Agroforestry Projects:** Several initiatives in Kilifi have successfully integrated vanilla cultivation with agroforestry practices, demonstrating increased biodiversity, improved yields, and enhanced livelihoods for local farmers (Kusters & Belcher, 2004).
2. **Global Examples:** Similar approaches in countries like Madagascar and India provide valuable lessons on the benefits and challenges of sustainable vanilla farming (Kusters & Belcher, 2004).

Challenges to Sustainability

Climate Change Impacts

Climate change poses a significant threat to sustainable vanilla farming in Kilifi, Kenya. The region experiences erratic weather patterns, including prolonged droughts and unpredictable rainfall, which affect vanilla crop yields. Vanilla plants are particularly sensitive to temperature and humidity variations, making them vulnerable to changing climatic conditions. Studies show that increased temperatures and altered precipitation patterns can lead to reduced flowering and lower vanilla bean quality, thereby impacting farmers' productivity and income (FAO, 2017).

Additionally, climate change can exacerbate pest and disease outbreaks. Warmer temperatures and higher humidity levels create conducive environments for pests such as thrips and fungal diseases like root rot. These challenges necessitate the adoption of adaptive farming practices to mitigate the adverse effects of climate change on vanilla cultivation (Mugalavai et al., 2013).

Economic Pressures on Farmers

Economic pressures significantly affect the sustainability of vanilla farming in Kilifi. The global vanilla market is highly volatile, with prices fluctuating dramatically due to supply and demand imbalances. This volatility makes it difficult for farmers to plan and invest in long-term sustainable practices. Many farmers face financial constraints, limiting their ability to adopt innovative and sustainable farming techniques (Krishnan, 2017).

Moreover, the high initial costs of establishing vanilla plantations, including the need for shade trees and support structures, pose a barrier for small-scale farmers. Access to credit and financial services is often limited, further exacerbating economic pressures. These financial challenges can lead to practices that prioritize short-term gains over long-term sustainability, such as the use of chemical fertilizers and pesticides (Brown et al., 2020).

Land Use and Deforestation

Land use changes and deforestation present significant challenges to sustainable vanilla farming and biodiversity conservation in Kilifi. The expansion of agricultural land often leads to the clearing of forests, which are crucial habitats for a wide range of species. Deforestation reduces biodiversity, disrupts ecosystems, and contributes to soil degradation and loss of ecosystem services (Kariuki et al., 2018).

In Kilifi, population growth and the demand for arable land drive deforestation. Farmers may clear forested areas to expand vanilla cultivation, leading to habitat destruction and increased carbon emissions. Sustainable land management practices are essential to balance agricultural productivity with environmental conservation. This includes promoting agroforestry systems that integrate vanilla cultivation with forest conservation (Mwangi & Mutua, 2015).

Strategies for Biodiversity Conservation

Community Engagement and Education

Community engagement and education are critical for promoting sustainable vanilla farming and biodiversity conservation in Kilifi. Empowering local communities with knowledge about sustainable farming practices and the importance of biodiversity can lead to

more environmentally friendly agricultural practices. Educational programs can be conducted through workshops, field demonstrations, and collaboration with local agricultural extension services (UNESCO, 2016).

Involving local communities in conservation efforts ensures that they understand the ecological benefits of preserving forests and biodiversity. Community-based conservation initiatives, such as establishing protected areas and promoting agroforestry, can enhance biodiversity while providing economic benefits to farmers. These initiatives should focus on integrating traditional knowledge with modern agricultural practices to create sustainable farming systems (Pretty, 2003).

Government Policies and Incentives

Government policies and incentives play a vital role in promoting sustainable vanilla farming and biodiversity conservation. The Kenyan government can implement policies that encourage sustainable land use practices, such as providing subsidies for organic farming inputs and offering tax incentives for farmers who adopt agroforestry practices. Additionally, policies that support access to credit and financial services can help farmers invest in sustainable farming technologies (Government of Kenya, 2018).

Creating regulatory frameworks that protect forested areas and promote reforestation can also enhance biodiversity conservation. The government can collaborate with non-governmental organizations and international agencies to fund conservation projects and provide technical assistance to farmers. These efforts should aim to create a conducive policy environment that balances agricultural productivity with environmental sustainability (NEMA, 2019).

Research and Development

Investing in research and development is crucial for advancing sustainable vanilla farming practices and biodiversity conservation. Research can focus on developing climate-resilient vanilla varieties, improving pest and disease management techniques, and optimizing agroforestry systems. Collaboration between research institutions, universities, and agricultural organizations can facilitate the exchange of knowledge and innovations (KARI, 2015).

Field trials and pilot projects can help identify best practices for integrating vanilla cultivation with biodiversity conservation. Research should also explore the socioeconomic aspects of sustainable farming, including market access, value chain development, and the economic impacts of conservation practices on local communities. By generating evidence-based solutions, research and development can support the adoption of sustainable practices that benefit both farmers and the environment (CGIAR, 2017).

CASE STUDIES

Successful Models of Sustainable Vanilla Farming

1. Kilifi, Kenya: Integrating Vanilla Cultivation with Agroforestry

In Kilifi, Kenya, sustainable vanilla farming has been integrated with agroforestry practices, which include growing vanilla under the canopy of existing trees. This method not only supports vanilla growth but also enhances biodiversity. A notable example is the collaboration between local farmers and non-governmental organizations like the Kilifi Agroforestry Project, which provides training and resources for sustainable farming practices. These efforts have led to improved yields and increased biodiversity by maintaining a variety of plant species within the farming system (Kenya Agricultural & Livestock Research Organization, 2021).

2. Community-Based Initiatives

Community-based initiatives in Kilifi have shown promise in promoting sustainable vanilla farming. These initiatives often involve forming cooperatives that allow farmers to share resources, knowledge, and market access. For instance, the Kilifi Vanilla Farmers' Cooperative has implemented sustainable farming practices, such as organic farming and integrated pest management, which reduce chemical use and enhance soil health. This cooperative model has resulted in increased vanilla production and income for local farmers while preserving the local ecosystem (Ochieng, 2020).

Comparative Analysis with Other Regions

1. Madagascar: A Benchmark for Sustainable Practices

Madagascar, the world's leading vanilla producer, offers valuable lessons in sustainable vanilla farming. The Sava region in Madagascar has implemented a multi-stakeholder approach involving farmers, NGOs, and the private sector. Programs such as the Sustainable Vanilla Initiative (SVI) focus on improving agricultural practices, ensuring fair trade, and conserving biodiversity. Key practices include shade-grown vanilla, organic certification, and biodiversity corridors. These initiatives have led to a more resilient vanilla supply chain and increased biodiversity (Vanilla Sustainable Initiative, 2022).

2. India: Integrating Technology and Tradition

In India, particularly in Kerala, vanilla farming combines traditional agricultural knowledge with modern technology. Farmers use intercropping systems, where vanilla is grown alongside other crops like bananas and spices, promoting biodiversity and enhancing soil fertility.

Additionally, digital tools are used for monitoring crop health and managing resources efficiently. This integration of technology and traditional practices has resulted in sustainable production and conservation of local flora and fauna (Singh et al., 2019).

3. Uganda: Challenges and Opportunities

Uganda, an emerging player in the vanilla market, faces challenges such as inconsistent quality and climate variability. However, initiatives like the Vanilla Development Program aim to address these issues through farmer education and sustainable practices. Emphasis is placed on organic farming, crop diversification, and the use of natural pest control methods. While still in early stages, these efforts show potential in improving both vanilla yield and biodiversity conservation (International Institute of Tropical Agriculture, 2020).

CONCLUSION

Summary of Findings

The study highlights that sustainable vanilla farming in Kilifi, Kenya, offers a viable pathway to biodiversity conservation. Key findings include:

- 1) **Integration with Agroforestry:** Sustainable vanilla farming practices in Kilifi, such as agroforestry, enhance biodiversity by maintaining a diverse range of plant species and providing habitat for various fauna.
- 2) **Community-Based Models:** Cooperative models have been effective in promoting sustainable practices, leading to improved yields and economic benefits for local farmers.
- 3) **Comparative Insights:** Lessons from other regions, such as Madagascar and India, underscore the importance of integrating traditional knowledge with modern technology and ensuring multi-stakeholder collaboration for sustainable farming.

Recommendations for Future Research

To further advance sustainable vanilla farming and biodiversity conservation, future research should focus on:

1. **Longitudinal Studies:** Conducting long-term studies to monitor the impact of sustainable practices on biodiversity and vanilla yield.
2. **Climate Resilience:** Investigating strategies to enhance the resilience of vanilla farming to climate change, including drought-resistant vanilla varieties and improved water management techniques.

3. **Policy Frameworks:** Developing policies that support sustainable farming practices and provide incentives for biodiversity conservation.
4. **Market Access:** Exploring ways to improve market access for smallholder farmers through fair trade certification and direct marketing channels.

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ABOUT AUTHORS

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John Philip Sele is a scholar with a rich academic background, currently pursuing a **Master's degree in Development Studies** with a focus on the **Theology of Development**. He holds a bachelor's degree in **Theology and a minor in Development Studies** from Africa International University (AIU), Nairobi. His academic and professional journey reflects a deep commitment to integrating theology with development

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Sele serves as a lecturer of Development Studies at Africa International University (AIU). His work in academia and development is informed by years of leadership experience, including his tenure as the International Students Representative at AIU, and the Chief Executive Officer of Content Creators Hub. As Deputy Vice Chancellor for Administration at ASCEN University, Liberia, he oversees strategic administrative operations and promotes a culture of excellence and diversity.

His scholarly work is underpinned by a commitment to community engagement, practical theology, governance and politics, resource mobilization, and social justice, with a focus on empowering marginalized communities, particularly in Jos, Plateau State, Nigeria. His current research interests include governance, social inclusion, and the theology of development, with a particular emphasis on their practical implications in the African context.

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2. Cynthia Wanjiku

Cynthia Wanjiku is a determined development practitioner from Kenya who is dedicated to using academic knowledge and workable solutions to address pressing global issues. Her work, which is informed by her excellent academic background, addresses some of the most important global challenges of our day, such as social justice, sustainable development, poverty reduction, and the complex effects of globalisation. Cynthia is passionate about these subjects because she thinks research may have a beneficial impact on policy and encourage change.

Cynthia is now participating in an international exchange program in Romania. Her experiences have helped her to get a broader awareness of the issues associated with development on both a local and global scale. Her exposure to various development methods and cultural contexts has enhanced her approach to problem-solving and strengthened her resolve to close the gap between theory and practice.

Cynthia's ultimate objective is to make a significant contribution to the scholarly conversation while providing useful, applicable insights for real-world situations. She hopes to have a significant effect on the area of development by promoting policies that advance justice, sustainability, and fairness on a worldwide basis. She does this by fusing rigorous research with a practical perspective.