Feed the Future Tanzania Kilimo Tija Project

Technical Bulletin: Climate Smart Agriculture

INTRODUCTION

Climate-smart agriculture (CSA) is defined as farming practices that sustainably increase productivity and income, enhance resilience and adaptation to climate change, and improve food and nutrition security while also offering mitigation benefits aligned with national development priorities (National Task Force Planning Workshop Report, 2016). By implementing diverse practices and technologies across crops, livestock, and fisheries, CSA addresses the interplay between productivity, adaptation, and mitigation. These practices not only tackle environmental, social, and economic challenges but also align with the priorities of various stakeholders, fostering more efficient, effective, and equitable food systems. In Tanzania, the Kilimo Tija Project (KTP) exemplifies the implementation of climate-smart agriculture through its suite of innovative agronomic practices tailored to enhance sustainability and resilience in farming. KTP's approaches are grounded in the principles of CSA, as they not only aim to increase agricultural productivity and farmers' income, but also strengthen the resilience of agricultural systems to climatic stresses and reduce the environmental footprint of farming.

Figure 1: Tomato demo plot implemented with government extension officer in Kilosa, Morogoro. CSA practices include drip irrigation technology, strong live barriers, hybrid seeds, raised beds, IPM, and staking.
Photo: Fintrac Global Inc.

PILLARS OF CLIMATE SMART AGRICULTURE

I. Productivity

CSA is dedicated to enhancing agricultural productivity and incomes from crops, livestock, and fisheries in a sustainable manner that minimizes environmental impact. This enhancement is crucial for improving food and nutritional security. Central to this goal is the concept of sustainable intensification, which seeks to increase output from existing farmland in a way that lessens pressure on the environment.

II. Adaptation

The objective of CSA in terms of adaptation is to minimize farmers' vulnerability to immediate risks while bolstering their ability to withstand and recover from episodic disruptions and long-term climatic changes. A significant aspect of this pillar is the protection and utilization of ecosystem services, which are vital for maintaining productivity and enhancing the capacity to adapt to climate changes.

III. Mitigation

CSA attempts to reduce or eliminate greenhouse gas emissions wherever feasible. This involves decreasing the emissions per unit of food, fiber, and fuel produced and avoiding deforestation caused by agricultural expansion. Additionally, CSA promotes the management of soils, crops, livestock, and vegetation to optimize their capacity as carbon sinks, thereby enhancing their ability to absorb CO2 from the atmosphere.

CSA PRACTICES AND TECHNOLOGIES

The Kilimo Tija Project promotes climate-smart agriculture by implementing practices that enhance productivity, adaptation, and mitigation efforts specifically tailored to the needs of Tanzanian horticultural farmers. Focusing on key crops such as tomatoes, cabbages, onions, sweet peppers, potatoes, and leafy greens, KTP integrates various CSA practices to address unique challenges and optimize crop performance.

1. Sustainable Water Management

Effective water management is critical in CSA, especially for horticultural crops that often require precise water inputs. Sustainable water management practices help ensure water availability, optimize water use, and minimize environmental impact, which is particularly vital in Tanzania where water scarcity can challenge agricultural productivity.

1.1. Drip Irrigation Systems

1.1.1. **Precision Watering:** Drip irrigation delivers water directly to the root zone of plants such as tomatoes and sweet peppers, minimizing evaporation and runoff. This system is particularly effective in arid regions or during dry seasons, ensuring that water use aligns with the plants' needs without waste.

Figure 2: Drip irrigation in tomato production
Photo: Fintrac Global Inc.

1.1.2. **Fertigation Integration:** By integrating fertigation—where water-soluble fertilizers are delivered through the irrigation system—farmers can efficiently provide nutrients directly to the plant roots, enhancing nutrient uptake and reducing the potential for nutrient leaching.

1.2. Rainwater Harvesting

1.2.1. **Storage Solutions:** Constructing rainwater collection systems, such as ponds with dam liners or tanks, allows for the accumulation and storage of rainwater. This stored water can be a critical resource during periods of drought, particularly for water-intensive crops like cabbages and leafy greens.

1.2.2. **Surface Runoff Utilization:** Designing farm landscapes (layouts) to capture and channel runoff into storage areas can significantly increase water availability without the need for pumps, thus conserving energy and reducing costs.

Figure 3: A dam liner retains the water supply for a drip irrigation system.
Photo: Fintrac Global Inc.

1.3. Mulching

1.3.1. **Moisture Conservation:** Applying organic mulches around crops such as African eggplant, tomato, okra, and sweet pepper helps retain soil moisture by reducing evaporation. This method also suppresses weed growth, which competes with crops for water.

1.3.2. **Temperature Regulation:** Mulch acts as an insulator, keeping soil temperatures more stable during temperature fluctuations, which can be beneficial for root development and microbial activity in the soil.

Figure 4: Organic mulch
Photo: Fintrac Inc.

2. Soil Health Improvement

Improving soil health is essential for sustaining the productivity and resilience of horticultural systems. Healthy soil supports robust plant growth, enhances water retention, and improves resilience to pests and diseases.

2.1. Organic Matter Enrichment

2.1.1. **Composting:** Utilizing organic compost adds essential nutrients back into the soil and improves its structure. For crops like tomatoes and peppers, which are heavy feeders, enriching the soil with well-decomposed compost can boost nutrient availability and enhance growth.

2.1.2. **Cover Cropping:** Planting cover crops such in rotation with horticultural crops helps fix nitrogen in the soil, prevents erosion, and suppresses weeds, thereby improving soil fertility and structure.

2.2. Reduced Tillage Practices

2.2.1. **Conservation Tillage:** Reducing the frequency and intensity of tillage helps preserve soil structure, reduce erosion, and maintain organic matter levels. For root crops like potatoes and onions, minimal tillage also minimizes disruption to the soil microbiome, crucial for nutrient uptake and root health.

2.2.2. **No-till Farming:** Implementing no-till methods in suitable areas can further enhance soil structure and water retention, reduce labor and energy costs, and improve carbon sequestration.

2.3. Crop Rotation

2.3.1. **Disease and Pest Management:** Rotating crops helps break cycles of pests and diseases, particularly important in intensive horticulture systems. For instance, rotating onions with non-host crops can reduce the buildup of soil-borne pathogens.

2.3.2. **Nutrient Management:** Alternating nutrient-extracting crops with nitrogen-fixing legumes can balance soil fertility levels, reducing the need for synthetic fertilizers and enhancing soil health over time.

2.4. Soil Testing and Nutrient Management

2.4.1. **Regular Soil Testing:** Conducting regular soil tests to monitor nutrient levels and soil pH enables tailored nutrient management, ensuring that specific nutrient needs of crops like leafy greens and cabbages are met without excessive fertilizer application.

3. Crop Diversification and Resilient Crop Varieties

Crop diversification and the use of resilient crop varieties are vital strategies to enhance the sustainability and adaptability of agricultural systems. In Tanzania's horticultural sector, these approaches are instrumental in mitigating risks associated with climate variability, enhancing biodiversity, and improving overall crop health and yield.

3.1. Strategic Crop Rotation:

3.1.1. **Nutrient Management:** Rotate nitrogen-hungry crops like cabbages with nitrogen-fixing legumes, which replenish soil nutrients naturally. This reduces dependency on synthetic fertilizers and enhances soil health.

3.1.2. **Disease Control:** Implement rotations that disrupt the life cycles of pests and diseases. For example, follow tomatoes with crops that are not hosts to common tomato pathogens, such as onions or sweet peppers, to naturally reduce disease pressure.

3.2. Intercropping and Companion Planting

3.2.1. **Enhanced Pest Management:** One example of enhanced pest management is to plant onions between rows of carrots to deter carrot flies through the strong scent of onions, a practice known as companion planting that provides a natural pest deterrent.

3.2.2. **Optimal Space Utilization:** An example of optimal space utilization is to grow leafy greens like spinach or kale alongside slower-growing vegetables like cabbages. This not only maximizes the use of space but also can lead to a more efficient canopy, which improves photosynthesis and soil moisture retention.

3.3. Introduction of Resilient Crop Varieties

3.3.1. **Drought Resilience:** Introduce drought-resistant tomato and sweet pepper varieties that maintain productivity during dry spells, crucial for maintaining yields in variable climate conditions.

3.3.2. **Disease Resistance:** Promote the use of cabbage and potato varieties that are resistant to prevalent diseases and pests in the region, such as clubroot in cabbages and blight in potatoes, reducing crop loss and chemical input needs**.**

Figure 5: Okra is a nutrient-rich crop that is resilient to high temperatures.
Photo: Fintrac Global Inc.

4. Integrated Pest Management

Integrated pest management (IPM) is a sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks.

4.1. Biological Control

4.1.1. **Beneficial Insects:** Utilize natural predators like ladybugs to control aphid populations in crops such as tomatoes and sweet peppers. Introduce parasitic wasps for controlling pest larvae in cabbage and leafy greens.

4.1.2. **Microbial Pesticides:** Employ fungi and bacteria to specifically target pest species without harming other insects or plants. For example, Bacillus thuringiensis (Bt) can be used against caterpillar pests in cabbages and other leafy vegetables.

4.2. Cultural Practices

4.2.1. **Crop Rotation:** Rotate crops to disrupt the life cycles of pests, reducing their buildup and the incidence of soil-borne diseases. For instance, rotating onions with non-related crops such as tomatoes can help manage onion thrips.

4.2.2. **Sanitation:** Remove plant debris and weeds that can harbor pests or disease agents. Regular cleaning of the field between crop cycles is essential to prevent the carryover of pests and diseases.

4.2.3. **Planting Timing:** Adjust planting times to avoid peak pest populations. For example, scheduling tomato planting to miss the high activity periods of whiteflies can significantly reduce infestation levels.

4.3. Physical and Mechanical Controls

4.3.1. **Barriers and Traps:** Use floating row covers to protect crops like cabbages and leafy greens from moths and butterflies. Employ sticky traps around tomato and pepper fields to monitor and reduce adult insect populations.

4.3.2. **Manual Removal:** Encourage the manual removal of pests where feasible, an effective method for small-scale farmers to manage localized pest outbreaks without chemical inputs.

4.4. Chemical Control (as a last resort)

4.4.1. **Targeted Pesticide Application:** Apply pesticides that are selective and less harmful to non-target organisms only when necessary and after monitoring indicates that pest levels exceed economic thresholds.

4.4.2. **Pesticide Rotation:** Rotate chemicals with different modes of action to prevent the development of pest resistance, extending the effectiveness of existing pesticides.

Figure 6: Pheromone traps can help trap fruit flies and other pests.
Photo: Fintrac Global Inc.

5. Capacity Building and Technology Transfer

Capacity building and technology transfer are pivotal to ensuring that Tanzanian horticultural farmers can adopt and sustain CSA practices effectively. These initiatives equip farmers with the knowledge, skills, and tools necessary to improve productivity, enhance resilience to climate variability, and reduce environmental impacts.

5.1. Training and Workshops

5.1.1. **CSA Practices:** Conduct regular training sessions and workshops for farmers on CSA principles such as efficient water use, soil health management, and integrated pest management tailored to specific crops like tomatoes, sweet peppers, and leafy greens.

5.1.2. **Hands-On Demonstrations:** Facilitate field demonstrations where farmers can see the practical application of new technologies and practices, such as the use of drip irrigation systems or the introduction of heat-tolerant crop varieties.

5.2. Extension Services

5.2.1. **Regular Field Visits:** Ensure that extension officers regularly visit farmers, offering on-site advice and support to troubleshoot issues and optimize the use of new technologies and practices.

5.2.2. **Feedback Mechanisms:** Establish channels through which farmers can provide feedback on their needs and the challenges they face, allowing for the adaptation and improvement of training programs and technologies.

5.3. Networking and Collaboration

5.3.1. **Farmer Cooperatives:** Support the formation and strengthening of farmer cooperatives or groups that facilitate the sharing of resources, knowledge, and experiences among members.

5.3.2. **Linkages with Research Institutions:** Foster partnerships between farmers and local agricultural research institutions to ensure that horticultural practices are informed by the latest scientific research and technological advancements.

CONCLUSION

As we advance, it is increasingly evident that integrating CSA into Tanzania's horticultural practices is not just a necessity but a strategic advantage. The Kilimo Tija Project has thoroughly outlined and implemented CSA practices that are specifically tailored to enhance the sustainability, productivity, and resilience of Tanzania's smallholder farmers.

Through sustainable water management, soil health improvement, crop diversification, integrated pest management, and robust capacity building and technology transfer, KTP has laid a solid foundation for a transformative climate-smart agricultural practice. These strategies collectively address the immediate and long-term challenges posed by climate variability, ensuring that Tanzanian farmers are not only able to survive but thrive in an ever-changing climate landscape.

The benefits of adopting these practices are many. They include improved crop yields and quality, enhanced resilience to environmental stressors, reduced dependency on chemical inputs, and the promotion of biodiversity. Moreover, the emphasis on capacity building ensures that Tanzanian farmers are well-equipped with the knowledge and tools necessary to adapt and innovate, fostering a culture of continuous improvement and sustainability.

The long-term success of these initiatives hinges on ongoing collaboration among farmers, government agencies, research institutions, and international partners. It is imperative that these stakeholders continue to support and invest in scaling up CSA practices, not only to meet the current demands of food security and economic stability, but also to prepare for future challenges.

In conclusion, the integration of climate-smart agriculture practices through the Kilimo Tija Project represents a critical step forward in securing the sustainability and profitability of Tanzania's horticultural sector. It is a model that promises not only to enhance agricultural output and efficiency, but also to safeguard the environment and improve the livelihoods of countless Tanzanian farmers.