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Analysis of pest management strategies among sweet potato farmers: Insights from a study in Homa Bay County, Kenya

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Abstract
This research investigated the pest management strategies among sweet potato farmers in Homa Bay County, Kenya. The study focused on how farmers managed the Sweet potato weevil (*Cylas puncticollis*.). Using a participatory rural appraisal methodology, the study involved 269 farmers through focus group discussions, transect walks, and pairwise ranking to identify and improve Integrated Pest Management strategies suitable for the specific context. The primary method identified was re-ridging during weeding. This method was used by 26.2% of the farmers in Rachuonyo and 15.3% in Ndhiwa Sub-counties. Re-ridging is a physical adjustment of the soil around the crops to bury the sweet potato weevil eggs and larvae. The main observation was that the use of re-ridging to combat pests was prevalent based on the simplicity and efficiency of the approach to matching the farmer's operational capabilities. It was observed that an average of 64.5% of the farmers in Ndhiwa did not adopt any control measure, highlighting a significant gap in knowledge and resource availability for pest management. Other less prevalent methods included early harvesting and the use of clean planting vines. The study recommends the strengthening of Agricultural Extension Services in the county to bridge the knowledge gap among the invincibly vulnerable farmers. The research identified that some farmers use innovative methods with a possible high potential for positive outcomes to address the pests. However, many farmers remain ignorant or lack access to critical measures due to various constraints. The study, therefore, recommends increased investment in research and engagement with community workers to educate farmers. Additionally, policy intervention is required to ensure effective use and resource availability to all farmers. This would ensure sustainable agricultural practices and promote food security combining the traditional processes with modernity.

Keywords: Sweet potato farming, pest management strategies, integrated pest management (IPM)

Introduction
The challenge of pest management in sweet potato cultivation is a crucial issue drawing global research attention. Studies spotlight the adaptability and resilience of pests like the sweet potato weevil, *Cylas puncticollis*., emphasizing the use of barrier plants as part of integrated pest management strategies to combat pests such as *Cylas formicarius* threatening sweet potato yields. Additionally, Gurr *et al*. (2016) [3] emphasize applying ecological and traditional practices in sweet potato production systems in Papua New Guinea's highlands, showcasing the importance of culturally specific pest management strategies.

In Africa, research delves into the complexities of pest management in agricultural ecosystems, emphasizing the need for sustainable solutions. Kwadha *et al*. (2021) [7] highlight the spread of the spotted wing drosophila, *Drosophila suzukii*, in Sub-Saharan Africa, prompting a reassessment of monitoring and management strategies. Concurrently, Concurrently, Chepchirchir's studies (Chepchirchir, F. 2023) [1] in Kenya and Uganda reveal the economic, health, and environmental burdens posed by pests like *Tuta absoluta* on tomato production, advocating for integrated pest management practices over reliance on chemical pesticides.

Skendžić *et al*. (2021) [10] stress the impact of climate change on agricultural insect pests in East Africa, calling for modified integrated pest management practices to address these evolving challenges. Furthermore, Khamis *et al*. (2021) [6] suggest that understanding genetic variations in whitefly pests in Kenya is essential for sustainable management and control

measures. In Homa Bay County, Kenya, sweet potato cultivation plays a vital role in the local agricultural sector and food security framework. However, this essential crop is under significant threat from pests like the sweet potato weevil (*Cylas puncticollis*). Research reveals that these pests cause substantial yield losses, both in the fields and during storage after harvest (Jaoko *et al*., 2021) [4]. Excessive use of pesticides in response to these issues has raised concerns about the well-being of agricultural workers (Marete *et al*., 2021) [8], highlighting the necessity for transitioning to sustainable pest control methods. Given the economic impact of pest infestations, it is crucial to develop effective and environmentally friendly pest management strategies (Rosmiza *et al*., 2021) [9]. This study aims to explore and assess various pest management approaches to address these challenges and promote sustainable agriculture in Homa Bay County. Building upon prior research findings, such as those by Karuri *et al*. (2016) [5] that underscored the impact of plant parasitic nematodes on yield losses, this research highlights a critical gap in our knowledge of comprehensive pest management in the region.

Research Objective

The study objective was to evaluate different pest management strategies used by sweet potato farmers in Homa Bay County, Kenya.

Significance of the Study

This research on pest management strategies among sweet potato farmers in Homa Bay County, Kenya, significantly enriches the existing body of knowledge in agricultural practices and integrated pest management (IPM). By investigating the effectiveness of various pest control methods in a specific socio-economic and ecological setting, the study offers vital insights that can be utilized to enhance crop productivity and sustainability in similar regions globally. The findings hold particular importance for local communities, policymakers, and educational institutions by providing evidence-based recommendations that can lead to increased agricultural output, improved food security, and reduced poverty. Additionally, this study contributes to academic curricula in agricultural sciences, offering a real-world example of how localized pest management strategies can be implemented effectively.

Scope and Limitation of the Study

The study was conducted to explore the management strategies for a pest used by sweet potato farmers in Rachuonyo and Ndhiwa sub-counties of Homa Bay County, Kenya. The research was based on the farmers' activities performed between 2019 and 2020 related to the common weevil *Cylas puncticollis* to ensure a more holistic understanding of agricultural processes and management. Therefore, the project was planned to take into account a broad range of aspects, yet, it was local, and such technological and economic factors were excluded from consideration. To reduce potential bias and improve the research's significance, Participatory Rural Appraisal was used to ensure proper contact with farmers and obtain informative data reflecting their practices. As one might notice, the outcomes' presentation was conducted thoroughly, taking into account potential fallacies and involving an expanded range of aspects. As a result, the research methodology, including both the data collection techniques, considerably favored the study of a unique area such as Homa Bay.

Statement of Problem

The prevailing problem was the vulnerability of sweet potato crops to pest infestations, which if not checked affects the livelihoods of local farmers. Globally, sweet potato crops endure significant yield and quality impairments due to pests, with the sweet potato weevil, *Cylas puncticollis*, identified as causing extensive damage in various production regions (Khamis *et al*., 2021) [6]. The issue of managing these pests effectively is a common challenge, particularly highlighted in regions with limited resources and access to sustainable pest management solutions.

Focusing on East Africa, and specifically Homa Bay County, the study found that changes in climate conditions potentially increase pest populations and their impact on sweet potato yields (Skendžić *et al*., 2021) [10]. Furthermore, the prevalent use of chemical pesticides among farmers in the area posed not only health risks (Marete *et al*., 2021) [8] but also raised concerns about environmental hazards.

The study's findings indicated that the most affected demographic were smallholder farmers who relied on sweet potato cultivation as a pillar of their food security and income. The study addressed the need to explore and potentially redefine pest management strategies. By examining the methods employed by the sweet potato farmers in Homa Bay County, the study is expected to contribute to ways of improving both the productivity and sustainability of agricultural practices, thus supporting the broader goals of community development and food security.

Methodology

Study area

Homa Bay County, Kenya, specifically Rachuonyo and Ndhiwa sub-counties, was visited during the research. This study area was chosen because it has a high proportion of sweet potato farming. The county has diverse agro-ecological zones characterized by different altitudes and soil types which inform the farming practices and pest management needs.

Research design

A Participatory Rural Appraisal approach comprising farmers' knowledge and perceptions through focus group discussions, transect walks, and pairwise ranking guided the research. The research design was descriptive and participatory, with research oriented toward guiding the development of contextual pest management strategies for resource-poor farmers.

Target population, sample size, and sampling techniques

The target population for the study was sweet potato farmers in the Homa Bay County area, and a total of 269 respondents were selected. According to standard estimates, various sampling techniques were used to calculate the sample size, taking into account the known number of sweet potato farmers. Purposive sampling was carried out with specific targets on only those farmers with more than five years of experience farming sweet potatoes based on informed agricultural extension officers.

Data collection methods

Data was collected using a semi-structured questionnaire that was administered to collect information from the targeted respondents. Various colored photographs showing various pests and pest damage on sweet potatoes facilitated proper pest identification. The focus group discussions were guided by the local extension officers, which yielded further insights into the perspectives of farmers on pest management strategies, associated constraints, and opportunities or gaps for upscaling the management strategies.

Results and Discussion

The section elaborates on the findings attained from the evaluation of production constraints and the effectiveness of pest control methods applied by local farmers in Homa Bay County, Kenya. The central purpose of the research was to examine the perception and management of farmers concerning the sweet potato weevil, and the threat to crop productivity.

Participant Demographics

A total of 269 sweet potato producers from Rachuonyo sub-county and Ndhiwa sub-county were involved in the study. The vast majority of the participants were women, making up 70.3%, and many of them received primary education, which is essential for the successful application of pest control.

Analysis of Pest Management Strategies

The extensive analysis of the pest control practices utilized by farmers in Homa Bay County, Kenya, demonstrates a dynamic where traditional strategies continue to dominate, along with varying levels of awareness and usage. The data presented in Table 1 not only portray dominating strategies but also showcase the gaps in the adoption rates between various approaches and regions.

Table 1: Control methods for *Cylas puncticollis* on sweet potato crop by farmers

S/N	Control Method(s) as practised by respondents	Counts of respondents			Percentage of respondents					
					Within the sub-County			Within the two sub-Counties		
		SB1 (m)	SB2 (n)	∑ SB1 + SB2 (p)	SB1 (u)	SB2 (v)	∑ SB1 + SB2 (w)	SB1 (x)	SB2 (y)	∑ SB1 + SB2 (z)
					u=m/145 * 100	v =n/124 * 100	w=p/269 * 100	x =m/p * 100	y =n/p * 100	z =p/p * 100
1	Not applicable (Don't control the weevils)	16	80	96	11.0	64.5	35.7	16.7	83.3	100
2	Early harvesting	21	8	29	14.5	6.5	10.8	72.4	27.6	100
3	Earthing up of the ridges during weeding (re-ridging)	38	19	57	26.2	15.3	21.2	66.7	33.3	100
4	Planting during rainy season (Early planting)	18	1	19	12.4	0.8	7.1	94.7	5.3	100
5	Use of Pesticides	3	1	4	2.1	0.8	1.5	75.0	25.0	100
6	Removal of exposed roots from the ground	16	0	16	11.0	0.0	5.9	100	0.0	100
7	Disposal of infested roots during harvesting	17	15	32	11.7	12.1	11.9	53.1	46.9	100
8	Planting on ridges	28	0	28	19.3	0.0	10.4	100	0.0	100
9	Use of clean planting vines	22	0	22	15.2	0.0	8.2	100	0.0	100
10	Planting in fields that are situated far away from old sweet potato fields	6	0	6	4.1	0.0	2.2	100	0.0	100
11	Field sanitation	3	0	3	2.1	0.0	1.1	100	0.0	100
12	Practice crop rotation	4	0	4	2.8	0.0	1.5	100	0.0	100
13	Covering exposed roots with soil	34	0	34	23.4	0.0	12.6	100	0.0	100
14	Intercropping sweet potato with other crops (cowpea or maize)	1	0	1	0.7	0.0	0.4	100	0.0	100
15	Farmer minimizes moving in the field once the crop is ready for harvest	29	0	29	20.0	0.0	10.8	100	0.0	100
16	Crop rogueing	0	9	9	0.0	7.3	3.3	0.0	100	100
17	Use of wood ash	0	1	1	0.0	0.8	0.4	0.0	100	100

Key: SB1 means Rachuonyo sub-County
SB2 means Ndhiwa sub-County

Re-ridging remains the most practised control method, being reported by 26.2% of farmers in Rachuonyo and 15.3% in Ndhiwa. The method consists of physically adjusting the soil around crops, which buries the potential eggs and larvae, stopping them from transforming into an adult that can cause crop destruction. The unique popularity of the mentioned method is believed to be driven by the combination of two factors. First, the method can be labelled among easy and efficient means. Secondly, it is

especially beneficial for small-scale farmers, which is relevant for both studied regions. Thus, the high indication of the method is characterized by a cultural approach to the inclusion of shown control into crop care routines.

At the same time, the reported 64.5% of Ndhiwa farmers who do not use any control methods is a concern. No implementation can stem from various reasons, including lack of knowledge, lack of resources, and economic barriers to investing in controlling practices. Thus, the high indicator once again pointed to the weakness of the extension services, which indicates the room for intervention regarding information provision and equipping farmers with appropriate tools and knowledge to control pests like *Cylas puncticollis*.

Two other identified practices were early harvesting and the use of clean planting materials. Although they were less practised than re-ridging, 10.8% and 8.2% of farmers, respectively, across the two sub-counties still implemented these practices as part of the full set of IPM measures reported. The general idea is also to avoid the peak weevil window through early harvesting. The method with clean materials also aims to avoid weevil entry and distribution. However, two other control measures revealed farmers' awareness and the trend of diversified IPM use.

Table 1 analysis of the listed pest control practices provides the final information on the existing gap and challenges concerning the issue. Some farmers are increasingly using alternative and potent practices to fight *Cylas puncticollis*, while others are either unaware or unable to access them due to various reasons. The gap demonstrates the opportunity for farmer-oriented extension aiming to bridge the knowledge gap and provide the required knowledge and tools to fight pests effectively.

The immediate IPM implication is the necessity of an integrated approach to the problem. The integrated supplement to this approach should also include modern biological and chemical strategies to support farmers in promoting resilience to pests. The policy implication is in the existence of revealed barriers to such implementation, which should be addressed. The findings are in line with Tipu *et al*.'s (2021) [11] recommendation on the centrality of the solution diversity and complexity for efficient sweet potato weevil combating.

Importance of Research Findings

Another level of significance in the evidence presented is the significantly high reliance on re-ridging and other traditional management methods. This may indicate a gap in the available modern pest management methods accessible to farmers. It explains that a reasonable percentage of farmers still lack the necessary resources, knowledge, or access to solutions that are possible for smallholders.

Implications for Pest Control

Others' responses and options cited in Table 1 exhibit the multi-dimensionality of pest management in Kenyan smallholders' farming systems. It shows that although some farmers are innovating their management methods, a large percentage lacks awareness or the ability to bridge the information gap due to a lack of resources.

Conclusion

The analysis included herein presents compelling evidence of the challenges and coping strategies of fighting the pervasive threats of the sweet potato weevil (*Cylas puncticollis*) amongst sweet potato farmers in Homa Bay County, Kenya. It argues that *Cylas puncticollis* is the key pest of the farmers based on its high incidence and correlation to significant yield losses. The findings indicate that more than 80% of the community has for instance identified and is using partially resistant sweet potato varieties but differ significantly in management practices otherwise. Some farmers are using cultural practices such as many re-ridging, and early planting, and others are using minimal amounts of pesticides. Many have turned to numerous unverified traditional methods, showing the urgent need for extension services to translate sustainable, researched technologies into affordable and accessible practices for smallholders. By relating to the continuous reliance of certain communities on unverified management systems, the evidence echoes the meaning of sustainable assessments. The mixed methods of evidence firm in this section imply that an integrated pest management system is necessary.

Recommendations

Based on the findings of this research, the study makes the following recommendations to improve pest management practices in Homa Bay County: Based:

1. Extend the extension services to enable farmers to adequately build their knowledge on integrated pest management (IPM) techniques. The emphasis is on teaching farmers to reliably address this pest issue through an innovative integration of all cultural, biological, and chemical tools.
2. Make research on and conserve varieties of the right species of sweet potatoes having resistance to *Cylas puncticollis*. Promote breeding systems that develop pest resistance and improve yield and nutrients in parallel.
3. Conduct certified programs and informative field work to make more individuals understand the merits of Integrated Pest Management techniques. The focus is to move away from mono applications of pest control techniques which often fail and replace them with a multi-pest control approach designed to reduce pest counts.
4. Campaign for the policy changes that support such sustainable agriculture practices as the introduction of subsidies for bioinsecticides and also offering awards to the farmers for the adoption of IPM systems which will minimize pest impact in a sustainable manner.

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