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Sweet Potato Leaf Spot Diseases and Farmer's Indigenous Knowledge in Parts of Western Kenya

Adera A. Norah[1*], Onyango O. Benson[2], Nyunja Regina[3], Ogolla O. Fredrick[4]

[1,2,3]*Jaramogi Oginga Odinga University of Science and Technology (JOOUST), Bondo, Department of Biological Sciences*

[4]*Chuka University, Department of Biological Sciences, Chuka, Kenya*

Corresponding Authors:** ***Adera A. Norah, *Jaramogi Oginga Odinga University of Science and Technology (JOOUST), Bondo, Department of Biological Sciences*

Abstract: *Sweet potato (Ipomoea batatas L.) is a starchy, tuberous root with worldwide consumption. Production of sweet potatoes in Kenya is low due to disease constraints, such as fungal sweet potato leaf spot (SPLS), which is not well studied in the region. The infection results in reduced photosynthetic leaf area through premature defoliation and senescence. Effective management of SPLS presents an opportunity for increased production, improved food security and enhanced income. Farmers' indigenous knowledge on plant disease control can provide a framework to refine current integrated management practices. This study evaluated SPLS occurrence, and assessed farmer's indigenous knowledge. A multi-stage sampling technique was used to identify sampling plots and disease incidence and severity evaluated using quadrats. Disease incidence significantly ($p < 0.05$) ranged from 11% to 30.38% at Kakelo and Kamollo villages respectively, while severity was significantly ($p < 0.05$) highest at Kokwanyo (28.37%) and lowest at Rapogi (15.27%). Most farmers (90.91%) reported SPLS-like symptoms on their farms, although more females were able to differentiate between the diseases. Farmers' education on sweet potato diseases such as SPLS is recommended to enhance disease management and boost yield.*

Keywords: *Sweet Potato Leaf Spot, Western Kenya*

1. INTRODUCTION

Sweet potato (*Ipomoea batatas L.*) is a starchy tuber enriched with fibers, proteins, vitamins (A and C) and amino acids such as methionine and cysteine [1] [2]. China is the world's largest producer and consumer of sweet potatoes with over 517,900,000 tons in 2019 [3]. In Africa, sweet potato production is under exploited and regarded as a poor man's food, grown mainly under marginal conditions [4]. In East Africa, Uganda with 1.75 million metric tons and Ethiopia with 1.76 million metric tons are top producers while Kenya produces about 0.8 million metric tons [3]. Kenya has the potential to produce up to 38 tons/ha with average yield ranges of 20-50 tons/ha [5]. However, sweet potato production in Kenya is below 10 tons/ha due to several constraints, including pests and diseases [6] [7]. Diseases and pests contribute to 75 percent of sweet potato yield losses [8], while diseases alone contribute 11.9% loss [9]. Low sweet potato production is exacerbated by scarcity of improved varieties and disease-free planting materials [6] [9].

In western Kenya, sweet potato is cultivated by small scale farmers in Busia, Kakamega, Siaya, Kisumu, Homa Bay, Nyamira, Kisii and Migori counties [6]. Little work has been done to evaluate SPLS occurrence in the region. Studies on disease incidence is necessary for adequate disease management, improved yield and enhanced earning to farmers. Further, studies may provide knowledge on the extent of disease spread. The infection was reported in China and Nigeria [10] [11] [12]. Investigations of sweet potato diseases in Kenya have been skewed towards viral infections [13] [14] [15] [16] and *Alternaria* blight [17] [18]. Yet SPLS infection has a devastating effect on sweet potato yield. Symptoms include irregular or circular brown lesions on the margin or center of lower leaves and sometimes upper leaves [10]. The spots enlarge gradually and join together to form grey, brown necrotic lesions with yellowish halos. Diseased leaves eventually become senesced and drop off [19].

Sweet potato farmers in western Kenya counties of Kisumu and Homabay utilize traditional farming technologies [20]. Modernization of agriculture may result in increased yields, however, it rarely

incorporates farmers' indigenous knowledge. Understanding the local farmer's indigenous knowledge on sweet potato leaf spot disease is critical, as a channel for infusion of modern techniques of integrated disease control [21] [22]. Determination of farmers' perception of plant diseases, the level of yield damage and effectiveness of locally practiced control methods, may offer long term disease management solutions [23]. However, there is knowledge gap on the strategies used by farmers in western Kenya to manage SPLS.

2. MATERIALS AND METHODS

2.1 Study Area

A survey of sweet potato farms for SPLS occurrence was conducted in Homa bay and Kisumu counties in Western Kenya. Homa bay County covers an area of 4,267.1 Km^2 and is located in South western Kenya along Lake Victoria shoreline (Fig 1). The county borders Kisumu and Siaya counties to the north, Kisii and Nyamira counties to the east and Migori County to the south.

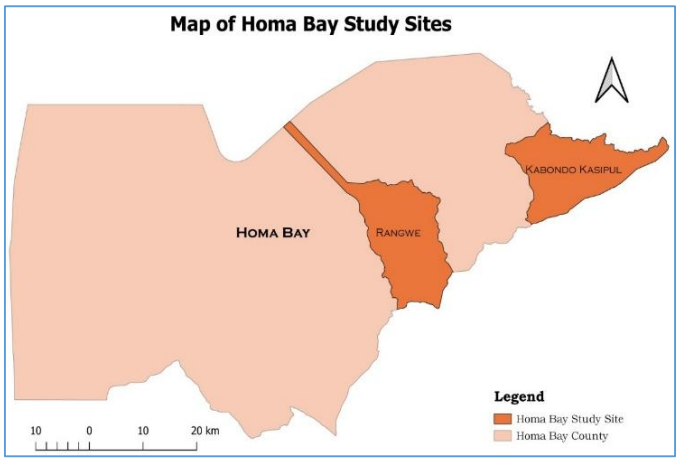

Figure1. *A map showing Rangwe and Kabondo-Kasipul sub-counties in Homa-bay County*

The County is divided into two agro-ecological zones: Upper and Lower Midlands. The study was specifically carried out in Kabondo-Kasipul and Rangwe Sub -counties. In Rangwe sub-county, the farms surveyed were at Kamollo, Nyakwadha, Nyawita, Asumbi, Kabor and Gem villages while in Kasipul- Kabondo, the farms surveyed were at Kakelo, Kojwach, Kokwanyo, Oriang -1, Kakngutu and Kakumu.

Kisumu County covers an area of 2085.9 Km^2. It neighbors Siaya County to the West, Vihiga to the North, Nandi County to the North East, Kericho County to the East, Nyamira County to the South and Homa Bay County to the South West. The county has a shoreline on Lake Victoria occupying northern, western and a part of the southern shores of the Winam Gulf. It has 7 sub counties but Kisumu East sub-county was selected as study site due to active cultivation of sweet potatoes in East and West Kajulu. The farms were at Ongadi, Obwolo, Wathorego, Oriang-2, Okok and Rapogi.

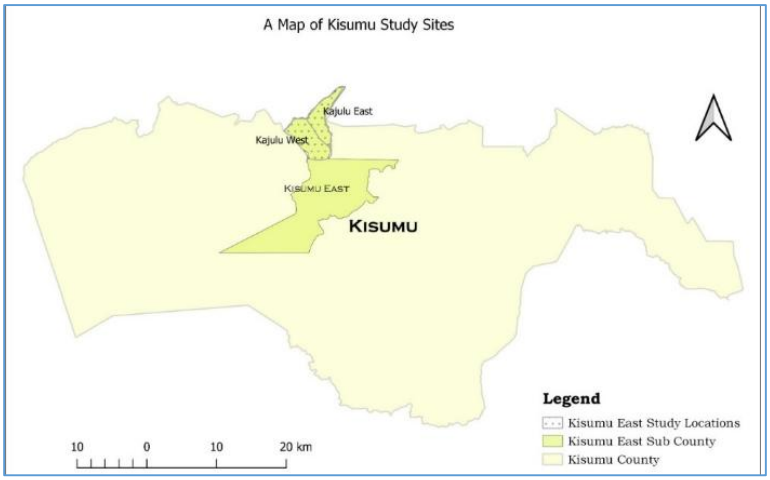

Figure2. *A map of sampling points in Kisumu East sub-county: East Kajulu and West Kajulu*

2.2 Determination of Incidence and Severity of Sweet Potato Leaf Spot

Assessment of incidence and severity of SPLS disease was conducted in farmers' fields with habitable space of diseased plants according to Sseruwagi *et al*. [24]. A multi-stage sampling technique was used to select representative villages and the farms were identified purposively based on acreage of sweet potato crop. A 4×4 m micro plot was established at each farm, along diagonal transects at equidistance of 5 m. A quadrat measuring 1 m × 1 m was randomly thrown, and disease incidence assessed diagonally by counting the number of leaves with spots, against the total number of leaves within the quadrat. The number of diseased leaves was expressed as a percentage of the total number of leaves sampled according to Mahantesh *et al.* [25] as:

$$\% \text{ Disease incidence} = \frac{\text{Number of infected potatoes}}{\text{Total no. of potatoes assessed}} x100$$

Disease severity assessment was done by visual estimation of percentage leaf area with spot on 20 randomly selected plants per quadrat using a scale of 1 – 5 (CIP, 2017)

Table1. *Disease rating scores used in severity test*

Disease Rating	% of leaf area with spot	Intensity of symptoms
1	0	Free from disease
2	15	Slight symptoms
3	16-30	Moderate symptoms
4	31- 45	Slightly severe Symptoms
5	> 50	Severe Symptoms

The percent severity index was calculated as:

$$\text{Percent Disease Severity} = \frac{\text{Number of individual ratings}}{\text{Total number of leaves assessed}} x \frac{100}{\text{Maximum scale}}$$

2.3 Survey on Farmers' Knowledge of Sweet Potato Leaf Spot Disease

A survey was conducted by administering a structured questionnaire to sweet potato farmers in Rangwe, Kabondo-Kasipul and Kisumu-East sub counties. The questionnaire was used to interview 22 farmers per Sub County that totalled to 66 farmers based on history of sweet potato cultivation. A face-to-face interview combined with farm observations was done from May to August, 2020. Each interview lasted for about 30 minutes. Information obtained included age of crop, variety grown, tolerance/susceptibility to fungal diseases, source of vines, use of fertilizers, planting methods used, ability to differentiate diseases, most infected stage of growth, disease history and its effect on production. A pilot study was conducted in 10 farms in Kisumu East Sub County not included in the sample, a month before actual study. Minor adjustments were made on the questionnaire to enhance clarity.

2.4 Data Analysis

Percentage disease incidence and severity data was analysed using General Linear Model ($p < 0.05$) and significant means separated using least significant difference in Scientific Analysis System (SAS) version 9.4. Data on farmer perception of SPLS occurrence was analyzed using the Chi-Square (χ^2) test of association on SAS version 9.4.

3. Results and Discussion

3.1 Incidence of Sweet Potato Leaf Spot Disease

Disease incidence significantly varied ($p < 0.05$) between the 18 villages surveyed (Table 2). The highest incidence (30.38%) was observed in Kamollo, while lowest incidence of 11% was observed at Kakelo village. Rangwe sub-county had significantly ($p < 0.05$) the highest percentage incidence of 21.35%, followed by Kisumu East sub-county at 16.9% while lowest incidence of 12.45% was observed in Kabondo- Kasipul sub-county (Fig 3). Farms within the 18 villages surveyed showed significant variation ($p < 0.05$) in SPLS severity. A severity index of 28.37% was observed at Kokwanyo village in Kabondo - Kasipul sub-county, which was significantly higher, compared to 15.27% observed in Rapogi village within Kisumu East sub-county (Table 2). Kabondo-Kasipul and Kisumu East sub-counties reported significant variation ($p < 0.05$) in severity of SPLS with values of 23.96% and 21.49% respectively (Fig. 3). However, the disease severity in Rangwe sub-county was not significantly

different ($p > 0.05$) from Kasipul Kabondo and Kisumu East sub-counties. Variation in incidence and severity of SPLS infection in the three sub counties is partly attributed to climatic and soil conditions which could have affected disease development. Cool humid weather conditions have been reported to favor leaf spot development and foliar destruction [26] [11]. Disease development could further have been affected by plant defense mechanisms, which differ by species and environmental patterns [27]. Disease incidence may have also been influenced by the specific sweet potato variety cultivated [28]. Pathogen factors such as virulence, dispersal rate, and farm practices such as sources of sweet potato vine and variety planted also influenced disease incidence and severity [29] [30], factors attributed to the variation in SPLS incidence and severity in the study area. The SPLS disease reduces yield due to effect on plant physiology. Plants' photosynthesis capacity and translocation of sugars as well as water and minerals may be hampered drastically due to killing of leaf areas [31] [11]. Infected plants experience impaired physiological activities such as increased respiration rates and reduced photosynthesis that lead to yield losses [32] [33].

Table2. *Incidence and severity of sweet potato leaf spot in villages in Rangwe, Kisumu East and Kabondo – Kasipul Sub Counties*

Village	Sub-county	Incidence (%)	Severity (%)
Kamollo	Rangwe	30.38^{a}	22.10^{c}
Gem	Rangwe	26.64^{ab}	22.75^{bc}
Nyakwadha	Rangwe	22.08^{bc}	22.93^{bc}
Wathorego	Kisumu-East	21.59^{bcd}	23.02^{bc}
Nyawita	Rangwe	20.49^{cb}	20.49^{b}
Okok	Kisumu-East	18.82^{ecd}	23.94^{b}
Kabor	Rangwe	18.77^{ecd}	22.13^{c}
Oriang_2	Kisumu East	17.43^{edf}	22.66^{bc}
Asumbi	Rangwe	15.38^{efg}	23.67^{bc}
Kakngutu	Kabondo-Kasipul	15.22^{efg}	18.12^{d}
Ongadi	Kisumu-East	14.63^{fgh}	17.42^{d}
Obwolo	Kisumu- East	14.22^{fgh}	23.51^{bc}
Rapogi	Kisumu-East	12.97^{ghi}	15.27^{e}
Kokwanyo	Kabondo-Kasipul	12.81^{ghi}	28.37^{a}
Oriang_1	Kisumu East	12.10^{hi}	23.17^{bc}
Kakumu	Kabondo-Kasipul	11.96^{hi}	22.99^{bc}
Kojwach	Kabondo-Kasipul	11.73^{hi}	26.62^{a}
Kakelo	Kabondo-Kasipul	11.00^{i}	23.99^{b}
Mean		16.45	22.794
LSD ($p<0.05$)		1.248	1.766
CV (%)		20.261	20.02

[a]Means followed by the same letters are not significantly different ($p<0.05$).

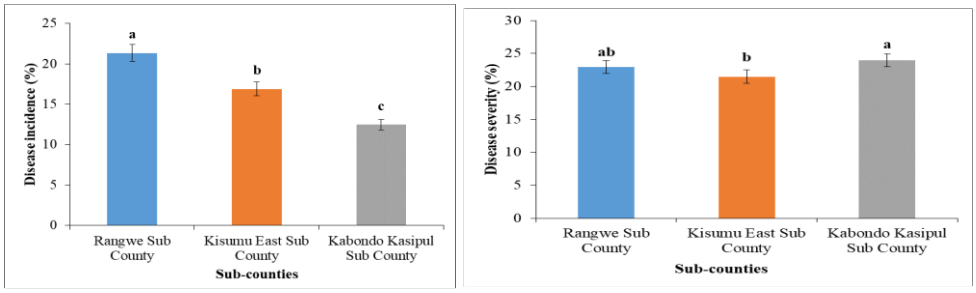

Figure2. *Sweet potato leaf spot incidences and severity in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

3.3 Farmers indigenous Knowledge and Practices

3.3.1 Sweet Potato Varieties Grown

Varieties cultivated was significantly ($p < 0.05$) different and associated with gender in Kabondo-Kasipul ($X^2 = 4.774$, $p = 0.0248$) and Kisumu East sub-counties ($X^2 = 8.294$, $p = 0.004$; Table 4). Most farmers grew Odinga variety, which is a local landrace with high tuber yields. It is preferred for

consumption due to its high dry matter content and good taste (Table 4). Variety SPK004 was also cultivated in the study area, since it is rich in beta-carotene thus improved nutritional status of the consumers [34]. Averagely, 50% of female farmers in Kabondo-Kasipul planted Odinga variety while 4.55% planted variety SPK004. Equal number of males and females (22.73%) planted both Odinga and SPK004 varieties. In Kisumu East sub-county, 86.36% of the farmers grew Odinga variety, while only 13.37% grew SPK004 variety. Data on sweet potato variety grown agrees with studies by Bashaasha *et al.* [35] and Sindi and Wambugu [36] that some varieties are preferred by the farmers. Varietal preference may be attributed to high yields, rooting quality, better growth in different types of soil and sweet potato nutrition value and taste [37] [38] [39] [40]. This implies that variety grown in an area is mainly influenced by preference of consumers and farmers.

Table3. *Variety of sweet potato grown during the study in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

Factor	Sub-county	Farmer response	Sex of respondents			*Chi* Square	*p* value
			Male (%)	Female (%)	Total %		
Variety of sweet potato grown during study.	Rangwe	SPK004	18.18	63.64	81.82	1.2731	.2592
		Odinga	9.09	9.09	18.18		
	Kabondo-Kasipul	SPK004	22.73	4.55	27.27	4.7743	.0248
		Odinga	22.73	50.0	72.73		
	Kisumu East	SPK004	4.55	8.82	13.37	8.294	.004
		Odinga	9.09	77.27	86.36		

3.3.2 Source of Sweet Potato Vines for Planting

Source of sweet potato planting material in all the sub counties was not significantly ($p > 0.05$) associated with gender (**Table 5**). Majority of farmers obtained planting vines from the last season's crop, with Rangwe and Kabondo-Kasipul scoring 100% and Kisumu East 88.89% (**Table 5**). This agrees with the findings of Sseruwu *et al*. [41] and Aldow [42] that farmers prefer to obtain planting materials from last season crops. Out of 37.88% of the farmers, 25.76% reported occurrence of diseases, compared to 12.12% who did not report occurrence of sweet potato fungal leaf spot. This implies that the major source of SPLS transmission in the study area is recycling of sweet potato vines among farmers. Recycling of poor seed material facilitates diseases transmission and spread among farmers' lands [43].

Table4: *Sources of sweet potato planting vines used by farmers in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

Factor	Farmer response	Sub-county	Response	Sex of respondents			*Chi* Square	*p* value
				Male (%)	Female (%)	Total %		
Where obtained the last sweet potato vine?	Friends	Rangwe	Yes	33.33	50.00	83.33	1.20	.273
			No	16.67	0.00	16.67		
		Kabondo-Kasipul	Yes	16.67	66.67	83.33	0.24	.624
			No	0.00	16.67	16.67		
		Kisumu East	Yes	0.00	50.00	50.00	3.00	.083
			No	33.33	16.67	50.00		
	Last season	Rangwe	Yes	16.67	83.33	100.00	1.20	.094
			No	0.00	0.00	0.00		
		Kabondo-Kasipul	Yes	60	40.00	100.00	0.84	.63
			No	0.00	0.00	0.00		
		Kisumu East	Yes	0	88.89	88.89	0.92	.071
			No	11.11	0	11.11		
	Friends and last season	Rangwe	Yes	10	60	70	0.476	.490
			No	10	20	30		
		Kabondo-Kasipul	Yes	50	33.33	83.33	1.2	.273
			No	0	16.67	16.67		
		Kisumu East	Yes	0	14.29	14.29	0.194	.659
			No	16.67	83.33	85.71		

3.3.3 Sweet Potato Farming System

The system of farming (subsistence or commercial) was significantly ($p < 0.05$) associated with gender in Kabondo-Kasipul sub-county ($X^2 = 10.476$, $p = 0.0017$) where 63.64% of farmers grew sweet potatoes for commercial purposes (Table 6). This agrees with Ezin *et al.* [44] that sweet potato is grown mainly for the fresh market, since tubers are sold in the surrounding markets for income. Most male farmers (45.45%) planted sweet potatoes for commercial purposes, while the females (36.36%) grew the crop for subsistence. A higher commercial value of the crop amongst the males may be attributed to higher responsibilities and increased market demands, resulting in more marketability. According to Low [45], the increasing role of sweet potato as a cash crop attracts participation of males in its production. Additionally, a lower commercial farming by women may generally be attributed to land ownership, since women own less land of lower agricultural quality. Bach and Andersen [46], reported that women in Africa only own one per cent of the land and they have to contend with limited access to financial and technical resources.

Table5. *Farming systems practiced by sweet potato farmers in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

Factor	Sub-county	Farmer response	Sex of respondents			*Chi* Square	*p* value
			Male (%)	Female (%)	Total (%)		
Scale of farming practiced by farmer	Rangwe	Subsistence	18.18	54.55	72.73	0.153	.6958
		Commercial	9.09	18.18	27.27		
	Kabondo-Kasipul	Subsistence	0.00	36.36	36.36	10.476	.0017
		Commercial	45.45	18.18	63.64		
	Kisumu East	Subsistence	4.55	77.27	81.82	5.4893	.0727
		Commercial	9.09	9.09	18.18		

3.3.4 Sweet Potato Planting Method

The planting method used by farmers was significantly ($p < 0.05$) associated with gender in Kabondo-Kasipul sub-county ($X^2 = 4.455$, $p = 0.0348$) where 54.55% of farmers used ridges to plant the sweet potatoes while 45.45% used mounds. Most males (18.18%) used mounds while most females (31.82%) planted using ridges (Table 7). In Rangwe, and Kisumu east majority of the farmers used mounds as compared to use of ridges. The findings agree with earlier reports that both mounds and ridges are used to plant sweet potatoes in the region [47]. According to Dhliwayo and Chiunzi [48], farmers believe that use of ridges increases sweet potato yields. Preference of planting method may be attributed to terrain or flood issues. According to Gomes [48], ridges may be helpful in farms prone to water logging.

Table6. *Planting method used to cultivate sweet potatoes in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

Factor	Sub-county	Farmer response	Sex of respondents			*Chi* Square	*p* value
			Male (%)	Female (%)	Total %		
Planting method used	Rangwe	Ridge	4.55	18.18	22.73	0.1725	.6779
		Mound	22.73	54.55	77.27		
	Kabondo-Kasipul	Ridge	13.64	31.82	54.55	4.455	0.0348
		Mound	18.18	22.73	45.45		
	Kisumu East	Ridge	4.55	22.73	27.27	0.0643	.7998
		Mound	9.09	63.64	72.73		

3.3.5 Fertilizer Use in Sweet Potato Production

The use of fertilizers in sweet potato farming was significantly ($p < 0.05$) associated with gender in Kabondo-Kasipul sub county ($X^2 = 1.691$, $p = .01935$) where more females (18.18%) used fertilizers than males (4.55%). Only 27.73% of farmers used fertilizers in sweet potato production (**Table 8**). Most farmers did not use fertilizers in the region but they reported use of manure. However, soil nutrition changes caused by appropriate fertilization leads to an overall improvement in crop productivity since continuous cultivation depletes soil organic matter hence the need for fertilization during sweet potato production [49]. Growth and yield of sweet potato is affected by plant population and nutrient supply, and low yields could be attributed to poor soil nutrients. Organic and inorganic fertilizers are thus used

to improve the yield and growth rate of sweet potato. Dapaah *et al.* [50] reported that application of nitrogen, phosphorus and potassium fertilizers influenced growth and yield of sweet potato. Potassium and nitrogen promote high yields since Potassium increases water uptake, efficient use of nitrogen, translocation of assimilates, photosynthesis, drought and disease resistance. Potassium also enhances sweet potato tuber taste, shape, size, colour and texture [51].

Table7. *Use of fertilizers by sweet potato farmers in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

Factor	Sub-county	Farmer response	Sex of respondents			*Chi* Square	*p* value
			Male (%)	Female (%)	Total %		
Do you use fertilizer for growing potatoes?	Rangwe	Yes	0	27	27	3.0938	.60786
		No	27.27	45.45	72.73		
	Kabondo-Kasipul	Yes	4.55	18.18	27.73	1.691	.01935
		No	40.91	36.36	77.27		
	Kisumu East	Yes	0	13.64	13.64	0.5485	.4589
		No	13.64	72.73	86.36		

3.3.6 Frequency of Growing Sweet Potatoes

Production of sweet potatoes continuously in the same farm was not significantly associated with gender in the sub counties ($p > 0.05$; Table 9). However, more females grew sweet potatoes continuously than males, with the highest females at 50% in Kisumu East sub-county (Table 9). Continuous cultivation of sweet potato in the same farm may be attributed to the fact that it is a food security, drought and pest tolerant crop that can be produced all year round. Thus, sweet potato ensures continuous food supply where other crops are faced with risk of failing [52].

Table8. *Frequency of growing sweet potato continuously in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

Factor	Sub-county	Farmer response	Sex of respondents			*Chi* Square	*p* value
			Male (%)	Female (%)	Total %		
Do you grow sweet potatoes continuously?	Rangwe	Yes	9.09	40.91	50.00	0.6351	.3384
		No	18.18	31.82	50.00		
	Kabondo-Kasipul	Yes	13.64	36.36	50.00	2.9333	.868
		No	31.82	18.18	50.00		
	Kisumu East	Yes	4.55	50.0	54.55	0.6304	.4272
		No	9.09	36.36	45.45		

3.3.7 Sweet Potato Leaf Spot Disease Occurrence

The relationship between SPLS occurrence and region surveyed was not significant ($p>0.05$). However, in Kabondo-Kasipul sub-county 30% of respondents reported occurrence of SPLS compared to 3% who did not report disease cases. These findings are supported by those of Sseruwu *et al.* [41] who reported variation of farmers response on occurrence of SPLS in different areas. Factors such are varied environmental factors and farming practices may be atributed to these differences. The SPLS disease occurrence was not significantly ($p > 0.05$) associated with the sub counties (Table 10). However, in Kabondo-Kasipul and Rangwe sub counties farmers reported presence of diseases in their sweet potato farms at 90.91% and 81.82% respectively. Low disease occurrence of 22.73% was reported in Kisumu-East sub-county. Most females reported disease occurrence in Rangwe sub-county at 63.64% while the male farmers in Kisumu-East sub-county reported no disease occurrence. Equal number of male and female farmers (45.45%) in Kabondo-Kasipul sub-county reported disease occurrence.

Table9. *SPLS disease occurrence in sweet potato farms in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

Factor	Sub-county	Farmer response	Sex of respondents			*Chi* Square	*p* value
			Male (%)	Female (%)	Total %		
Have you experienced	Rangwe	Yes	18.18	63.64	81.82	1.2731	0.2592
		No	9.09	9.09	18.18		
		Yes	45.45	45.45	90.91	1.8333	0.1757

SPLS disease in your farm?	Kabondo-Kasipul	No	0.00	9.00	9.09		
	Kisumu East	Yes	0.00	22.73	22.73	1.0217	0.3121
		No	13.62	63.64	77.27		

3.3.8 Identification of Diseases

Ability to differentiate between diseases in the farms was insignificant in the three sub counties ($p>0.05$). However, sweet potato farmers in Kabondo-Kasipul and Kisumu-East sub counties were able to differentiate the diseases in their farms at 90.91% each, while 72.73% of sweet potato farmers in Rangwe sub-county were not able to differentiate the sweet potato diseases on their farms (Table 11). Most female farmers in Kisumu-East sub county were able to differentiate the sweet potato diseases at (77.27%) as compared to females in Kabondo-Kasipul at 45.45%, while in Rangwe 54.55% of female farmers reported inability to differentiate sweet potato diseases occurring in their farms. In overall, female farmers were able to differentiate the sweet potato diseases except in Kabondo-Kasipul where 40.91% of male farmers were able to differentiate the sweet potato diseases. These findings agrees with those of Echodu *et al.* [9] which observed that farmers were able to recognize disease signs and symptoms in sweet potatoes though most of them could not tell the causative agent correctly. We observed that higher percentage (72.73) of farmers in Rangwe were not able to identify sweet potato diseases. For effective disease management, there is need to educate sweet potato farmers in Rangwe sub county on how to identify diseases.

Table10. *Identification of sweet potato diseases by farmers in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

Factor	Sub-county	Farmer response	Sex of respondents			*Chi* Square	*p* value
			Male (%)	Female (%)	Total %		
Are you able to differentiate the diseases in your farm?	Rangwe	Yes	9.09	18.18	27.27	0.1528	.6959
		No	4.55	54.55	72.73		
	Kabondo-Kasipul	Yes	40.91	45.45	90.91	0.2058	.6500
		No	0.00	13.64	9.09		
	Kisumu East	Yes	13.64	77.27	90.91	0.3474	.5556
		No	0.00	9.09	9.09		

3.3.9 Sweet Potato Leaf Spot Disease History

In Rangwe sub county, there was significant ($p < 0.05$) association between gender of farmers and SPLS disease history perception ($X^2 = 10.116$, $p = 0.0064$). About 13.64% of male farmers reported that it was an old disease while 22.73% of female farmers reported that it was a new disease. However, 63.64% of farmers in the sub county did not know the history of the disease. In overall, it was considered an unknown disease in Kabondo-Kasipul and Kisumu- East sub counties at 68.18% and 86.36% respectively (Table 12). Use of uncertified sweet potato planting vines may be attributed for the new cases reported by the farmers in this study particularly where the planting materials are shared from farms with old cases of the disease. Local inoculum has been reported facilitate spread of sweet potato diseases [53]. Adequate disease management approaches such as introduction of clean planting materials and farmers' education is necessary in the area to eradicate SPLS cases.

Table11. *History of SPLS disease in farmers' fields in Rangwe, Kisumu East and Kabondo-Kasipul Sub Counties*

Factor	Sub-county	Farmer response	Sex of respondents			*Chi* Square	*p* value
			Male (%)	Female (%)	Total %		
How long has your sweet potato suffered from the disease?	Rangwe	New	0	22.73	22.73	10.1161	.0064
		Old	13.64	0	13.64		
		Don't know	13.64	50.0	63.64		
	Kasipul-Kabondo	New	9.09	13.64	22.73	0.0856	.09581
		Old	4.55	4.55	9.09		
		Don't know	31.82	36.35	68.18		
	Kisumu East	New	4.55	4.55	9.09	2.5596	.2781

		Old	0	4.55	4.55		
		Don't know	9.09	77.27	86.36		

4. Conclusion and Recommendation

The incidence and severity of SPLS was varied between studied villages and sub counties due to variation in climatic, soil conditions and farming practices. Varieties SPK004 and Odinga were the most popular, since the former is orange fleshed and rich in beta-carotene, while the latter is high yielding with tasty tubers. Sweet potato vines were mostly recycled from the last season crop and from friends. More females grew sweet potatoes continuously in all the three sub counties, since it is considered a food security crop, tolerant to pests and diseases thus can be produced all year round. Male farmers grew sweet potatoes for commercial purposes, while female farmers practiced subsistence farming. The planting method involved both mounds and ridges, while fertilizer use was minimum by the females. Most farmers reported occurrence of sweet potato diseases in their farms, however, the females were able to differentiate sweet potato diseases as compared to the males. In overall, sweet potato leaf spot disease was considered an unknown disease in the study area, however farmers reported reduced yields that may be attributed to leaf pots observed in most farms surveyed. Farmers' education on sweet potato diseases such as SPLS is recommended to enhance disease management and boost yield.

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