A Baseline Survey on Enhancing Sweet potato Production through Development and Promotion of Appropriate Weed Management and Spacing Technologies in Kenya

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Abstract: Sweet potato (*Ipomoea batatas* L) is an important tuber crop worldwide. It is the second most economically important after Irish potato in Sub- Sahara Africa. In Kenya, it is an important food crop alongside maize. Sweet potato has gained popularity among many farmers in Kenya due to its ability to give satisfactory yields under adverse climatic and soil condition as well as under low or no use of external inputs. However, its yield potential of 20-50 t/ha of root dry weight is yet to be exploited by farmers due to abiotic constraints. A Participatory rural appraisal and survey was carried out in central, eastern and western Kenya in August to October 2012 in order to understand and validate problematic weeds of sweet potatoes, methods and costs of control, with the aim of conducting research. Results indicated that hand weeding using hoes was the most popular method farmers used to control weeds. And that most farmers across the counties spent between Ksh. 2,000-2,999 to control them.

Index Terms: Sweet potato, Technologies, Weed management, Spacing

I. INTRODUCTION

C weet potato (*Ipomoea batatas L*) is a warm season tropical tuber crop that adapts to diverse climatic conditions. It is ranked Sifth economically after rice, wheat, maize, and cassava; sixth in dry matter production; seventh in energy production and ninth in protein production in the world, and is the second most economically important tuber after Irish potato in Sub - Saharan Africa [4], [8], [18], [19]. It is the third greatest production level after cassava and yams and is widely grown by small scale farmers in Sub - Saharan Africa [7]. In Kenya, sweet potato is grown from sea level to 2200m above sea level with major production concentrated in about 80% of the land that is either arid or semi-arid. It is an important food crop alongside maize. Though grown by small-scale farmers for subsistence, its importance is rising as an attractive income generator [15], [5]. Its ability to give satisfactory yields under adverse climatic and soil condition as well as under low or no use of external inputs has made it gain popularity among many farmers in Kenya [13], [15]. In addition, its flexibility in mixed farming systems and ability to take short period to mature thus offering household food security has made it an important livelihood strategy for small scale farmers [11]. Sweet potato can play a very important role in food security strategy for Kenya since it is drought resistant, is relatively a short term crop with flexible time of harvest allowing a high degree of flexibility in food security strategy. It also improves the yield of maize in a crop rotation compared to continuous maize production [20]. Research has shown that rotating sweet potato with maize improves farmers' incomes through higher yields of maize as well as income from sweet potato [15]. The crop can be harvested in piece meal and stored, which makes it a suitable food security crop [2]. The storage roots are boiled and eaten or chipped, dried and milled into flour which is used to prepare snacks and baby weaning foods [9]. It is also dried and made into flour used to make porridge, or mixed with wheat flour and baked to produce bread. The flour is also used to make snacks and desserts such as pies, puddings, biscuits, cakes, chips, crisps, mandazis, and chapatis. In addition, fresh storage roots are sold in open markets to generate income and or canned for export markets. Sweet potato roots are also used as a raw material to produce starch and vines are used as livestock feed [1]. Consumption of yellow and orange fleshed sweet potato rich in pro-vitamin A help reduce vitamin A deficiency [6], [18].

In Kenya about 59.2 thousand hectares of land is under sweet potato production annually which is only 4% of the land grown with sweet potato in East Africa. Its annual production of 9.53t/ha is relatively less than the world's 14.1 tones/ ha. Improved production of the crop will make it a potential source of income and also food [15]. The yield potential of 20-50 t/ha of root dry weight in the tropics is yet to be exploited by farmers in sub Saharan Africa. This is attributed to biotic, abiotic and socio-economic constraints such as poor agronomic varieties, pests, diseases and weeds [14]. Socio-economic constraints in sweet potato production include, poor post-harvest handling and storage facilities, lack of value addition skills, lack of clean seed, and poor

seed distribution system. Abiotic constraints affecting production of sweet potato include water stress, soil nutrient deficiencies and weed management [3], [12], [16]. Weeds compete with the crop for nutrients, water and sunlight cause losses as high as 50–60% [17]. Their control is, therefore, necessary during the first 2 months when the crop growth is slow and weed competition is high [10]. A participatory rural appraisal and a survey was conducted in various counties to evaluate production constraints and farmers practices with the aim of conducting research to mitigate constraints to production.

II. METHODOLOGY

A Participatory rural appraisal and survey were carried out in central, eastern and western Kenya regions in August, September and October 2012. Districts were randomly selected with the assistance of the Agricultural officers in each region. Data was collected using questionnaires which were administered to randomly selected sweet potato farmers. A minimum of thirty questionnaires were administered to household heads found in homes of each district, giving a total of 345 in all regions. Focused group discussions were also held and structured questionnaires administered to participants. Data was collected on Socio-demographic characteristics of households (such as farm size, gender, age, marital status and education level), the farmer's agronomic and crop husbandry practices such as variety and source of planting material, spacing used, planting method, weed control methods and cost of controlling weeds. Collected data was analyzed using SPSS software.

Results and Discussion

The survey was carried out in divisions of five counties, namely; Homabay, Kirinyaga, Machakos, Makueni and Murang'a. It covered 12 districts, 30 divisions, 42 locations and 101 sub-locations (Table 1).

				Cumulative
County	Division	Frequency	Percent	percent
Murang'a	Kiharu	33	9.6	9.6
Murang'a	Maragua	31	9.0	18.6
Makueni	Kaiti	30	8.7	27.3
Makueni	Kee	30	8.7	36
Machakos	Kivani	29	8.4	44.4
Machakos	Kangundo	32	9.3	53.7
Kirinyaga	Mwea	4	1.2	54.6
Kirinyaga	Ndia	29	8.4	62.4
Homabay	Asego	20	5.8	68.8
Homabay	Kabondo	11	3.2	72.3
Homabay	Ndhiwa	34	9.9	82.2
Homabay	Rangwe	62	18.0	100.2
Total	12	30	42	101

Table 1: Divisions in Counties surveyed

Farm Size

Homabay County had significantly (p<0.05) the largest average farm size per family whereas Kirinyaga had the least. Small farm size in agriculturally higher potential areas can be attributed to high population density due to land subdivisions (Table 2). Although farm sizes under sweet potato farming ranged from 1-4 acres, some farmers had more than 10 acres of land while a few planted on 0.5 acres of land

Table 2: Farm size							
County	Mean Farm sizes	Minimum	Maximum				
Homabay	4.06	1	20				
Kirinyaga	1.62	1	4				
Machakos	2.75	1	8				
Makueni	2.85	1	15				
Murang'a	2.24	1	12				

Gender, age, marital status and education level of Farmers

Most sweet potato growers were married (Table 3). Results also indicated that women, aged between 41-50 years were significantly (p<0.05) more, indicating that middle aged women are mostly involved in sweet potato production, as a means of providing food to the family. However, married farmers who had attained primary level education were significantly (p<0.05) more, though a few had attained tertiary education (Table 4).

	Table 5. Maritar status							
County	single	married	windowed	Total				
Homabay	2	102	23	127				
Kirinyaga	3	29	0	32				
Machakos	1	46	13	60				
Makueni	2	51	8	61				
Murang'a	0	59	6	65				
Total	8	287	50	345				

Table 4: Education level

County					Tota
	none	primary	secondary	Tertiary	1
Homabay	6	85	34	2	127
Kirinyaga	2	21	9	0	32
Machakos	8	27	24	1	60
Makueni	11	36	13	1	61
Murang'a	10	37	16	2	65
Total	37	206	96	6	345

Family size and age groups

The majority of farmers interviewed had 1-2 children, followed by 3-5 children whereas polygamous families had over 12 children. However, most family members were aged 21-40 years followed by 0-10 years (Table 6). This age bracket comprises of young growing members and lactating mothers who are in high demand of sweet potatoes.

Table 5: Family Size							
	Ho	use hold	size (Num	ber of pe	ersons)		
County	1-2	3 - 5	6-8	9-11	≥12		
Homabay	78	35	8	2	4		
Kirinyaga	22	2	3	1	4		
Machakos	28	11	9	9	2		
Makueni	29	16	11	4	2		
Murang'a	39	9	9	4	4		
Total	196	73	40	20	16		

Table 6: Family's age (years)

	Age group (Years)								
County	0-	0- 11- 16- 21-							
	10	15	20	40	41-60	> 60			
Homabay	33	25	21	25	19	4			
Kirinyaga	7	0	3	7	6	9			

Total	77	50	50	93	49	26
Murang'a	9	12	7	26	4	7
Makueni	14	8	7	15	13	5
Machakos	14	5	12	20	7	1

Sweet potato varieties

22 varieties of sweet potatoes were grown in all counties, Vitaa being significantly (p<0.05) favoured more across counties. However names of landraces recorded grown across counties differed/ varied but farmers preferred released varieties more than the landraces (Table 7).

C	Homa-	Kiriny-	Macha-	Maku-	Mura-	
Genotype	bay	aga	kos	eni	ng'a	Total
Vitaa	4	2	2	2	2	12
Kabonde	4	2	2	2	0	10
Amina	4	0	2	2	0	8
Yellow	0	2	2	2	2	8
White	0	2	2	2	2	8
Kembu10	0	2	2	2	2	8
Mwavuli	0	2	2	2	2	8
Kiganda	0	2	2	2	2	8
KARI	0	2	2	2	2	8
Bungoma	4	2	0	0	2	8
Blanketi	4	0	0	0	0	4
Kalamb Nyerere	4	0	0	0	0	4
Kuny kibwonjo	4	0	0	0	0	4
Nilikuja Kuzaa	4	0	0	0	0	4
Nyakeya	4	0	0	0	0	4
Nyasoda	4	0	0	0	0	4
Nyatonge	4	0	0	0	0	4
Odhieyo	4	0	0	0	0	4
Mwei	0	0	2	2	0	4
Mvita	0	0	2	2	0	4
Maruko	0	2	0	0	2	4
Kiluu	0	0	2	2	0	4
Total	48	20	24	24	18	134

Table7: Sweet potato varieties

Source of Planting Material

Farmers (181) who recycled sweet potato planting material from their previous crop were significantly (p<0.05) more than those (125) who got from their neighbours and a few (19) who used certified seeds (Table 8). Whereas clean and certified seed fetch higher yields, most farmers did not understand the importance. Low yields in all counties could be attributed to use of recycled and infected planting material instead of certified seed.

County	Division	own seed	Neighbour	Certified seed	Others	Tota 1
Homabay	Asego	13	5	1	0	19
	Kabondo	6	3	2	1	12
-	Ndhiwa	10	18	2	4	34
-	Ragwe	46	12	2	2	62
		75	38	7	7	127
Kirinyaga	Mwea	0	5	0	0	5
	Ndia	8	21	0	0	29
		8	26	0	0	34
Machakos	Kangundo	25	5	1	1	32
	Kivani	17	9	2	1	29
		42	14	3	2	61
Makueni	Kaiti	12	6	7	5	30
	Kee	13	11	1	5	30
		25	17	8	10	60
Murang'a	Kiharu	23	8	0	1	32
	Maragua	8	22	0	0	31
		31	30	0	1	63
	Total	181	125	19	20	345

Method of planting sweet potatoes

Ridges were the most popular method of planting sweet potatoes. The majority of farmers (329) used ridges as compared to planting on flat ground. Only a few farmers planted sweet potatoes on stools (Table 9).

	Flat		Other= stools
County	ground	Ridges	
Homabay	1	110	1
Kirinyaga	1	33	0
Machakos	15	47	0
Makueni	30	29	1
Murang'a	6	57	0
Total	51	276	2
Cu	329		

Table 9: Method of planting sweet potatoes

Spacing of Sweet potato

Interviews indicated that farmers intercropped sweet potatoes with other crops such as maize, cassava, cowpeas, bananas, sorghum, pigeon peas and beans, hence different planting spacings were used in all counties. However, spacings mostly preferred across counties were 60x60 cm and 75x30 cm followed by 75x60 cm (Table 10).

Table10: Sweet potato spacing							
Spacing	Homa-	Kiriny-	Macha	Maku-	Mura-		
(<i>cm</i>)	bay	aga	- kos	eni	ng'a	Total	
100x10	5	0	2	3	0	10	
0							
120x60	0	6	0	0	5	11	
45x30	3	0	1	1	0	5	
60x30	0	0	6	1	1	8	
60x60	16	0	3	2	1	22	

60x45	3	0	1	0	0	4
75x30	7	1	6	3	5	22
75x60	7	4	5	2	2	19
Total	40	11	24	11	13	100

Weeds Identified in sweet potatoes

Fourteen different types of weeds were identified as major weeds in sweet potato farming across the counties. However, *Bidens pilosa* (Black jack) and *Digitaria abbysinica* (Couch grass) were major problematic sweet potato weeds in all counties (Table 11). Other dominant weeds included *Amaranths spp* and *Oxygonum sinuatum* (Double thorn).

Tuble11. Weeds in Sweet polatoes							
Nama	Homa-	Kiriny-	Macha	Maku-	Mura-		
Ivame	bay	aga	- kos	eni	ng 'a		
Commelina	3	4	1	0	1		
benghalensis							
Oxygonum	1	1	7	19	4		
sinuatum							
Cynodon	2	1	0	8	5		
dactilon							
Bidens pilosa	80	5	25	26	10		
Rhynchelytrum	2	0	0	1	0		
repens							
Striga	10	0	0	0	0		
hermonthica							
Oxalis latifolia	0	4	0	0	0		
Mexican	4	0	5	2	1		
marigold							
Galinsoga	7	4	1	0	1		
parviflora							
Ageratum	2	0	1	0	0		
conyzoides							
Euphorbia	0	1	0	0	3		
geniculata							
Digitaria	17	0	6	23	1		
abbysinica							
Boerhavia	0	0	1	1	0		
diffusa							
Amaranths spp	11	1	5	0	0		
Total	139	21	52	80	32		

Table11: Weeds in Sweet potatoes

Weed control methods

The majority of farmers in all counties surveyed controlled weeds manually by hand weed using hoes or machetes. Hand pulling and chemical control were hardly used (Table 12).

Table 12: Weed control method							
County			Hand				
	Hoe	Machete	pullin	Chemical			
	weeding	weeding	g	spray	Total		
Homabay	106	0	1	0	107		
Kirinyaga	22	11	0	0	33		
Machakos	53	2	0	0	55		
Makueni	45	5	0	1	51		
Murang'a	44	15	0	0	59		

Total 270	33	1	1	305
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Cost of weed control

Weed management is critical, costly and a major constraint to successful sweet potato production. Most farmers in the study spent between Ksh. 2000-5000 to control weeds in sweet potatoes though some used family labour which was hard to cost (Table 13).

Table13: Cost of weed control							
Cost	Homa-	Kiriny-	Macha	Maku-	Mura-		
(Ksh.)	bay	aga	- kos	eni	ng'a	Total	
Family	0	0	10	11	3	24	
labour							
1-	1	7	0	7	13	28	
1001-	15	13	13	18	23	82	
1999							
2000-	53	11	18	7	19	108	
2999							
3000-	31	3	13	11	5	63	
4999							
>5000	3	0	2	1	0	6	
Total	103	34	56	55	63	311	

III. CONCLUSION

Weeds reduce sweet potato yield and quality by as high as 50–60%. Integrated weed management (IWM) approach such as mechanical, cultural, mulching and use of herbicides is needed to effectively control weeds during early stages of growth when the growth of the crop is low and weed competition high, in order to enhance production. It is difficult to control *Digitaria abbysinica* (Couch grass) by manual weeding or ploughing using hoes or machetes. Use of glyphosate herbicide 2-4 weeks before planting is effective.

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