Participatory on-farm sunflower variety evaluation in northern and eastern Uganda

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ABSTRACT

Sunflower genotypes were evaluated on farmers' fields between 2005 to 2007 growing seasons in eastern and northern parts of Uganda. The evaluation covered five districts. Researchers worked with extension and private sector staff whereby the latter identified the farmers and also helped in monitoring the trials. Each genotype was planted in a single plot of 5m in length with 4 to 6 rows per farmer field. For each variety, the plot was divided into two blocks so that one block received N60 P30 kg/ha using urea and single superphosphate as source of nitrogen and phosphorous, respectively; meanwhile, the other block had no fertilizer application to compare the effect of fertilizer application on the different genotypes. The main data recorded included seed yield (kg/ha), plant height, head diameter, 1000 seed weight, uniformity, vigour, lodging and maturity. Results showed that the better genotypes were sunflower hybrids from South Africa which included Pan 7351 from Pannar Seed Company; AGSUN 8251 and AGSUN 5383 from AGRICOL Seed Company; DKF68-22 and DK4040 from Monsanto Seed Company. It was observed that plots where fertilizers were applied improved their seed yield, plant height and head diameter significantly. The highest seed yield was by DKF68-22 with 3,556 kg/ha from Bunambutye, in Sironko district. In most areas, hybrids such as DK4040, DKF68-22, and AGSUN 8251 performed better than PAN7351, which was officially released in Uganda in 2003. Because of their good performance from these trials on farmers' fields, those three new varieties were also officially released for commercial production in Uganda in 2007.

Key words: farmer participation – sunflower– variety evaluation

INTRODUCTION

The cultivated sunflower (*Helianthus annuus* L.) ranks with soybean, rapeseed and groundnut as one of the four most important annual crops in the world grown mainly for edible oil. Sunflower is grown in around 20 million hectares in the world. Average grain yield in the world is around 1.1 t/ha, varying from 0.5 to 3.6 t/ha (Krizmanic et al., 2006).

In Uganda, sunflower has become the most important oilseed crop. The other oilseed crops are sesame, soybean, groundnut, and oil palm. It is mainly grown in the eastern and northern parts of the country, where it has become an integral part of the farming system. The crop is primarily cultivated for its grain, which is used for oil extraction and production of animal feeds. The extracted oil is generally used as a cooking medium and in the manufacture of soap.

Uganda's interest in sunflower production dates back to the late 1940's (Bua and Molo, 1985). However, research activities were minimal and varietal evaluation was on imported hybrids and open-pollinated varieties. Up to the late 1990's, evaluation of sunflower varieties and hybrids were done on trial verification centers (TVCs) located across regions in the country. These trial centers, owned by the government, although good for understanding the performance of the different varieties across locations, do not present the attitude and criteria of selecting varieties by farmers. Selection of varieties by farmers themselves leads to a wider acceptability of that variety. Researchers in most cases rely on results from on-station research when evaluating variety performance. The problem is that on-station conditions rarely mirror the farmer's production constraints, that include demands of manual cultivation, input shortages and limited labor supply and yet they have to grow the crops (Laker-ojok, 1994). The Vegetable Oil development Project (VODP) impact assessment report (VODP, 2007) indicated that the reasons for choice of type of sunflower variety demanded by farmers in Uganda were higher yields (60%), tolerance to weather and diseases (18%), high oil content (13%) and fast maturity period (9%).

The objective of this paper is to present the results and the methodology used in the participatory evaluation of the sunflower varieties planted together with the farmers in their own fields.

MATERIALS AND METHODS

The evaluation trial undertaken on farmers' fields was carried out between 2005 to 2007 growing seasons in eastern and northern parts of Uganda. A collaborative approach was undertaken whereby agricultural extension staff and private seed sector staff working in the localities of the farms identified the farmers or farmer groups who were active in cultivating sunflower in their area. Each variety was planted in single plots of 4 or 6 rows at a length of 5 m. In some cases, two blocks were organized so that one block was applied with fertilizer at a rate of N60 P30 kg/ha using urea and single super phosphate as source of nitrogen and phosphorous, respectively, whereas the remaining block had no fertilizer application. Spacing followed was 75 x 30 cm with one plant per hole.

Farmers participated in planting together with the extension staff of the area and the researchers involved. Weeding and thinning were the responsibility of the farmer. Planting was done in at least four districts per season and in at least two farmer fields per district. Farmers also participated in selecting criteria for identifying better varieties before the actual yield was recorded. The main districts covered were Lira, Apac in northern Uganda, Soroti, Kumi, Bukedea and Sironko in eastern Uganda. Data recorded were: head diameter, plant height, uniformity, lodging, vigour of the plot, leaf spot disease, 1000 seed weight, and yield per plot converted to yield per hectare. To avoid damage by birds, the locals were encouraged to scare the birds. Head diameter, plant height, uniformity, lodging and vigour were recorded during physiological maturity, while leaf spot was recorded two weeks after flowering. 1000 seed count and yield were recorded in the laboratory after seed cleaning. Ten to fifteen plants were measured for plant height and head diameter.

The scales used for scoring sunflower data if no actual measurement taken were:

Plant height:	1= Very short	9= Very tall
Lodging:	1= No lodging	9= Completely lodged
Head diameter:	1= Very big head	9= Very small head
Vigour:	1= Very vigorous	9= Very poor vigour
Maturity:	1= Very early	9= Very late
Uniformity:	1= Very uniform	9= Very variable
Leaf spot disease	1= immune	9= completely diseased

RESULTS AND DISCUSSION

In the evaluation undertaken in the second season of 2005 in Apac district, the best hybrid was PAN7351 in the plots where no fertilizer or some fertilizer was applied (Table 1). Where the fertilizer was applied, it had yields of 2,067 kg/ha. Other hybrids that also did well were DK4040, DKF68-22 and AGSUN 8251, which originated from South Africa. All these hybrids have already been released officially for commercial production in Uganda. PAN 7351 was also the tallest hybrid (183 cm) except for AGSUN 8251 which was the tallest under the fertilized condition with 186 cm. Where fertilizer was applied, there was a significant yield increase in some hybrids, especially the high yielding hybrids. Fertilizer increased plant height and head diameter (Table 1).

In Lira district, the hybrid DKF68-22 recorded 2,333 kg/ha as the highest yielder where no fertilizer was applied and AGSUN 8251 recorded the highest yield with 2,600 kg/ha where fertilizer was applied. These were indicators of good hybrids to compete with PAN 7351. Fertilizer also increased plant height, head diameter and vigour of the plants.

Table 1. Performance of yield and other components of ten sunflower hybrids/varieties as affected by fertilization at Loro (Apac District) in the second season of 2005.

Genotype	Country of origin	Seed yield (kg/ha)[1]		Plant Height (cm)		Head diameter (cm)		Vigour[2]		Uniformity[3]		Lodging[4]	
		N0[5]	N1	N0	N1	N0	N1	N0	N1	N0	N1	N0	N1
PAN 7351	South Africa	1,600 (1)	2,067 (1)	183.5	183.5	14.0	14.1	4.5	4.5	3.0	4.0	2.0	2.0
DK 4040	South Africa	1,233 (5)	1,567 (4)	143.5	160.5	13.8	14.8	4.5	3.5	2.0	2.5	1.5	1.5
DK 68-22	South Africa	1,567 (2)	1,800 (3)	167.8	166.5	15.0	14.3	5.0	4.5	2.5	2.0	2.0	1.5
NSH 160	India	1,100 (6)	1,367 (6)	139.8	156.8	14.6	15.8	5.5	5.0	3.5	2.5	4.0	4.0
S 3503	India	967 (8)	967 (9)	163.5	170.3	16.9	17.6	5.5	4.0	2.5	3.0	4.0	2.0
AGSUN 4683	South Africa	633 (10)	767 (10)	134.5	148.8	12.9	15.3	6.5	4.0	3.5	3.0	2.0	2.5
AGSUN 5551	South Africa	1,400 (4)	1,567 (4)	148.3	176.0	14.5	15.6	4.5	3.0	2.5	1.5	2.0	1.5
ASUN 8251	South Africa	1,467 (3)	1,867 (2)	137.3	186.4	13.3	16.4	4.5	3.0	2.0	2.0	1.5	1.5
8998	Kenya	734 (9)	1,067 (8)	125.8	160.0	12.2	15.2	6.0	5.0	3.5	4.0	4.0	2.5
SUNFOLA	Uganda	1,000 (7)	1,267 (7)	162.3	175.5	12.6	13.6	5.5	45	4.0	3.5	4.5	2.5
Mean		**1,170**	**1,430**	**150.6**	**168.4**	**14.0**	**15.4**	**5.2**	**4.1**	**2.9**	**2.8**	**2.8**	**2.2**

[1]Numbers in brackets indicate the ranking of the genotypes at each treament
[2]From 1= Very vigorous to 9= Very poor vigour
[3]From 1= Very uniform to 9= Very variable
[4]From 1= No lodging to 9= completely lodged
[5]N0=no fertlization, N1=fertilization with N60 P30 kg/ha

Table 2. Performance of yield and other components of ten sunflower hybrids/varieties as affected by fertilization at Bar Apwo (Lira District) in the second season of 2005.

Genotype	Country of origin	Seed yield (kg/ha)[1]		Plant Height (cm)		Head diameter (cm)		Vigour[2]		Uniformity[3]		Lodging[4]	
		N0[5]	N1	N0	N1	N0	N1	N0	N1	N0	N1	N0	N1
PAN 7351	South Africa	2,267 (2)	2,267 (3)	224.0	223.4	18.8	18.4	4	3	4	3	2	1
DK 4040	South Africa	2,267 (2)	2,267 (3)	198.0	217.0	16.8	17.0	3	3	3	3	1	1
DK 68-22	South Africa	2,331 (1)	2,400 (2)	209.0	218.0	13.6	18.0	4	4	3	2	2	1
NSH 160	India	2,067 (5)	1,667 (7)	154.0	174.0	13.0	16.2	5	5	2	2	1	2
S 3503	India	1,733 (7)	1,933 (6)	190.0	204.0	14.4	14.4	5	4	3	2	1	1
AGSUN 4683	South Africa	1,000 (10)	1,000 (10)	157.0	168.0	15.4	13.2	5	6	3	3	1	2
AGSUN 5551	South Africa	2,133 (4)	2,100 (5)	164.0	186.0	12.2	13.4	5	4	2	2	1	2
ASUN 8251	South Africa	1,067 (9)	2,600 (1)	158.0	185.0	14.4	16.6	5	3	2	2	1	1
8998	Kenya	2,000 (6)	1,333 (9)	137.0	149.0	13.4	9.2	6	6	4	3	1	2
SUNFOLA	Uganda	1,200 (8)	1,400 (8)	168.0	192.0	16.4	14.6	5	5	4	5	2	2
Mean		**1,807**	**1,897**	**175.9**	**191.6**	**14.9**	**15.7**	**4.6**	**4.3**	**3.8**	**2.7**	**1.2**	**1.4**

[1]Numbers in brackets indicate the ranking of the genotypes at each treament
[2]From 1= Very vigorous to 9= Very poor vigour
[3]From 1= Very uniform to 9= Very variable
[4]From 1= No lodging to 9= completely lodged
[5]N0=no fertlization, N1=fertilization with N60 P30 kg/ha

During the first season of 2006 (Table 3) at Kasoka in Bukedea district, DKF68-22 had the highest yield of 2,067 kg/ha and it had also good vigour and head diameter. The hybrids that showed very good plant vigour were PAN7351, DK4040, DKF68-22 and AGSUN 5383, recording a value of one.

Table 3. Evaluation of sunflower hybrids/varieties at Kasoka (Bukedea District) during the first season of 2006.

	Yield (kg/ha)			Plant height (cm)		Head diameter (cm)		Vigour[3]		Maturity[4]	
Hybrid/Variety	N0[1]	N1	Mean[2]	N0	N1	N0	N1	N0	N1	N0	N1
PAN 7351	1,822	1,200	1,511 (3)	160	166	27.9	23.0	2	1	5	6
DK 4040	1,222	1,311	1,267 (8)	135	152	22.4	24.0	1	1	5	6
DKF 68-22	2,000	2,133	2,067 (1)	166	167	20.6	21.7	3	1	5	5
NSH 160	800	1,600	1,200 (10)	148	149	19.3	19.4	4	4	4	4
S 3503	1,267	1,644	1,456 (6)	147	172	19.3	21.5	4	3	4	4
8998	711	1,111	911 (15)	130	161	18.0	19.7	4	3	4	4
AGUSUN 5282	1,044	1,311	1,178 (11)	163	199	17.0	18.6	3	1	6	6
AGSUN 5383	1,333	1,644	1,489 (4)	153	179	15.4	19.9	3	3	4	4
AUSIGOLD 4	1,644	1,244	1,444 (7)	170	171	21.2	19.1	3	4	4	4
AGSUN 8251	1,689	1,244	1,467 (5)	193	161	17.0	18.2	4	4	4	4
Hysun 33	1,711	1,556	1,634 (2)	172	173	18.0	18.2	3	4	6	5
Hysun 39	622	844	733 (16)	166	172	20.0	17.8	4	4	5	6
Hysun 44	533	489	511 (17)	151	152	17.6	18.9	5	4	6	5
Sunrise 1	978	1,511	1,245 (9)	154	173	13.0	19.3	4	5	4	4
Sunrise2	889	1,022	956 (14)	157	168	12.6	15.9	5	5	4	3
Sunrise 3	978	978	978 (13)	147	148	13.2	19.4	4	4	4	4
Sunfola	889	1,200	1,045 (12)	162	190	13.0	18.4	5	4	4	4
Mean	**1,184**	**1,297**	**1241**	**157**	**167**	**18.0**	**19.6**	**4**	**3**	**5**	**5**

[1]N0=no fertlization, N1=fertilization with N60 P30 kg/ha
[2]Numbers in brackets indicate the ranking of the genotypes at each treament
[3]From 1= Very vigorous to 9= Very poor vigour
[4]From 1= Very early to 9= Very late

In Table 4, evaluation of sunflower was undertaken at Bunambutye in Sironko district in the first season of 2006. This site recorded the highest seed yield. The genotype DKF68-22 again had the highest seed yield of 3,556 kg/ha followed by Sunrise 1 with 3,333 kg/ha. Due to high soil fertility in this area, plant height, head diameter, and 1,000 seed weight were high for most genotypes. Plant heights of over 270 cm and head diameter of over 28 cm were recorded in this area.

Table 4. Evaluation of sunflower hybrids/varieties at Bunambutye (Sironko District) during the first season of 2006.

	Seed yield (kg/ha)			Plant height (cm)		Head diameter(cm)		1000-seed weight (g)		Vigour[1]		Maturity[2]			
Hybrid/Variety	N0[3]	N1	Mean[4]	N_0	N_1	N_0	N_1	N_0	N_1	N0	N1	N0	N1	DF[5]	DM[5]
PAN 7351	2,444	2,556	2,667(4)	224	232	20.9	21.3	67.8	66.0	3	1	4	3	58	93
DK 4040	2,000	2,111	2,222(8)	180	203	22.9	23.2	81.4	80.4	2	2	3	2	55	98
DK F 68-22	3,556	3,556	3,556(1)	229	227	20.4	19.3	58.6	58.8	1	1	1	1	59	100
NSH 160	2,222	2,222	2,222(8)	204	207	20.5	19.1	70.2	64.6	5	5	3	5	47	83
S 3503	2,667	2,667	2,667(4)	230	227	23.3	21.5	64.6	59.0	3	3	2	2	53	89
8998	1,556	1,556	1,556(13)	188	177	20.6	20.2	69.2	71.0	5	6	4	5	52	89
Sunf. SAARI	1,778	1,889	2,000(11)	238	252	21.1	21.3	62.0	68.4	4	2	4	7	51	86
Sunf. UOSPA	1,778	1,667	1,556(13)	231	280	22.4	20.6	69.8	75.8	3	2	4	3	55	89
Hysun 33	2,667	2,889	3,111(3)	247	247	20.2	19.1	64.2	69.8	2	1	2	3	59	97
Hysun 39	2,222	2,445	2,667(4)	262	280	20.2	21.9	69.0	59.0	1	1	3	2	60	99
Hysun 44	2,222	2,045	1,867(12)	251	219	24.2	28.8	49.6	62.6	1	1	4	2	63	102
Sunrise 1	3,778	3,556	3,333(2)	265	241	20.0	20.7	74.0	71.8	3	3	2	3	55	96
Sunrise2	2,667	2,572	2,477(7)	212	198	18.7	19.7	60.4	64.6	5	4	5	4	49	86
Sunrise 3	2,667	2,445	2,222(8)	220	227	21.8	22.0	57.8	55.4	2	2	2	2	54	93
Mean	**2,441**	**2,445**	**2,461**	**230**	**227**	**21.3**	**21.2**	**66.2**	**65.6**	**2.4**	**2.9**	**3.1**	**3.1**	**55**	**93**

[1]From 1= Very vigorous to 9= Very poor vigour
[2]From 1= Very early to 9= Very late
[3]N0=no fertlization, N1=fertilization with N60 P30 kg/ha
[4]Numbers in brackets indicate the ranking of the genotypes at each treatment
[5]DF=Days to flowering; DM=Days to maturity

Table 5. Seed yield (kg/ha) for sunflower on-farm variety trials across locations during the first season of 2007[1].

	Ocamon yang (Lira)	Adeko kwok (Lira)	Atik (Apac)	Atana (Apac)	Bar-Apwo (Lira)	Kasoka (Bukedea)			Nyero (Kumi)		
						N0[2]	N1[2]	Mean	N0[2]	N1[2]	Mean
DKF 68-22	1,200(8)	1,600(4)	1,000(9)	1,200(4)	2,667(1)	1,867	2,067	1,967(6)	2,200	1,677	1,934(3)
Alexandra	1,467(6)	800(9)	800(12)	666(10)	1,533(3)	1,800	2,000	1,900(7)	2,000	2,067	2,034(2)
Arena	1,667(3)	1,667(3)	1,600(5)	1,333(3)	1,533(3)	2,000	2,000	2,000(4)	2,067	1,667	1,867(5)
NKMY	267(15)	400(10)	1,133(7)	867(8)	867(11)	667	533	600(11)	733	1,000	867(10)
NKAR	733(11)	333(11)	1,000(9)	800(9)	600(13)	1,200	867	1,034(9)	1,600	1,533	1,567(7)
AGSUN 4672	400(14)	333(11)	-	333(12)	267(14)	533	400	467(12)	733	400	567(12)
AGSUN 5282	1,267(7)	1,267(5)	1,800(4)	1,200(4)	1,200(6)	2,467	2,200	2,334(1)	1,333	1,467	1,400(8)
AGSUN 5383	1,800(2)	1,267(5)	2,000(2)	1,467(2)	933(10)	2,467	800	2,200(2)	2,000	1,667	1,834(6)
AGSUN 5551	1,000(9)	1,200(7)	1,600(5)	1,133(6)	1,133(7)	2,600	1,467	2,000(4)	1,733	2,533	2,133(1)
AGSUN 8251	1,867(1)	2,600(1)	2,333(1)	1,533(1)	1,467(5)	2,533	2,000	2,167(3)	1,733	2,067	1,900(4)
AGSUN 8751	733(11)	200(13)	1,000(9)	467(11)	-	2,333	1,200	1,000(10)	933	467	700(11)
Sunrise	467(13)	1,000(8)	-	-	1,600(2)	800	-	-	-	-	-
Hysun 33	1,600(4)	-	-	-	1,133(7)	-	-	-	-	-	-
PAN 7351	1,000(9)	1,867(2)	2,000(2)	1,133(6)	867(11)	-	-	-	-	-	-
8998	1,533(5)	-	1,067(8)	200(13)	1,000(9)	1,333	1,200	1,267(8)	1,200	1,133	1,167(9)
Mean	**1,133**	**1,118**	**1,444**	**949**	**1,200**	**1,678**	**1,478**	**1,578**	**1,522**	**1,472**	**1,498**

[1]Numbers in brackets indicate the ranking of the genotypes at each treatment
[2]N0=no fertlization, N1=fertilization with N60 P30 kg/ha

During the first season of 2007 (Table 5), yield data were recorded and compared across locations in eastern and northern parts of Uganda. In Lira and Apac, which are located in northern Uganda, AGSUN 8251 had the highest yields in four locations while hybrid DKF68-22, Arena, and AGSUN 5383 were considered stable across locations. Kasoka (Bukedea) on-farm trial had the highest mean yield of 1,578 kg/ha followed by Nyero (Kumi district) with 1,497 kg/ha. As a result of this on-farm trial and other trials evaluated on government trial centers across locations, three hybrids were officially released in Uganda for commercial production on top of PAN 7351, which was earlier released in 2003. These new hybrids released are: DKF68-22, DK4040 and AGSUN 8251.

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