A REPORT ON DEMONSTRATION OF FERTILIZER USE ON FIVE VARIETIES OF SUNFLOWER IN EASTERN AND NORTHERN UGANDA



Pius Elobu and Walter Anyanga
National Semi Arids Resources Research Institute (NaSARRI)

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Executive Summary

Five sunflower varieties were grown at the National Semi Arids Resources Research Institute (NaSARRI) and on 24 farmers' fields in the districts of Soroti, Kumi, Pallisa, Mbale, Sironko, Katakwi, Kaberamaido and Apac in Uganda, with and without fertilizers. Two commercial varieties (one hybrid called PAN 7351 imported from South Africa and one open pollinated variety called Sunfola, bred in Uganda) and three candidate hybrids (372/271, 383/271 and 404/271) developed from NaSAARI, Uganda were used. Two fertilizer application rates ($N_{30}P_{60}$ and $N_{60}P_{60}$) referred to here as mid-fertilizer and high fertilizer rates respectively, were compared with a no fertilizer control (N_0P_0). Single super phosphate (ssp) provided the phosphorous, and urea provided the nitrogen. With no fertilizer, mid-fertilizer and high fertilizer rates Sunfola yielded 344.1, 445.1 and 547.2 respectively. The NaSARRI candidate hybrid 383/271 yielded 418.4, 595.5 and 642.5 kg/acre respectively, compared to 372/271 which yielded 354.8, 552.4 and 594.0 respectively, and to hybrid 404/271 (361.1, 491.0 and 624.1 kg/acre respectively). The trend for PAN 7351 was 502.3, 668.5 and 765.2 kg/acre respectively. With the commercial hybrid PAN 7351, a 30 kg increase in Nitrogen applied, from N_0 to N_{30} was associated with a 166.2 kg/acre increase in yield, while a 30 kg increase from N_{30} to N_{60} caused a yield increase of 96.7 kg/acre. The mid fertilizer rate was more recommendable for farmers compared to the higher one in order to optimize yield return to every unit of applied nitrogen fertilizers. But both fertilizer rates ensued big volumes of sunflower seed for the oil industry. Low buying price of Uganda Shillings 500=/kg of row sunflower prevented many farmers from realizing positive net gains from fertilizer use, especially in Sunfola, but a projected minimum buying price of 800= would have led to big net incomes among many of the farmers.

Introduction

Sunflower is an important oilseed crop in Uganda, with expanding areas under production. The crop is a heavy feeder, extracting large amounts of nitrogen (N), phosphorous (P) and potassium (K) from the soils. These nutrients contribute significantly to the amounts and quality of sunflower oil which gives the crop its paramount importance, besides the residual cake after oil extraction. This extraction of soil nutrients has led to unconfirmed, discouraging allegations from some circles, that sunflower depletes soils. Of course any crop produced continually, without following proper rotation guidelines, not only depletes the soils, but also aggravates pest problems. Proper soil management practices need to be followed and additional fertility and amendments need to be added to the soils. Adequate soil fertility is one of the requirements for profitable sunflower production. Nitrogen (N) is the most yield-limiting nutrient, unless there are high residual NO_3-N levels in the soil. Phosphorus (P) is the next most limiting nutrient.

Most soils in Uganda lack sufficient amounts of the essential nutrients N, P and K (Rusoke et al, 2000), often leading to low yields. Over the last five years research by NaSARRI on the use of inorganic fertilizers in sunflower production, has generated a lot of promising results. For example application of 30 kg of N combined with 60 kg of P ($N_{30}P_{60}$) on *sunfola* variety at Kaberamaido in 2004, for example was able to raise yields from 469 to 844 kg/ha during a bad-cropping season. A similar rate to one of the hybrids DKF 68-22 raised yields at NaSARRI from 711 to 1052 kg/ha (Elobu and Anyanga, 2007). Limited tests at different areas in Eastern and Northern Uganda showed good responses from application of either $N_{30}P_{60}$ or $N_{60}P_{60}$. Due to limitations of resources, these rates have not been widely demonstrated to many farmers who grow sunflower, and to others who have the negative feelings that sunflower exhausts soils and should not be grown at all.

The objectives of this collaborative work were to

1. Demonstrate to a wide spectrum of farmers the yield advantages of fertilizer use in sunflower production
2. Confirm with the farmers, which of the two rates are economical for their different sunflower production areas and enlighten the farmers on proper application of fertilizers to their crops for maximum benefits
3. Provide a backing, based on soil analysis results, to demystify the negative notion about sunflower production and soil fertility degradation
4. Have soil fertility baselines upon which fertilizer recommendations for sunflower can be made for a number of areas
5. Ascertain the performance of three of the sunflower hybrids recently developed from NaSARRI under different farmer conditions and fertilizer regimes.

Materials and methods

Two commercial varieties of sunflower, *Sunfola* (an open pollinated variety) and *PAN 7351* (a hybrid) were compared with three candidate varieties, recently bred from NaSARRI. These were cod-named 372/271, 383/271 and 404/271, until a time when they might be released as commercial varieties. *Sunfola* is a widely grown variety in Eastern and Northern Uganda, while *PAN 7351*, imported from South Africa, has been widely grown amongst farmers from the North, although its use has just started in the Eastern parts of the country.

These commercial varieties were grown together with one of the candidate varieties with and without fertilizers on twenty-nine farmers' fields in the districts of Soroti, Kumi, Pallisa, Mbale, Sironko, Katakwi, Kaberamaido and Apac. Due to insufficiency of seed, each of the farmers grew the two commercial varieties and at least one of the new Serere hybrids, so that in a particular sub-county or zone each of the new hybrids was planted in at least one field. One control, researcher-managed trial of a similar design, but with all the five varieties was planted at NaSARRI, making a total of 30 fields. All planting was done at the beginning of second rains in July 2008, except for a few where fields were not ready on time, or germination was first bad, so replanting had to be done in September.

A core soil sample for routine soil analysis was taken from each field before planting. At harvest time, additional soil samples were to be taken from each site, and from individual plots. Results from these analyses would have been used to verify the effects of the different varieties and fertilizer treatments on residual soil status. This information was also to be used to clarify on the allegation that sunflower depletes soil nutrients. This second sampling, however, was not done due to insufficient funds towards project end, as a result of sudden increases in input costs.

Farmers managed the demonstrations under the direct supervision of the Field Extension Staff (FEWs), but to ensure timeliness in all operations, farmers were facilitated with funds for land opening, planting, weeding and harvesting. Activities such as marking the field, planting, fertilizer application and harvesting were done by the farmers together with the Researchers and FEWs.

Fertilizer treatments were applied to the varieties grown in each site and the two rates used were $N_{30}P_{60}$ and $N_{60}P_{60}$, against the no ferlizer control (N_0P_0). At planting 300 kg of single super phosphate (SSP) with 20% P_205 was applied to all plots that were to receive fertilizers. This was equivalent to applying 60 kg/ha of P_20_5 per hectare (6 bags of SSP/ha or 2.4 bags per acre). Also at planting, 32.4 kg of Urea (46%N), which is equivalent to 15 kg N/ha was applied to medium rates. Twice these amounts were applied to the high rate plots. All the fertilizer was broadcast after marking out the plots and the fertilizers worked into the soil at planting. *Calculated recommended rate is 1.5 bags of Urea/ha (0.5 bags/acre).*

During first weeding similar amounts of Urea were applied to the plots of medium and high fertilizer rates for the deferent fertilizer rates that were applied. These were of $N_{30}P_{60}$ (300kg/ha of SSP combined with about 65 kg of Urea/ha); i.e. 230 kg/acre of SSP combined with 28 kg of Urea/acre) and $N_{60}P_{60}$ (300 kg/ha of SSP combined with 130kg/ha of Urea i.e. 130 kg/ acre of SSP combined 56 kg /Urea/ha). In summary $N_{30}P_{30}$ meant applying 2.5 bags of SSP combined with 0.5 bags of urea per acre, while $N_{30}P_{60}$ meant applying 2.5 bags of SSP combined with 0.5 bags of urea per acre.

Sunflower was planted at 75 x 30 cm and later thinned to one plant at first weeding.

Results and discussions

Soil analysis

Data on soil analysis for the various fields before planting is presented in Appendix 1, and this is only for farmers from whom, yields were got. Floods destroyed one demonstration from Sironko while some other farmers in various places bulked the crop before we weighed.

All the soils had good Ph values within the range for sunflower growth, and above the critical value. Organic matter was a big limiting factor with only 3 out of the 26 fields exhibiting values above the critical value of 3.0 %. The result was that all soils were not able to supply the nitrogen required by the sunflower, since all N % values were below the critical value of 0.2 %. Except for 3 fields, phosphorous never limited sunflower growth but potassium was very much below the critical value for all the 26 fields.

Performance of the sunflower varieties

The hybrids generally gave problems at planting because of lower viability and this was more so in PAN 7351 and the candidate hybrid 404/271. Replanting had to be done in a few areas, while in some, gap filling or transplanting was attempted as shown below.



Poor germination of candidate hybrid 404/271 on the left hand rows compared to Sunfola on the right



A farmer transplanting the candidate hybrid 404/271 at Aparisa, Katakwi

Sunflower yielded on average 527.1 kg/acre. PAN 7351 gave the highest yield (645.3 kg/acre) and responded very well to fertilizer application. With the mid-fertilizer rate PAN 7351 yielded 668.5 kg/acre compared to 502.3 without fertilizers. With the high fertilizer rate, the variety gave a yield of 765.2 kg/acre.

All the three candidate NaSARRI hybrids out-performed *Sunfola* at all levels of fertilizer application, to which each of them responded well. The candidate hybrid 383/271 was the best with a mean yield of 552.2 kg/acre. With no fertilizer, mid-fertilizer and high fertilizer rates the hybrid 383/271 yielded 418.4, 595.5 and 642.5 kg/acre respectively, compared to *Sunfola* (344.1, 445.1 and 547.2 respectively), to the candidate hybrid 372/271 (354.8, 552.4 and 594.0 respectively) and to the candidate hybrid 404 (361.1, 491.0 and 624.1 kg/acre respectively).

All the three NaSARRI candidate hybrids were much earlier in maturity than PAN 7351, averaging 90-95 days, although *Sunfola* was much earlier than all the other varieties in all locations (Data not presented). The candidate varieties were also much shorter in height than the rest of the varieties and many female farmers recommended them as easier to harvest compared to the taller *Sunfola* and PAN 7351.

Response of sunflower to fertilizer application

All farmers appreciated the response of all the sunflower varieties to fertilizer application because the positive effects were visible on the sunflower vigour as early as 30 days from application, except where the crop was not weeded early.

		
Failure to weed on time obstructed immediate visibility of fertilizer effects to sunflower	*Fertilizer effect on the right was obviously contrasted with the no fertilizer treatment on the right, although similar varieties*	*No obvious difference was seen between effects of the mid-fertilizer and the high-fertilizer rates two weeks after top dressing with urea*

Fertilizer application increased sunflower yields directly as the applied nitrogen rate increased. The mean fertilizer effects on yields across all the varieties were 396.1, 550.5 and 643.6 kg/acre for the three fertilizer rates (N_0P_0, $N_{30}P_{60}$ and $N_{60}P_{60}$ respectively).

These came about because fertilizer application increased stem and head diameters of all the varieties.

Generally for every 30 kg/ha of N applied irrespective of variety, there was at least a 100-kg/acre increase in yields (computed from Tables 4 and 5). But particularly for PAN 7351 a 30 kg increase in Nitrogen applied, from N_0 to N_{30} was associated with a 166.2 kg/acre increase in yield, while a 30 kg increase from N_{30} to N_{60} caused a yield increase of 96.7 kg/acre (compute from Table 9 under economic analysis for PAN 7351). It would be advisable therefore for farmers to apply the mid-rate of fertilizers compared to the higher one in order to optimize yield return to unit of applied nitrogen fertilizers.

Economic analysis

An attempt was made to analyze profitability of fertilizer use in the two commercial varieties *Sunfola* and PAN 7351). The prices for fertilizers during the demonstration was Uganda Shillings 120,000=/50 kg bag of SSP, up from 70,000= the previous season. A 50 kg bag of urea was Uganda Shillings 67,000=. The NaSARRI candidate hybrids were left out because they are not yet released so no seed cost could yet be attached to their production. Table 6 outlines the costs attached to the commercial varieties without fertilizers, and with the medium and high fertilizer rates. Producing *Sunfola* cost Uganda Shillings 103,600=, 453,120= and 490,640=/ acre respectively while that for PAN 7351 were 106820=, 456300=, and 493860=/acre respectively.

Using the mean yields obtained and with the fertilizer prices as they were, it would imply that growing *Sunfola* was only profitable if no fertilizer were used. This would have not been the case at the previous fertilizer prices. Losses of up to Uganda Shillings 200,000=/acre would be incurred if fertilizers were applied to *Sunfola*, but the losses would be lower when applied to PAN 7351 (Table 6).

Counting the numbers of farmers who obtained the various yields presented in Tables 1-3 and presenting these counts in Table 8, the data shows that without fertilizer use only five *Sunfola* farmers failed to break-even while 19 of them managed to break-even and make some profits. With PAN 7351, the situation was not very different, though better. Without fertilizer use all the 24 farmers broke-even and none failed. With fertilizer use, one farmer broke-even at the medium rate and three farmers profited at the higher rate. The reasons for these sad observations were low buying price for sunflower compared to the high fertilizer costs. At Uganda Shillings 500=/kg which millers paid to farmers (irrespective of variety) many farmers could not offset the cost of producing with fertilizers.

The beautiful thing about fertilizer use, however, was that definite and significant yield increases were seen. This ensured larger quantities of raw materials for the milling and oil processing industries. The millers benefited at the cost of the farmers.

A hypothetical situation where farmers would sell their crop at Uganda Shillings 1,000= /kg, assuming cost of production and yields remained constant, would give dramatic net

returns shown in Table 9. The dramatic increase would even be greater with sunfola where every farmer would break-even and make profits at the two fertilizer rates (Table 11). Fertilizer use would be more profitable at the higher rate, many more farmers would be attracted to the crop and to the fertilizer technology, and bigger volumes of sunflower seed would be supplied to the mills. The threshold yields at which farmers break-even would be much lower (Table 10).

Millers too need to maximize profits so Table 12 suggests optimum sunflower buying prices based on actual production costs encountered and yields obtained in these demonstrations. *Sunfola* would need to be bought at a higher price than PAN 7351, but an average realistic optimum buying price would be Uganda Shillings 812=/kg.

Conclusions

1. Hybrids performed better than sunfola
2. The commercial hybrid PAN 7351 out-competed the new candidate hybrids developed at NaSARRI
3. NaSARRI's candidate hybrid 383/271 performed best compared to the other two and could be considered for release, if other traits are satisfactory.
4. Fertilizer application increased yields of all sunflower varieties and any 30 kg increase in N applied increased sunflower yields by a mean of 100 kg/acre
5. It is advisable for farmers to apply the mid-rate of fertilizers compared to the higher one in order to optimize yield return to every unit of applied nitrogen fertilizers.
6. A greater research focus should be made to providing potassium to sunflower
7. Prices of fertilizers for example 130=/bag of ssp, were too high for profitable use in sunflower production so unless these prices are revised or sunflower buyers increase prices to at least Sh. 800=/kg, alternative affordable and sustainable sources of fertilizers should be sought.

Suggestions for way forward

1. Researchers should develop technologies, including varieties able to give a minimum sunflower yield of 450 kg/acre for any farmer seeking fertilizer use to benefit
2. Farmers should put greater interest to using the higher yielding hybrids
3. Buyers should consider higher prices to pay farmers
4. Input dealers need to review prices of fertilizers or some stakeholder should intervene with subsidies on fertilizers.
5. Alternative value addition strategies should be developed and promoted at the farm level to increase farmers' benefits.
6. Support for this demonstration to be scaled out to other sunflower producing areas, especially Acholi sub-region, which is just recovering from insurgency, needs to be sought.
7. Farmers should strive to plant sunflower early to benefit more from the limited rains

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Table 1: Effects of different fertilizer application rates on mean yields (kg/acre) of two sunflower commercial varieties and a Serere candidate hybrid 372/127, grown on 8 farmers' fields and on-station in 2008

Farmer	Sub-county/ District	Sunfola				PAN 7351				Serere hybrid 372/271			
		N0P0	N30P60	N60P60	Means	N0P0	N30P60	N60P60	Means	N0P0	N30P60	N60P60	Means
Ipoot Samson	Katakwi	364.6	413.2	510.5	**429.4**	505.6	632.0	735.5	**624.4**	457.0	510.5	515.3	**494.3**
Omilogor Jude	Kaberamaido	432.7	583.4	563.9	**526.7**	559.1	559.1	607.7	**575.3**	481.3	554.2	588.2	**541.2**
Ocen John	Aduku-Apac	243.1	348.1	568.8	**386.7**	257.7	461.8	724.4	**481.3**	218.8	359.7	680.6	**419.7**
Adepo Yuventine	Kateta-Soroti	364.6	632.0	680.7	**559.1**	534.8	680.7	735.3	**590.3**	437.5	680.7	729.2	**615.8**
Eriu Washington	Arapai-Soroti	500.7	529.9	617.4	**549.3**	534.8	870.2	792.4	**711.5**	291.7	437.5	534.8	**421.3**
Odica Amstrong	Nyero-Kumi	286.8	500.7	704.9	**497.5**	437.5	792.4	1011.2	**747.0**	452.1	602.8	632.0	**562.3**
Nyiro Jennefer	Kagumu-Pallisa	486.1	486.1	680.6	**550.9**	559.1	875.1	948.0	**794.1**	457.0	607.7	700.1	**588.3**
Wamokota Lofisa	Busiu-Mbale	194.5	340.3	350.0	**294.9**	354.9	388.9	403.5	**382.4**	194.5	554.2	403.5	**384.1**
On-station	Serere	435.1	687.9	875.1	**666.0**	525.0	850.8	1028.2	**801.3**	461.8	923.7	821.6	**735.7**

Table 2: Effects of different fertilizer application rates on mean yields (kg/acre) of two sunflower commercial varieties and a Serere candidate hybrid 383/127, grown on 8 farmers' fields and on-station in 2008

Farmer	Sub-county/ District	Sunfola				PAN 7351				Serere hybrid 383/271			
		N0P0	N30P60	N60P60	Means	N0P0	N30P60	N60P60	Means	N0P0	N30P60	N60P60	Means
Ogwel Peter	Katakwi	296.5	369.5	408.4	**358.1**	505.6	583.4	627.1	**572.0**	272.2	398.6	413.2	**361.3**
Adupo Berna	Kaberamaido	461.8	602.8	636.9	**567.2**	782.7	1020.9	1011.2	**938.3**	461.8	865.3	802.1	**709.7**
Egwang Tom	Apac-Apac	141.0	238.2	282.0	**220.4**	468.1	627.1	826.5	**640.6**	335.4	543.8	573.7	**484.3**
Olot Mary	Abongomola-Apac	189.6	345.2	369.5	**301.4**	510.5	632.0	670.9	**604.5**	311.1	461.8	534.8	**435.9**
Ocen Moses.	Kyere-Soroti	340.3	340.3	729.2	**470.0**	656.3	729.2	972.3	**785.9**	413.2	632.0	632.0	**559.1**
Imalingat Z	Kelim-Kumi	340.3	364.6	413.2	**372.7**	340.3	364.6	364.6	**356.5**	316.0	418.1	500.7	**411.6**
Nambafu Y.	Busiu-Mbale	311.1	330.6	335.4	**325.7**	413.2	607.7	598.0	**539.6**	340.3	563.9	534.8	**479.7**
Masaba Nelson	Bunambutye-Sironko	247.9	636.8	627.2	**504.0**	520.1	748.6	656.3	**641.2**	651.4	661.6	748.6	**687.2**
On-station	Serere	435.1	687.9	875.1	**666.0**	525.0	850.8	1028.2	**801.3**	627.6	790.0	1008.4	**808.7**

Table 3: Effects of different fertilizer application rates on mean yields (kg/acre) of two sunflower commercial varieties and a Serere candidate hybrid 404/127, grown on 8 farmers' fields and on-station in 2008

Farmer	Sub-county/ District	Sunfola				PAN 7351				Serere hybrid 404/271			
		N0P0	N30P60	N60P60	Means	N0P0	N30P60	N60P60	Means	N0P0	N30P60	N60P60	Means
Ejulut C.J.	Katakwi	48.6	316.0	388.9	**251.2**	364.6	559.1	486.1	**469.9**	189.6	213.9	286.8	**230.1**
Okado Francis	Alwa-K'do	418.1	437.5	457.0	**437.5**	627.1	729.2	875.1	**743.8**	432.7	461.8	500.7	**465.1**
Ocen Molly	Aduku-Apac	291.7	296.5	583.3	**390.5**	505.6	845.9	923.7	**758.4**	345.1	486.1	777.8	**536.3**
Edyangu Andrew	Arapai-Soroti	388.9	413.2	510.5	**437.5**	364.6	413.2	388.9	**388.9**	218.8	340.3	461.8	**340.3**
Ojira James	Kumi-Kumi	753.5	777.8	899.4	**810.2**	598.0	729.2	943.1	**756.8**	486.1	680.6	802.1	**656.3**
Nyamalulu S.	Buseta-Pallisa	602.8	602.8	709.8	**638.5**	792.4	894.5	1011.2	**899.4**	500.7	632.0	704.9	**612.5**
Mujasi Esther	Busiu-Mbale	72.9	97.2	243.1	**137.7**	291.7	486.1	899.4	**559.1**	194.5	340.3	525.0	**353.3**
Kanyanya John	Busiu-Mbale	388.9	437.5	534.7	**453.7**	534.7	632.0	875.0	**680.6**	461.8	729.2	875.0	**688.7**
Masera Moses	*Bunambutye-Sironko*	*189.6*	*379.2*	*413.2*	***327.3***	*286.8*	*427.8*	*447.2*	***387.2***	*325.7*	*418.1*	*481.2*	***408.3***
On-station	Serere	435.1	687.9	875.1	**666.0**	525.0	850.8	1028.2	**801.3**	661.2	775.4	923.7	**786.8**

Table 4: Effects of different fertilizer application rates on mean yields of sunflower (kg/acre) grown on 24 farmers' fields and on-station in 2008

Variety	*Sunfola*	*PAN 7351*	*Serere candidate hybrid code-named*			*Fertilizer means*
Fertilizer			*372/271*	*383/271*	*404/271*	
N0P0	***344.1***	***502.3***	***354.8***	***418.4***	***361.2***	*396.1*
N30P60	***445.1***	***668.5***	***552.4***	***595.5***	***491.0***	*550.5*
N60P60	***547.2***	***765.2***	***594.0***	***642.5***	***624.1***	*634.6*
Variety means	*445.5*	*645.3*	*500.4*	*552.2*	*492.1*	*521.6*
Lsd between variety means = 32.7; Fertilizer means = 25.3 & interaction means = 56.6						
Cv (%)						**19.3**

Table 5: Effects of different fertilizer application rates on mean yields of sunflower (kg/ha) grown on 24 farmers' fields and on-station in 2008

Variety	*Sunfola*	*PAN 7351*	*Serere candidate hybrid code-named*			*Fertilizer means*
Fertilizer			*372/271*	*383/271*	*404/271*	
N0P0	***850.2***	***1241.6***	***875.4***	***1034.6***	***899.7***	*980.3*
N30P60	***1103.4***	***1651.9***	***1363.8***	***1472.3***	***1213.9***	*1361.1*
N60P60	***1352.1***	***1892.9***	***1466.5***	***1588.4***	***1542.8***	*1568.5*
Variety means	*1101.9*	*1595.4*	*1235.2*	*1365.1*	*1218.8*	*1303.3*
Lsd for variety means = 80.8; Fertilizer means = 62.6 & interaction means = 10.0						
Cv (%)						**19.3**

Table 6: Production costs and net financial benefits associated with the various sunflower technologies demonstrated on farmers' fields in 2008

Item/activity	Rate/acre	Unit price	No fertilizer	Mid fertilizer rate	High fertilizer rate
Ploughing	-----	40,000=	40,000=	40,000=	40,000=
Planting	-----	20,000=	20,000=	20,000=	20,000=
Sunfola seed	1.6 kg	2,250=	3,600=	3,600=	3,600=
PAN 7356 seed	1.6 kg	10,500=	6,820=	6,820=	6,820=
SSP fertilizer	130 kg	2400=	-----	312,000=	312,000=
Urea fertilizer	28 kg	1,340=	-----	37,520=	-----
Urea fertilizer	56 kg	1,340=	-----	-----	75,040=
Thinning	-----	10,000=	10,000=	10,000=	10,000=
Harvesting & threshing	-----	30,000=	30,000=	30,000=	30,000=
Production costs:					
Sunfola			**103,600=**	**453,120=**	**490,640=**
PAN 7351			**106,820=**	**456,340=**	**493,860=**
Economic analysis					
Sunfola					
Mean yields	Kg/acre	-----	344.1	445.1	547.2
Buying price	Sh./kg	-----	500=	500=	500=
Gross revenue	Sh./acre	-----	172,050=	222,550=	273,600=
Less production cost of	Sh./acre	-----	103,600=	453,120=	490,640=
Net income	Sh./acre	-----	+ 68,450=	-230,570=	-212,040=
PAN 7351					
Mean yields	Kg/acre	-----	502.3	668.5	765.2
Buying price	Sh./kg	-----	500=	500=	500=
Gross revenue	Sh./acre	-----	251,150=	334,250=	382,600=
Less production cost	Sh./acre	-----	106,820=	456,340=	493,860=
Net income	Sh./acre	-----	+ 144,330=	-122,090=	-111,260=

NB: Calculated at millers buying price of sh. 500=/kg by around January 2009

Table 7: Threshold yields needed for breaking-even and for profitability at the current buying price of sh. 500=/kg, when the different fertilizer rates are to be applied (production cost/price)

Fertilizer rate/ Sunflower variety	No fertilizer	Mid fertilizer rate	High fertilizer rate
Sunfola			
Minimum yield	207.2	906.2	981.3
PAN 7351			
Minimum yield	213.6	912.7	987.7

Table 8: Numbers of farmers who managed to break-even or get profits and those who could not at the current buying price of sh. 500=/kg, when the different fertilizer rates were applied during the demonstration in 2008

Fertilizer rate/ Sunflower variety	No fertilizer	Mid fertilizer rate	High fertilizer rate
Sunfola			
Broke-even	19	0	0
Did not break-even	5	24	24
Total	24	24	24
PAN 7351			
Broke even	22	1	3
Did not break-even	0	23	21
Total	24	24	24

Table 9: Production costs and net financial benefits associated with the various sunflower technologies demonstrated on farmers' fields in 2008, assuming millers would buy at sh. 1,000=/kg

Item/activity	Rate/acre	Unit price	No fertilizer	Mid fertilizer rate	High fertilizer rate
Ploughing	-----	40,000=	40,000=	40,000=	40,000=
Planting	-----	20,000=	20,000=	20,000=	20,000=
Sunfola seed	1.6 kg	2,250=	3,600=	3,600=	3,600=
PAN 7356 seed	1.6 kg	10,500=	6,820=	6,820=	6,820=
SSP fertilizer	130 kg	2400=	-----	312,000=	312,000=
Urea fertilizer	28 kg	1,340=	-----	37,520=	-----
Urea fertilizer	56 kg	1,340=	-----	-----	75,040=
Thinning	-----	10,000=	10,000=	10,000=	10,000=
Harvesting & threshing	-----	30,000=	30,000=	30,000=	30,000=
Production costs:					
Sunfola			**103,600=**	**453,120=**	**490,640=**
PAN 7351			**106,820=**	**456,340=**	**493,860=**
Economic analysis					
Sunfola					
Mean yields	Kg/acre	-----	344.1	445.1	547.2
Buying price	Sh./kg	-----	1000=	1000=	1000=
Gross revenue	Sh./acre	-----	344,100=	445,100=	547,200=
Less production cost of	Sh./acre	-----	103,600=	453,120=	490,640=
Net income	Sh./acre	-----	+ 240,500=	- 8,020=	+ 56,560=
PAN 7351					
Mean yields	Kg/acre	-----	502.3	668.5	765.2
Buying price	Sh./kg	-----	1,000=	1,000=	1,000=
Gross revenue	Sh./acre	-----	502,300=	668,500=	765,200=
Less production cost	Sh./acre	-----	106,820=	456,340=	493,860=
Net income	Sh./acre	-----	+ 395,480=	+ 212,160=	+ 271,340=

Table 10: Threshold yields needed for breaking-even and for profitability if farmers sold at sh. 1000=/kg, when the different fertilizer rates are to be applied (production cost/price)

Fertilizer rate/ Sunflower variety	No fertilizer	Mid fertilizer rate	High fertilizer rate
Sunfola			
Minimum yield	103.6	453.1	490.7
PAN 7351			
Minimum yield	106.8	456.4	493.9

Table 11: Numbers of farmers who would manage to break-even or get profits and those who would not if buyers paid farmers a price of sh. 1000=/kg, at the yields obtained when the different fertilizer rates were applied as during the demonstration in 2008

Fertilizer rate/ Sunflower variety	No fertilizer	Mid fertilizer rate	High fertilizer rate
Sunfola			
Would break even	22	9	15
Would not break-even	2	15	9
Total	24	24	24
PAN 7351			
Would break even	24	22	20
Would not break-even	0	2	4
Total	24	24	24

Table 12: Threshold sunflower prices needed for breaking-even and for profitability at the sunflower production costs and yields obtained from the on-farm demonstrations with the different fertilizer rates applied (production cost/yield)

Fertilizer rate/ Sunflower variety	No fertilizer	With fertilizers		
		Mid rate	High rate	Mean price to pay fertilizer users
Sunfola				
Minimum price (x)	301=	1018=	903=	960=
PAN 7351				
Minimum price (x)	213=	683=	645=	664=
Threshold mean buying price	**257=**	**850=**	**774=**	**812=**

((xy)-Pc = 0 or x=Pc/y) where x is the buying price needed, y is the yield (kg/acre) obtained and Pc is the production cost at the chosen fertilizer level and with the chosen sunflower variety