ECONOMIC ANALYSIS OF IMPROVED VARIETIES AND CROP MANAGEMENT PRACTICES FOR SORGHUM AND MILLETS

KENYA AND TANZANIA

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Acronyms

CIMMYT	International Maize and Wheat Improvement Centre
HOPE	Harnessing Opportunities for Productivity Enhancement
ICRISAT	International Crops for Research In Semi-Arid Tropics
MRR	Marginal Rate of Return
N	Nitrogen
P	Phosphorus
pH	Power of Hydrogen
USD	US Dollar

Executive Summary

Research trials were conducted in Kenya and Tanzania to identify crop management practices that can increase the productivity of sorghum and finger millet. Improved management practices were tested in combination with improved varieties. Economic analyses were made to assess the economic incentive for farmers to adopt these crop management practices. Results are based on two seasons in Kenya and a single season in Tanzania.

Research trials were conducted to test improved soil and water management practices for sorghum. The results of the economic analysis showed that, in both Kenya and Tanzania, tied ridging gave negative returns, as a result of high labour costs (six to seven times higher than normal tillage). However, improved varieties yielded higher returns than the local variety across all the treatments in both countries. In both Kenya and Tanzania, the crop management practices that gave the highest net benefits were normal tillage and fertilizer micro-dosing (30 kg ha^{-1}). The highest net benefits were obtained with the variety Gadam in Kenya and Macia in Tanzania.

Research trials were conducted to test improved weed management practices on finger millet in Kenya. The results of the economic analysis showed that manual weeding gave higher returns than chemical weeding using selective and non-selective post emergence herbicides. Although the cost of manual weeding was higher than chemical weeding, yields were higher with manual weeding. The highest net benefit was obtained from weeding manually two times; the improved finger millet variety (U15) gave the highest net benefits with this practice.

Analysis of nitrogen (N) and phosphorus (P) fertilizer rates on finger millet in Kenya showed no consistency in the appropriate levels of macro nutrients application in the different varieties. Highest net benefits were reported in different macro-nutrient application levels by the three finger millet varieties under trial. However, the highest net return was obtained when N and P were applied at 40 kg ha^{-1} and 20 kg ha^{-1} respectively on the variety U15.

Sensitivity analysis conducted for all the trials showed that a 10% change in yield or input prices (fertilizers, herbicides) did not affect these results if the minimum acceptable rate of return was 50%.

Introduction

The HOPE Project (Harnessing Opportunities for Productivity Enhancement) is designed to increase farm incomes for smallholders by raising the productivity of sorghum and millets. Productivity will be increased through (1) improved varieties and (2) improved crop management practices. Objectives 2 and 4, respectively, of the HOPE project are designed to develop and test these technologies. As part of these objectives, trials were conducted on-station and on-farm in Ethiopia, Kenya, and Tanzania to assess the performance of the improved sorghum and finger millet cultivars and improved crop management practices, including fertilizer micro-dosing, soil and water management practices and weed control management. The agronomic results from these trials will be reported separately, this report is concerned simply with the economic results.

The general objective of this report is to analyze the economic returns that farmers may expect from adoption of these improved technologies. The specific objectives of the report are to:

1. Develop partial budgets for the treatments in each experiment;
2. Compare the economic returns of each treatment; and
3. Conduct sensitivity analysis for the treatments.

Limitations

The report focuses on Kenya and Tanzania, because data collected for Ethiopia were not made available for analysis. For Kenya and Tanzania, data for 2010 long rains and 2011 short rains was not available. The analyses for Kenya are based on average yield figures for two seasons (2010 short rains and 2011 long rains), but for Tanzania data was available for one trial only and for a single season (2011 long rains). Some of the available data was also found to be inconsistent.

Data and methods

Trials

The analysis was based on on-research yield data collected in 2010 (short rains) and 2011 (long rains) in trial plots in Tanzania and Kenya. In Kenya, finger millet trials were conducted at Alupe research station in Western Kenya while sorghum trials were conducted at Kampi ya Mawe research station in Eastern Kenya. Sorghum trials were conducted in Ari-Hombolo research station in Dodoma.

In 2011, Kampi ya Mawe station received an annual rainfall of 386.9mm (site records, 2011) with lows of 0mm in June, July and August and highs of 113.2mm in March. The soil type is chromic luvisols with sandy loam texture with a soil pH of 5.6 – 5.8 (Muchena, 1975). In 2011, the Alupe station recorded a rainfall level of 1825mm (site records, 2011) with highs of 439mm in November and lows of 0mm in December. The soil type in the station is clay loam to clay with dark reddish brown color and a pH of 4.5 (Njoroge et al., 2010).

In Kenya, three experiments were conducted (two for finger millet, and one for sorghum). While in Tanzania, four sorghum varieties were used for the soil and water practices trial. Table 1 illustrates the key traits of the varieties used in the trials.

Table 1: Sorghum and finger millet varieties used in the trials, 2010-2011

Variety	Field duration (days)	Yield potential (tons/Ha)	Grain characteristics	Traits
Sorghum				
Gadam	90-100	2.5t-4.5t	Greyish , large-sized grain	Attractive to birds Tolerant to stem borers, shoot fly and foliar diseases
Seredo	104-110	2.5t-4.5t	Brown, medium sized grain	Wide adaptability Tolerant to Striga
KARI Mtama 1	110-120	3.5t -6.5t	White, large and bold grains. Tan plant with no tannins, high fine grind extract	Wide adaptability Tolerant to stem borers. Attractive to birds multiple uses for food, feed, brewing
Macia	115-120	3.0t-6.0t	Creamy white, medium-sized grains with no tannins. Tan plant. Milling quality excellent, 80% flour yield. very good malting quality	Drought resistant, Resistant to aphids and common leaf diseases but Susceptible to kernel smut.
Tegemeo	135-140	3.5t-4.5t	Pearly Creamy white, medium sized grains with no tannins. Tan plant. Milling quality fairly good, 78% flour yield. very poor malting quality	Susceptibility to bird damage and Striga
Kiboko	110-120	1.5 t- 3.0t	Red, Large grain with corneous texture	Susceptible to bird damage and Striga. Suitable for food
Wahi	100	3.0 t-3.5t	bold white grains	Striga tolerant suitable for food and brewing
Hakika	110	2.5t-3.5t	White bold grain. Tan plant,	Striga tolerant. suitable for food and brewing
Finger millet				
U15	70 -80	high yielding	Uniform grain size reddish	Blast tolerance, market preferred for industry
P224	90-100	high yielding	large grains, desire head size and shape and responds well to input	High yielding, fair on blast, preferred for food.
ikhulule	117-120	Low yielding	dark brown to black	Preferred for brewing, susceptible to blast.

Sources: Monyo et al., (2004); ICRISAT, (2006); Mgonja et al., (2007).

For sorghum, trials were conducted for soil and water management practices in both Kenya and Tanzania, while for finger millet trials were conducted for weed management and fertilizer micro-dosing in Kenya only. Table 2 describes the various treatments applied in the sets of trials, together with the improved varieties.

Table 2: Treatments and varieties used in the research trials

Trials (no)	1	2	3
Description	Integrated soil fertility and soil water management	Integrated weed management	Response to nitrogen and phosphorus
Kenya			
Varieties used	Local check, Gadam, Seredo, Kari-mtama 1	Ikhulule, U15	Ikhulule, U15, P224
Treatments	1. Normal tillage, no fertilizer 2. Normal tillage, micro dosing 3. Tied ridges, no fertilizer 4. Tied ridges, micro dosing	1. Farmer practice of one weeding. 2. Manual weeding twice 3a. Chemical control with 2, 4-D once 3b. Chemical control with Roundup once 4a. Chemical control with 2, 4-D twice 4b. Chemical control with roundup twice	1. N0P0 - No Nitrogen, No Phosphorus 2. N20P0 – 20 kg ha^{-1} Nitrogen, No phosphorus 3. N0P20 - No Nitrogen, 20 kg ha^{-1} Phosphorus 4. N20P20 – 20 kg ha^{-1} Nitrogen, 20 kg ha^{-1} Phosphorus 5. N40P0 – 40 kg ha^{-1} Nitrogen, No phosphorus 6. N40P20 – 40 kg ha^{-1} Nitrogen, 20 kg ha^{-1} Phosphorus
Tanzania			
Varieties used	Wahi, Hakika, Macia, Tegemeo		
Treatments	1. Normal tillage, no fertilizer 2. Normal tillage, micro dosing 3. Tied ridges, no fertilizer 4. Tied ridges, micro dosing		

Profitability

Three measures of profitability were used, based on methods for the economic analysis of on-farm trials (CIMMYT, 1988). First, we used partial budgets based on the net revenue and costs that vary for each treatment. Second, we used marginal analysis (MRR) In order to make recommendations; dominance analysis of the treatments was then carried out by listing the treatments in order of increasing costs that vary. Any treatments with net benefits

less than or equal to the preceding treatments were considered dominated. The dominated treatments were eliminated and only the non-dominated treatments were considered for recommendations.

The MRR estimates the return that a farmer is likely to get when they shift from one practice to another. The minimum acceptable rate of return for the technologies was estimated at 50%. The yields were adjusted downwards by 10% to approximate the yield obtained on larger plots. The input and output prices were based on prevailing market prices. The labour costs were calculated using the opportunity costs of labour at the prevailing wage rate.

Finally, we carried out sensitivity analysis to determine how the returns were affected when the yields and input prices (fertilizer and herbicides) changed by 10%.

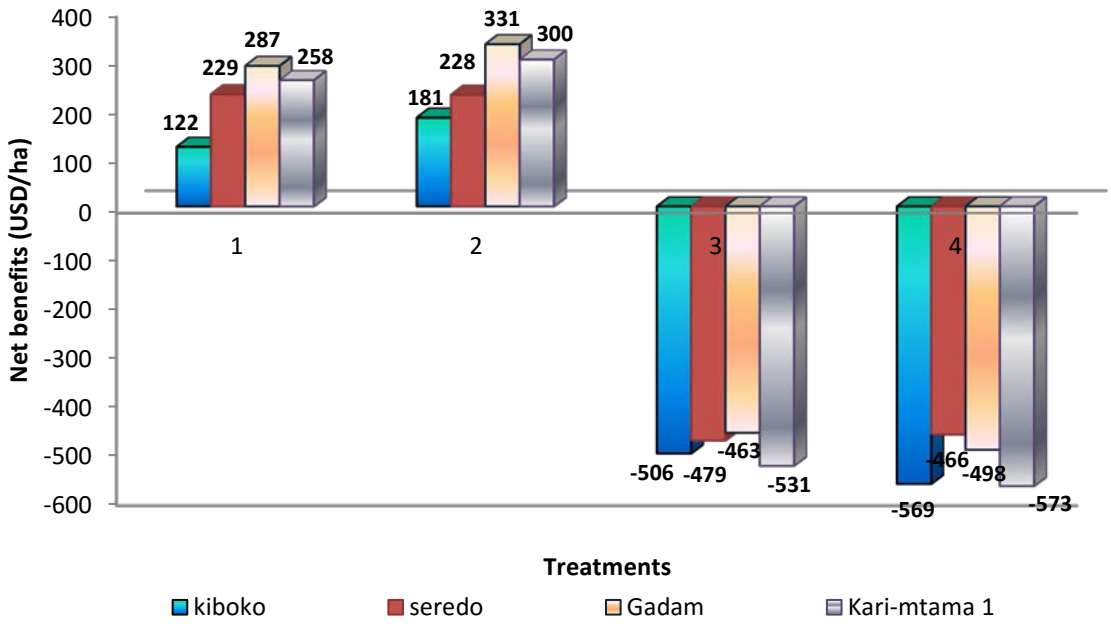
Results and Discussion

1. Kenya

1.1 Integrated soil fertility and soil water management practices

Net benefits

Fig.1: Net benefits of soil and water treatments for sorghum in Kenya (USD/ha)



Treatments: 1. Normal tillage, no fertilizer 2. Normal tillage, fertilizer 3. Tied ridges, no fertilizer 4. Tied ridges, fertilizer

Figure 1 shows the net benefits of the four soil and water treatments for four improved sorghum varieties in Kenya. Full details of the partial budgets are provided in Appendix 1. A summary of the results shows that:

1. The net benefits for the local check (Kiboko) were lower than the improved variety across all four treatments. For instance, in treatments 1 and 2, the net benefits for Gadam were slightly more than double the returns of the local check (Kiboko).

2. Except for Gadam, which recorded the highest net benefits in treatment 2 (micro-dosing, normal tillage), the other three varieties realized highest net benefits in treatment 1 (normal tillage, no fertilizer). The highest net benefit ($331) among all the varieties was reported in Gadam variety.
3. For all the varieties, negative net benefits were realized in treatment 3 and 4. This could be due to the high labor costs of ridging, the man-days required for tied ridging is slightly over six times more than labour requirement for normal tillage.

Marginal rate of return (MRR)

Table 3. Marginal analysis for soil water and soil fertility treatments (USD/ha)

Variety	Local check (Kiboko)			Seredo			Gadam			Kari-mtama 1		
Treatment	Total costs that vary	Net benefits	MRR (%)	Total costs that vary	Net benefits	MRR (%)	Total costs that vary	Net benefits	MRR (%)	Total costs that vary	Net benefits	MRR (%)
1	88	122		88	229		88	287		88	258	
2	144	179	102	144	228	*	144	331	80	144	300	76
3	819	-506	*	819	-479	*	818	-571	*	819	-531	*
4	892	-571	*	892	-466	*	892	-444	*	892	-573	*

Note: The asterisks (*) represent the dominated treatments.

Treatment 2 was the only non-dominated treatment for three varieties of the varieties; this indicates that shifting from no fertilizer to micro-dosing (Treatment 2) is most likely to yield higher returns. The MRR for the three varieties (Kiboko Gadam and Kari-mtama) in Treatment 2 was above the acceptable minimum rate of return (50%).

Though the local check (Kiboko) had the highest MRR (102%) between no fertilizer and micro-dosing, the highest net benefits still accrued from the Gadam variety. It is therefore recommended that farmers plant Gadam and apply micro-dosing and normal tillage. This recommendation of applying micro-dosing and normal tillage also holds for the other varieties except Seredo.

Sensitivity Analysis

Table 4 illustrates how a 10% change in yield will affect the net benefits and marginal analysis of the soil and water treatments shown in Figure 1. An increase in yield while holding the other variables constant will increase the net benefits while a decrease will decrease net benefits. However, results of the sensitivity analysis show that the earlier recommedations will not be altered. Treatment 2 (micro-dosing with normal tillage) remains the only recommended treatment for the three varieties (Kiboko, Gadam, Kari- Mtama 1).

Table 4: Sensitivity analysis (change in yield) for soil and water treatments in Kenya

MRR (%) at 10% increase in yield					MRR (%) at 10% decrease in yield			
Treatment	Kiboko	Seredo	Gadam	Kari-mtama 1	Kiboko	Seredo	Gadam	Kari-mtama 1
1								
2	128	*	97	93	86	*	61	58
3	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*

Note: The asterisks (*) represent the dominated treatments.

Table 5 illustrates how changes in fertilizer prices will affect the marginal returns and ultimately the recommendations. The results show that the original recommendations earlier made in table 1 will still hold. The MRR between the 1st and 2nd treatments of the Seredo variety have increased to 8%; this marginal return is however below the acceptable MRR of 50% to warrant its recommendation.

Table 5: Sensitivity analysis (change in price of fertilizer) for soil and water treatments in Kenya.

MRR (%) at 10% increase in fertilizer prices					MRR (%) at 10% decrease in fertilizer prices			
Treatment	Kiboko	Seredo	Gadam	Kari-mtama 1	Kiboko	Seredo	Gadam	Kari-mtama 1
1								
2	98	*	71	68	130	8	99	95
3	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*

Note: The asterisks (*) represent the dominated treatments.

1.2 Integrated weed Management practices in finger millet in Kenya

Net benefits

A partial budget analysis of the six weed control treatments was made with two finger millet varieties in Kenya. Figure 2 shows the results. Full details of the partial budgets are provided in Appendix 2.

The results show that:

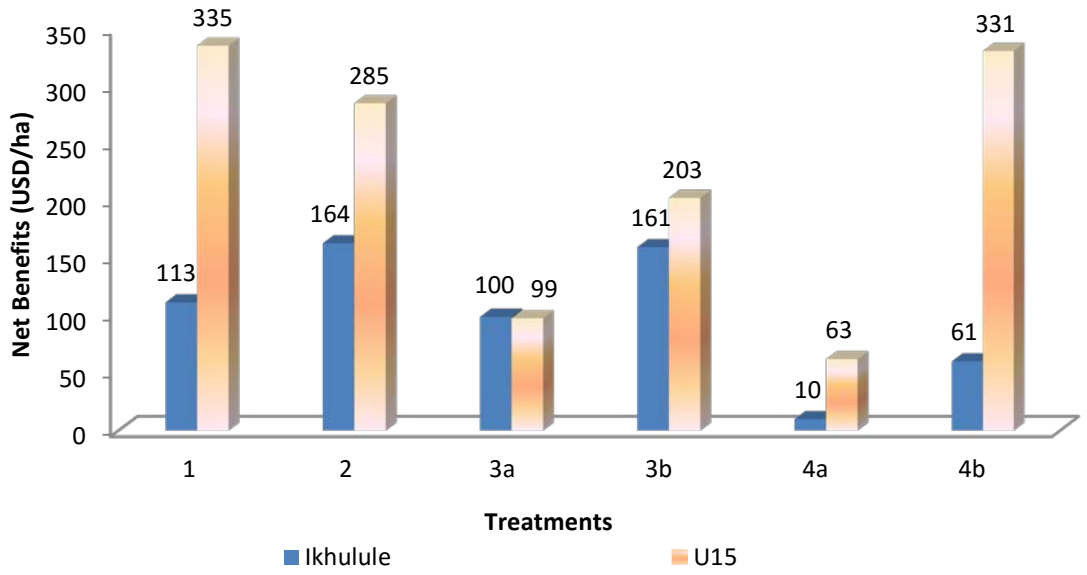
1. The costs for manual weeding were higher than chemical weeding. Manual weeding was slightly more than double the costs of chemical weed control.
2. The cost of the herbicide Round up was higher than for 2, 4-D, but the yields and net benefits for the low cost herbicide 2,4-D were higher than for Round up for both varieties .
3. For both varieties, the net benefits from manual weeding were higher than from chemical weeding using herbicides. The net benefit from herbicides using Round Up

was five times lower than from manual weeding for the variety U15 and 10 times lower than from manual weeding for the Ikhulule variety.

4. The net benefits for the improved variety (U15) were higher than the local variety (Ikhulule) across all the treatments. The net benefit for the improved variety was three times higher than the local variety in treatment 1 and five times higher in Treatment 6.

Chemical weeding cost less than manual weeding but the net benefits accruing from this technology were lower than the farmers' practice of manual weeding. Although manual weeding was labour intensive, the high yields realized were able to compensate for higher labour costs, resulting in higher net benefits.

Fig. 2: Net benefits of finger millets varieties for weed control treatments in Kenya.



Treatments: 1. Manual weeding once 2. Manual weeding twice 3a. Round Up once 3b. 2,4D once 4a. Round Up twice 4B. 2,4D twice

Marginal Rate of Return (MRR)

Table 6: Marginal Analysis for weed control treatment in Kenya (USD/ha).

Variety	Ikhulule						U15					
Chemical	2, 4-D			Round-up			2, 4-D			Round-up		
Treatment	Total costs that vary	Net benefits	MRR (%)	Total costs that vary	Net benefits	MRR (%)	Total costs that vary	Net benefits	MRR (%)	Total costs that vary	Net benefits	MRR (%)
1	88	113		88	112		88	335		88	335	
2	147	164	87	147	164	87	147	285	*	147	285	*

3	24	161	*	31	100	*	31	203	*	31	99	*
4	69	61	*	42	10	*	49	331	522	63	63	*

Note: The asterisks (*) represent the dominated treatments.

Table 6 shows that, for the local check Ikhulule, Treatments 3 and 4 were dominated, showing that weed control with herbicides 2, 4-D and Round up gave lower net benefits. For Ikhuhule, farmers should change from one to two manual weedings, since this gives an acceptable marginal return (85 %).

For the improved variety U15, the marginal analysis showed an MRR of 522 % from one application of 2, 4-D chemical to two. However, Treatment 1 (manual weeding) gave the highest returns ($335), and a shift from manual weeding to 2, 4-D would yield negative marginal returns. It is therefore recommended that farmers plant the variety U15 and use manual weeding as it would yield higher returns ($ 335).

Sensitivity analysis

Table 7 shows a 10% change in yield does not alter the recommendations earlier made. However, if the minimum acceptable return is raised to 100% treatment 2 will still be recommended once the yields are increased by 10%. This would not be the case when the MRR is as per table 6 (87%).

Table 7: Sensitivity analysis (10 % change in yield) for weed control treatments in Kenya.

MRR (%) at 10% increase in yield					MRR (%) at 10% decrease in yield			
	Ikhulule		U-15		Ikhulule		U-15	
Treatment	2,4-D	Round up	2,4-D	Round up	2,4-D	Round up	2,4-D	Round up
1								
2	106	106	*	*	69	69	*	*
3	*	*	*	*	*	*	*	*
4	*	*	827	*	*	*	651	*

Note: The asterisks (*) represent the dominated treatments.

Likewise, Table 8 shows that, a 10% change in herbicide prices will likewise not alter the earlier recommendations (Table 6). The net benefits for manual weeding are still higher than chemical weeding for both herbicides (round up and 2, 4-D). According to the results, manual weeding is still the most recommended practice.

Table 8: Sensitivity analysis (10 % change in herbicide prices) for weed control treatments in Kenya

MRR (%) at 10% increase in chemical prices					MRR (%) at 10% decrease in chemical prices			
	Ikhulule		U-15		Ikhulule		U-15	
Treatment	2,4-D	Round up	2,4-D	Round up	2,4-D	Round up	2,4-D	Round up
1								
2	87	87	*	*	69	69	*	*
3	*	*	*	*	*	*	*	*
4	*	*	516	*	*	*	533	*

Note: The asterisks (*) represent the dominated treatments.

1.3 Response of finger millet to fertilizer in Kenya

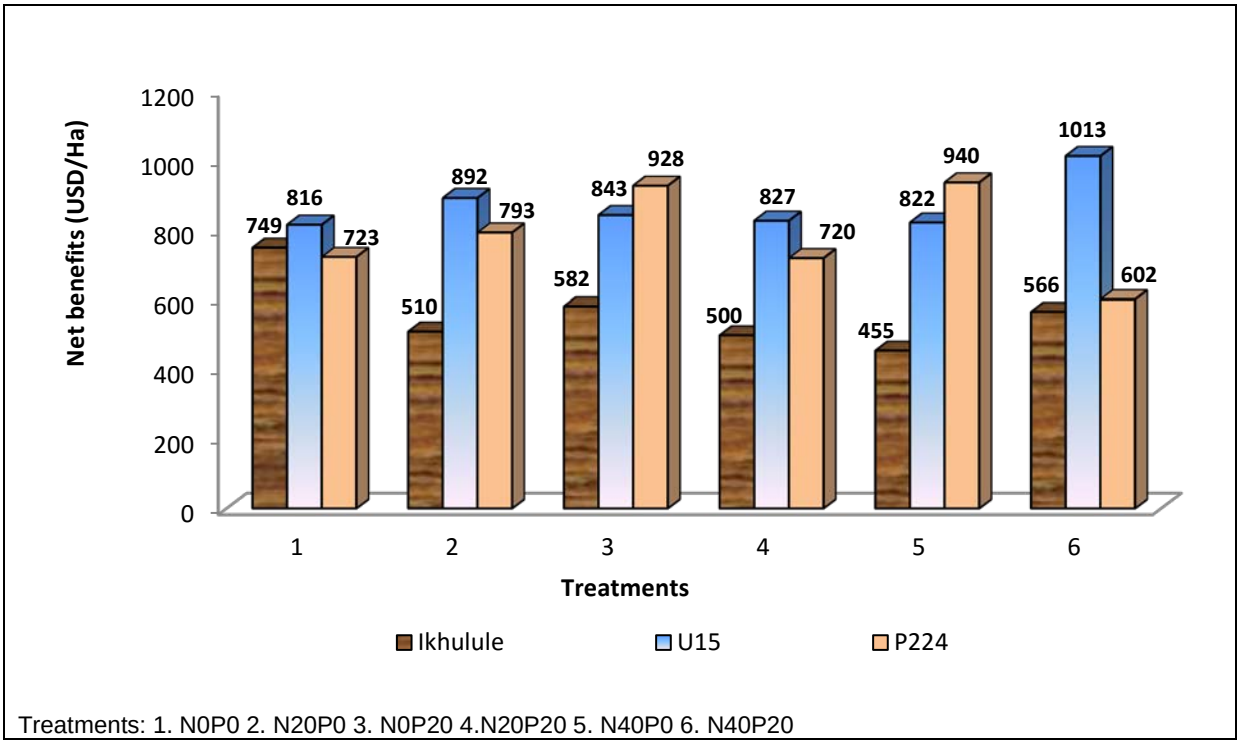
Net benefits

The results of the net benefits as represented in Figure 3 showed no consistency in treatments that yielded highest and lowest net benefits amongst the varieties.

In summary,

1. The highest net benefits for ikhulule variety were depicted in treatment 1 ($749), variety U15 in treatment 6 ($1013) and P224 in treatment 5 ($937).
2. The lowest net benefits were depicted in treatment 5 for the ikhulule variety ($ 456), variety U15 in treatment 1 ($816) and P224 variety in treatment 6 ($602).
3. Net benefits for the improved varieties (P224 and U15) were higher than for the local variety (Ikhulule) with the U15 variety having higher net benefits and being more responsive to fertilizer application.

Fig 3: Net benefits of different Micro-dosing levels for finger millet varieties in Kenya (USD/ha).



Treatments: 1. N0P0 2. N20P0 3. N0P20 4.N20P20 5. N40P0 6. N40P20

Marginal Rate of Return (MRR)

Table 9 shows that the marginal returns for micro-dosing treatments varied by variety. To reap higher returns, it is recommended that farmers should plant the U15 variety under treatment 6 (40kg/ha Nitrogen and 20kg/ha Phosphorus) as it gives the highest net benefits and an acceptable MRR. Treatment 1 and treatment 5 is most recommended for the local variety (ikhulule) and P224 respectively.

Table 9: Marginal analysis for macro-nutrients treatments in finger millet in Kenya (USD/ha).

Variety	Ikhulule			U15			P224		
Treatment	Net benefits	total costs that vary	MRR (%)	Net benefits	total costs that vary	MRR	Net benefits	total costs that vary	MRR (%)
1	749	0		816	0		723	0	
2	510	57	*	892	57	134	793	57	123
3	582	70	567	843	70	*	928	70	1065
4	500	98	*	827	98	*	720	98	*
5	455	114	*	822	114	*	937	114	1297
6	566	155	274	1013	155	472	602	155	*

Note: The asterisks (*) represent the dominated treatments.

Sensitivity analysis

The sensitivity analysis in Table 10 show that recommendations earlier made in Table 9 will still hold even when the yields are changed by 10%. The MRR of the non-dominated treatments are still above the minimum acceptable rate of return (50%) with 10% increases and decreases in yields.

Table 10: Sensitivity analysis (10 % change in yield) for macro nutrient treatments in Kenya

	MRR (%) at 10% increase in yield			MRR (%) at 10% decrease in yield		
Treatment	Ikhulule	U15	P224	Ikhulule	U15	P224
1						
2	*	158	145	*	111	100
3	634	*	1181	501	*	948
4	*	*	*	*	*	*
5	*	*	756	*	*	451
6	311	530	*	237	446	*

In Table 11 below, 10% changes in fertilizer prices will not be significant enough to merit any change to the recommendations made in Table 9. The MRR of the non-dominated treatments is within the acceptable MRR.

Table 11: Sensitivity analysis (10 % change in fertilizer prices) for macro nutrient treatments in Kenya

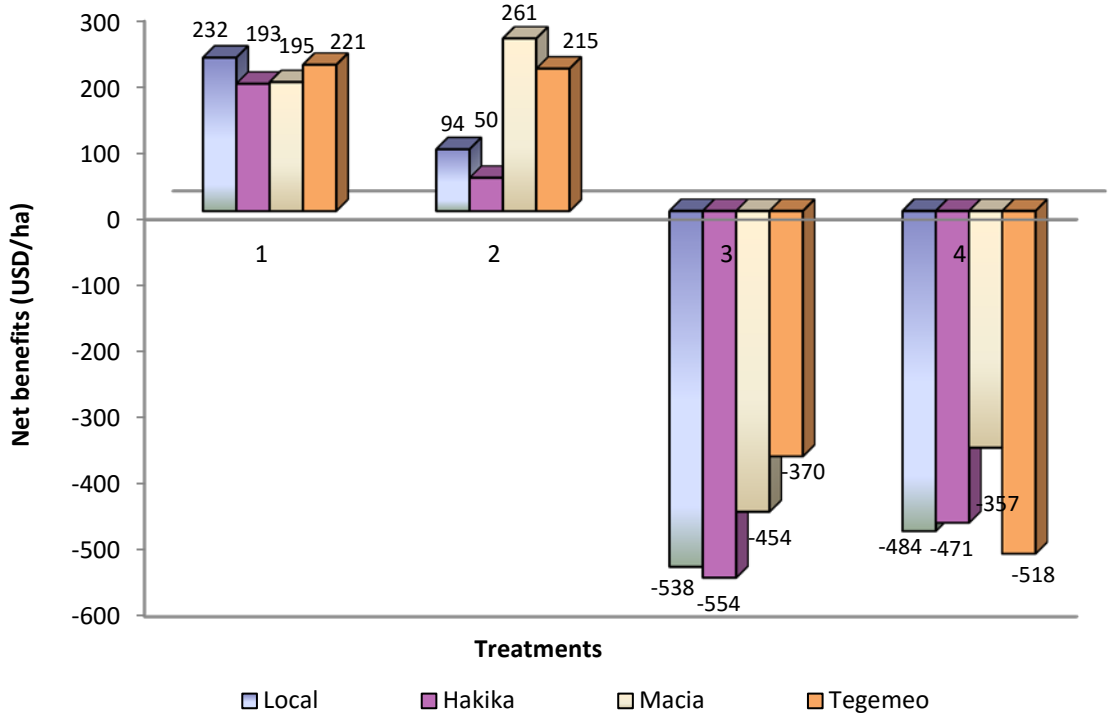
Treatment	MRR (%) at 10% increase in fertilizer prices			MRR (%) at 10% decrease in fertilizer prices		
	Ikhulule	U15	P224	Ikhulule	U15	P224
1						
2	*	123	112	*	135	134
3	503	*	959	641	*	1193
4	*	*	*	*	*	*
5	*	*	1560	*	*	1122
6	172	316	*	435	719	*

2. Tanzania

2.1 Integrated soil fertility and soil water management practices in Tanzania

Net benefits

Fig. 4: Net Benefits of soil and water treatments for sorghum varieties in Tanzania (USD/ha)



Treatments: 1. Normal tillage, No fertilizer 2. Normal tillage, fertilizer 3. Tied ridges, No fertilizer 4. Tied ridges, fertilizer

Figure 4 shows that:

1. Net benefits for the local variety were lower than the improved variety across all the treatments. The net benefits for Macia variety were six times higher than the local variety in treatment 1.
2. For all the varieties, negative net benefits were realized in treatment 3 and 4. This could be due to the high labour costs of ridging, the man-days required for tied ridging is slightly over 7 times more than labor requirement for normal tillage in Tanzania.
3. Three varieties (Tegemeo, Hakika and Local) realized highest net benefits in treatment 1 except Macia variety. The highest net benefit ($261) among all the varieties was reported in Macia variety and this was from treatment 2 (Micro-dosing and normal tillage).

Marginal Rate of Return (MRR)

Table 12 shows that all the technologies in Local, Hakika and Tegemeo variety were dominated. Normal farmers' practice (no fertilizer no micro-dosing) is therefore recommended for farmers who have to plant the three varieties. The Macia variety recorded an acceptable MRR (88%) between the 1st and 2nd treatment. It is recommended that farmers should plant Macia variety and apply the 2nd treatment (micro-dosing and normal tillage) as it yields higher returns.

Table 12: Marginal analysis for soil and water treatments in Tanzania (USD/ha)

Variety	Local			Hakika			Tegemeo			Macia		
Treatment	Total costs that vary	Net benefits	MRR (%)	Total costs that vary	Net benefits	MRR (%)	Total costs that vary	Net benefits	MRR (%)	Total costs that vary	Net benefits	MRR (%)
1	111	232		111	193		111	221		111	195	
2	199	94	*	199	50	*	199	215	*	199	261	88
3	819	-538	*	819	554	*	819	-370	*	819	-454	*
4	907	-484	*	907	-471	*	907	-518	*	907	-357	*

Note: The asterisks (*) represent the dominated treatments.

Sensitivity Analysis

The sensitivity analysis in Table 13 below show that the recommendations earlier made in Table 12 above will still hold with 10% changes in yield. Moreover, a 10% increase in yield will facilitate the recommendation of treatment 2 in Macia variety when the acceptable MRR is raised to 100% (this is not the case in the recorded MRR in Table 12)

Table 13: Sensitivity analysis (10 % change in yield) for soil and water treatments in Tanzania.

	MRR (%) at 10% increase in yield				MRR (%) at 10% decrease in yield			
Treatment	Local	Hakika	Tegemeo	Macia	Local	Hakika	Tegemeo	Macia
1								
2	*	*	*	107	*	*	*	70
3	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*

Note: The asterisks (*) represent the dominated treatments.

While a 10% increase in yield may allow rising of the minimum acceptable MRR to 100%, a 10% decrease in fertilizer prices may not, as shown in table 14. The MRR of Macia variety

between the 1st and 2nd treatment is below 100% (96%) but still, it is within the study's acceptable rate of return of 50%.

Table 14: Sensitivity analysis (10 % change in fertilizer prices) for soil and water treatments in Tanzania.

	MRR (%) at 10% increase in fertilizer prices				MRR (%) at 10% decrease in fertilizer prices			
Treatment	Local	Hakika	Tegemeo	Macia	Local	Hakika	Tegemeo	Macia
1								
2	*	*	*	82	*	*	*	96
3	*	*	*	*	*	*	*	*
4	*	*	*	*	*	*	*	*

Note: The asterisks (*) represent the dominated treatments.

Conclusions

Soil and water management practices in Kenya

Unexpectedly, micro-dosing and tied ridging did not yield high net benefits on most of the sorghum varieties. Micro-dosing only worked for one variety while tied ridging recorded negative returns. Tied ridging was found to be a labor intensive management practice. The improved varieties were however higher yielding than the local varieties. Results of the sensitivity analysis conducted indicated that 10% changes in yield or fertilizer prices will not alter the recommendations made as the calculated MRR for the recommended variety and treatment was still within the acceptable rate of return.

Weed management in Kenya

Farmer's practice of manual weeding which has a high labour cost yielded higher returns in this experiment, for both the local and improved finger millet varieties. This suggests that herbicides were not effective enough. More effective herbicides are required if herbicides are to give higher net benefits than manual weeding. Results of the sensitivity analysis conducted did not show the recommendations to be sensitive to 10% changes in yield or herbicide prices given the minimum MRR of 50%. If the yield is increased by 10% and the minimum MRR is raised to 100%, the recommendations will still hold.

Macro nutrients in Kenya

The results from this trial were inconsistent. However, the improved finger millet varieties used for the experiment were more responsive to fertilizer application than the local variety. Higher net returns were recorded in the improved variety than the local variety. The recommendations made in this experiment were likely not to be sensitive to 10% changes in yields or fertilizer prices at the given minimum acceptable rate of return of 50%.

Sorghum in Tanzania

Negative net benefits were realized in all the sorghum varieties under trial with tied ridging. Just like the Kenyan experiment, micro dosing realized the highest net benefits in only one variety. The improved varieties yielded higher net benefits than the local variety. Recommendations made from this experiment would likely not be altered with 10% changes in yield or fertilizer prices. However if the minimum MRR was to be raised to 100%, it is increases in yield and not 10% decreases in fertilizer prices which will make the recommendation hold.

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Appendices

1. Partial budgets for Sorghum varieties under various soil water and soil fertility management treatments in Kenya.

Figures in USD ($) per hectare (ha).

Variety	Kiboko				Seredo				Gadam				Kari-Mtama 1			
Treatment	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Average yield (Kg)	660	1023	985	1018	998	1167	1070	1341	1181	1495	1120	1241	1089	1397	905	1005
Adjusted yield (Kg)	594	921	887	917	898	1053	963	1207	1063	1346	1008	1117	980	1257	815	905
Gross field benefits	210	325	313	323	317	372	340	426	375	475	356	394	346	444	288	319
cost of fertilizer	0	26	0	26	0	26	0	26	0	26	0	26	0	26	0	26
Cost of tied ridging	0	0	819	819	0	0	819	819	0	0	819	819	0	0	819	819
Cost of micro-dosing	0	29	0	0	0	29	0	47	0	29	0	47	0	29	0	47
cost of normal tillage	88	88	0	0	88	88	0	0	88	88	0	0	88	88	0	0
Total costs that vary	88	144	819	892	88	144	819	892	88	144	819	892	88	144	819	892
Net benefits	122	181	-506	-569	229	228	-479	-466	287	331	-463	-498	258	300	-531	-573

2. Partial budgets for finger millet varieties under various weed control treatments in Kenya.

Figures in USD ($) per hectare (ha).

Variety	Ikhulule						U15					
treatment	1	2	3a	3b	4a	4b	1	2	3a	3b	4a	4b
Average yield (Kg)	632	979	416.67	583	236	347	1333	1361	410	715	396	1194
Adjusted yield (Kg)	569	881	375	525	213	312.50	1200	1225	369	644	356	1075
Gross field benefits	201	31	132	186	75	110	423	432	130	228	126	379
cost of 2,4-D	0	0	0	3	0	7	0.	0	0	3	0	7
Cost of round up	0	0	11	0	20	0	0	0	11	0	20	0
Cost of spraying	0	0	15	15	29	29	0	0	15	15	29	29
Cost of sprayer	0	0	6	6	12	12	0	0	6	6	12	12
Cost of hauling water	0	0	0.6	1	1.2	1	0	0	0.6	1	1	1
Cost of weeding	88	147	0	0	0.00	0	88	147	0	0	0	0
Total costs that vary	88	147	31	25	63	48	88	147.06	32	25	63	49
Net benefits	113	164	101	161	12	62	335	285.29	98	203	63	330

3. Partial budgets for finger millet varieties under various macro-nutrients treatments in Kenya.
Figures in USD ($) per hectare (ha).

variety	Local (Ikhululе)						U15						P224					
treatment	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Average yield (kgs)	1180	893	1026	940	897	1135	1284	1495	1438	1456	1474	1839	1138	1339	1570	1286	1448	1191
Adjusted yield (kgs)	1062	804	923	846	807	1022	1155	1345	1294	1310	1327	1655	1024	1205	1413	1158	1490	1072
Gross field benefits	749	567	652	597	570	721	816	950	913	925	936	1168	723	850	998	817	1051	757
cost of fertilizer	0	28	40	68	56	96	0	28	40	68	81	109	0	28	40	6	55.65	96
Cost of labor	0	29	29	29	59	59	0	29	29	29	59	59	0	30	29	29	59	59
Total costs that vary	0	57	70	98	114	155	0	57	70	98	140	168	0	57	70	98	114	155
Net benefits	749	510	582	500	455	566	816	892	843	827	797	1000	723	793	928	720	937	602

4.Partial Budgets for sorghum under various soil fertility and soil water management treatments in Tanzania.

Figures in USD ($) per hectare (ha)

Variety	MACIA				TEGEMEO				HAKIKA				LOCAL			
Treatment	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Average yield (Kg)	895	1307	1068	1570	972	117	1313	110	888	690	775	1236.67	1003.67	816.67	823.33	1200
Adjusted yield (Kg)	806	1176	961	1413	875	1056	1182	990	780	621	698	1113	903.3	735	741	1080
Gross field benefits	306	446	364	536	332	401	448	375	303	236	265	421	343	279	281	4010
cost of fertilizer	0	27	0	27	0	27	0	27	0	27	0	27	0	27	0	27
Cost of tied ridging	0	0.00	819	819	0	0.00	819	819	0	0.00	819	819	0	0.00	819	819
Cost of micro dosing	0	47	0	47	0	47	0	47	0	47	0	47	0	47	0	47
cost of normal tillage	111	111	0	0	111	111	0	0	111	111	0	0	111	111	0	0
Total costs that vary	111	185	819	893	111	185	819	893	111	185	819	893	111	185	819	893
Net benefits	195	261	-454	-357	221	215	-370	-518	193	50	-554	-471	232	94	-538	-484