Improving Sorghum Production in Water Deficit Environments of Eastern Africa

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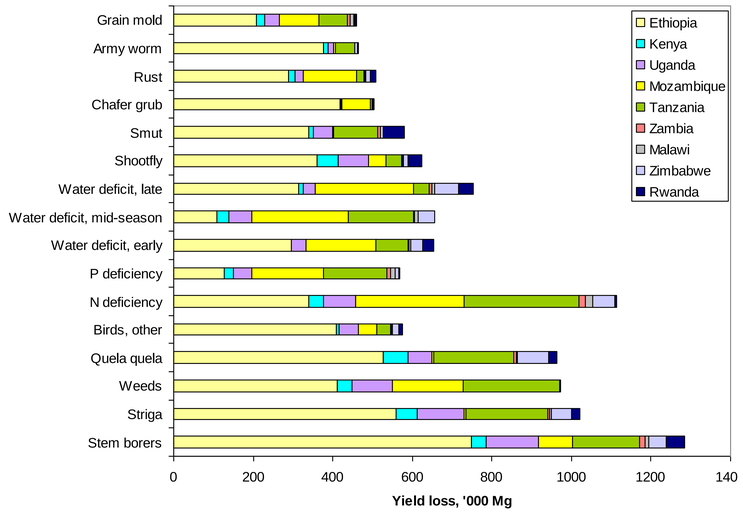
Figure 1. Sorghum yield loss due to major constraints in E&S Africa.



Soil water deficits during grain fill may reduce sorghum grain production in Ethiopia by 300,000 Mt yr^{-1} (Fig. 1). Deficits throughout the season reduce production in Uganda by 59,000 Mg yr^{-1}. Tillage and planting alternatives that have resulted in increased grain yield including tie-ridging, skip-row planting, and reduced tillage when appropriately applied.

Skip-row planting, a means to saving soil water for the grain fill period, was evaluated in Ethiopia where rainfall typically ceases shortly after anthesis. Tie-ridging to form micro-basins to prevent runoff conserves water by minimizing runoff when rainfall exceeds water infiltration was also evaluated in Ethiopia. Reduced tillage to eliminate pre-plant tillage to reduce water loss to evaporation and enable more timely planting was evaluated in eastern Uganda.

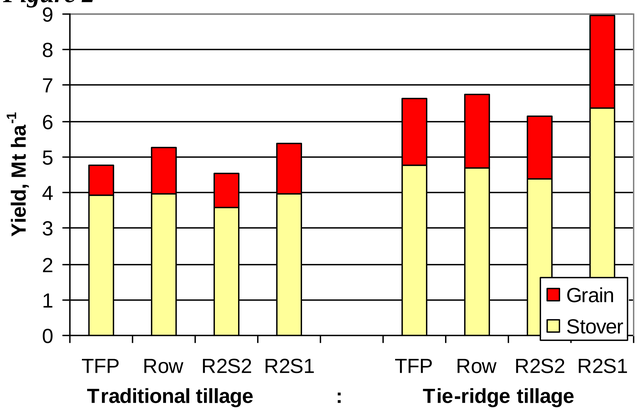
Skip-row planting and tie-ridging: Eight trials were conducted in northern and central Ethiopia as complete factorials. The skip-row treatments were: no skipped rows (S0); one planted alternated with one skipped row (S1:1); two planted alternated with two skipped rows (S2:2); and two planted alternated with one skipped row (S2:1). The tillage treatments were flat tillage and tie-ridging. Grain yields and harvest indexes were generally low. Treatment effects were not significant at two locations in central Ethiopia. Yield was increased by 19% with S2:1 planting and by 93% with tie-ridging compared with flat tillage in the north where yield was relatively low (Fig. 2).

Skip-row planting conserves soil water for grain-fill.

Runoff prevented with tied-ridging.

In northern Ethiopia, the planting configuration x tillage interaction was significant for both grain and stover yield because of greater response to the S2:1 planting with tie-ridging than with flat tillage Harvest index was much increased with tie-ridging.

Figure 2



Reduced tillage. Twelve on-farm trials were conducted in eastern Uganda to evaluate reduced tillage on loamy sand soil. The treatments were: plow tillage before planting, and no pre-plant tillage with and without fertilizer applied. Yield was low because of soil water deficits. Yield was increased by 37% and profit by 1000% by applying glyphosate instead of pre-plant plow tillage (Table 1). Fertilizer application further increased yield by 15% but this was not sufficient to justify the expense. Farmers observed reduced in-season weeding requirement with reduced tillage. The results indicate a need to apply fertilizer N in response to the crop condition at the time of second weeding and only if the crop is in good condition and the season appears promising. In separate trials, mucuna cover crop sufficiently suppressed weeds that planting without tillage or herbicide use was feasible.

Table 1. Reduced tillage effect on sorghum grain yield and profit under severe water deficit conditions in eastern Uganda.

Treatment	Grain yield, Mg ha^{-1}	Profit, \$ ha^{-1}
Plowing	1.31	11
Glyphosate	2.09	108
Glyphosate + 30 kg N + 10 kg P	2.46	52
LSD 0.05	0.20	

Conclusion

Tie-ridging and skip-row planting were beneficial in northern Ethiopia but did not result in increased yield in the central Rift Valley where rainfall was generally more during grain fill than in the northern sites. Even though S2:1 planting did not result in increased grain yield in central Ethiopia, it may be the best alternative to S0 in both semi-arid sorghum production areas where water deficits are often severe during grain fill because of reduced risk of crop failure. Skip-row planting and tied-ridging have potential to improve sorghum yield if well targeted to suitable environments, especially in northern Ethiopia in areas of a relatively short rainfall season. Skip-row S2:1 planting is recommended for situations of deep soil with good water capacity where severe water deficits often occur during grainfill.

Reduced tillage is promising for loamy sand soils of eastern Uganda for water conservation and timely planting. Fertilizer N application should be primarily side-dress application only when the condition of the crop is promising.

Choice of practice is location specific. Skip-row planting is expected to be most effective in cases of severe water deficit during grain fill and good soil water holding capacity, conditions common in northern Ethiopia but not in eastern Uganda. Tie-ridging is expected to be beneficial where runoff is common such as in Ethiopia but less so for the loamy sands of eastern Uganda. Reduced tillage was effective in increasing yield and profit in Uganda but is less likely to be effective in parts of Ethiopia where fields are bare at the end of the dry season and soil crust often forms with heavy rainfall. An exception is for early planting on Vertisols of the Miesso area where planting is often into bare, dry soil without tillage.