Assessment and Mitigation of Droughts in African Drylands

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ASSESSMENT

- Rainfall in drylands is extreme variable: either too wet or too dry.
- This creates risk in the design of water conservation measures
- Determine the type of drought: meteorological or soil? (Table 1)
- If soil drought: determine limiting factor: water, nutrients or both
- Quantify the field water balance: (Figure 1-3)
- Example Burkina Faso (average 3 years): P=660mm, T=100 mm. Why is T/P = Rain Water Use Efficiency = 100/660 = 15% so low? In USA T/P > 50%.
- Are there big water losses? R=40%=260mm, E=200mm
- Or is there unused water? Example Burkina Faso (average 3 years): U=120 mm
- Conclusion: other growth limiting factor(s) hamper water use
- Only water conservation in combination with other measures

LESSON: More integrated land & water management

Table 1 Two major types of agricultural drought in drylands

	METEOROLOGICAL DROUGHT	SOIL DROUGHT
Subtypes	Dry spells Short growing season Lack of total rain	WATER: Degraded physical soil properties NUTRIENTS: Lack of (balanced) plant nutrients
Causes	Rainfall anomalies Climate change	Desertification Lack of agricultural intensification
Assessment	Frequency analysis of onset and cessation Decade is dry if $P_{eff} < 0.5 * ET_0$. $P_{eff} = P-(1-R)$ Annual drought index	Determination physical of soil properties Measuring field water balance Soil/plant analysis Nutrient budgeting
Mitigation	Furrow-diking Deficiency irrigation	Soil SOM and soil profile improvement (ripping), root system Fertilization, higher crop intensity, root system

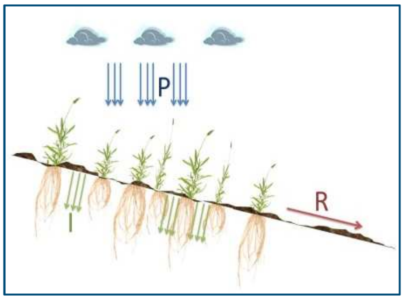

Figure 1 Rainwater balance

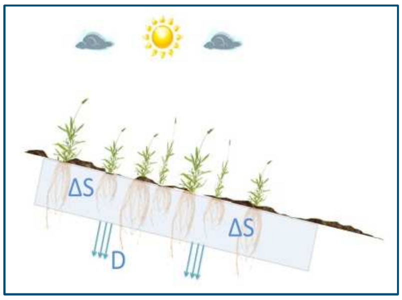

Figure 2 Infiltration water balance

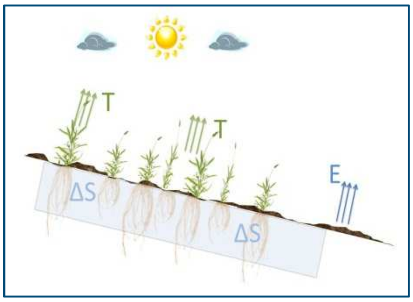

Figure 3 Soil water balance

MITIGATION OF SOIL WATER DROUGHT

- Makes sense only if gained water is used (for green biomass)
- Current: Sorghum: straw=2500 kg ha^{-1}, HI=0.4, Grain=1000 kg ha^{-1} Roots=1000 kg ha^{-1}, Total DM = 4500 kg ha^{-1} , TC=220 kgH_2O $kgdm^{-1}$ T=99 mm, T/P = 0.15
- After intensification: making T/P=30: T=200 kgH_2O $kgdm^{-1}$, Straw=6000 kg ha^{-1}, HI=0.4, Grain =2400 kg ha^{-1}
- Design of water conservation for too wet and too dry: 3 examples
- Stone lines: semi-permeable
- Ridges with 2% channel (and pits): slow forming terraces
- Furrow-diking: tied or open?

Table 2 Mitigation of soil water drought in African drylands

Water balance	Rain	Infiltration	Soil
	Reduce : R Increase: I	Reduce : D Increase: ΔS	Reduce : E Increase: T
Physical measures	Furrow-diking Stone lines Ridges Terracing Tillage (crust breaking)	Soil technology (ripping) Profile improvement Sedimentation (sand dam) 4	Tillage (dry soil mulch) Plastic mulch 3 4
Agronomical measures	Vegetation barriers 2 3 4	Increase SOM Increase rooting depth 3 4	Water-nutrient synergy food crop Add cover crop/tree Increase rooting depth Increase plant density

Photo 1 Ridges with channels (Zimbabwe,2011)

Photo 2 Tied ridges (Central Rift Valley, Ethiopia, 2011)

CONCLUSION

Only a small fraction of rainfall is used as green water (for transpiration) in African drylands. Even with big losses (runoff, soil evaporation) there remains unused water in the soil implying that there are other factors that hamper crop growth. It is not difficult to solve technical limitations; the technology is widely available. Limitations are more of an institutional character, more difficult to solve in Africa.

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