Research Application Summary

Predicting tef yield using AquaCrop model under various water availability regimes: A case study in Northern Ethiopia

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Abstract

Tef is one of the most important food crops grown in northern Ethiopia. This region is severely affected by drought. To continue producing the crop, it is necessary improve efficient use of water by tef within the context of climate variability. Moreover, the usefuleness of the FAO AquaCrop model and associated crop and soil factors to predict tef yield is not knownField experiments will be carried out in two areas: Mekelle University Main Campus and Raya Azebo woreda, Northern Ethiopia to predict Teff yield using FAO AquaCrop model under various water availability regimes. At the end of the study, a suitable and reliable method of predicting yield using FAO AquaCrop model will be developed.

Key words: AquaCrop model, FAO, tef, water availability

Résumé

Tef est l'une des plus importantes cultures vivrières cultivées dans le nord de l'Ethiopie. Cette région est sévèrement touchée par la sécheresse. Pour continuer à produire la culture, il est nécessaire d'améliorer l'utilisation efficace de l'eau par le tef dans le contexte de la variabilité du climat. En outre, l'utilité du modèle AquaCrop de la FAO et de la culture associée et les facteurs du sol pour prédire le rendement du tef ne sont pas connus. Les expériences sur terrain seront effectuées dans deux endroits: le campus principal de l'Université de Mekelle et Raya Azeboworeda, au Nord de l'Ethiopie afin de prédire le rendement du Teff à l'aide du modèle AquaCrop de la FAO sous divers régimes de disponibilité en eau. Au terme de l'étude, une méthode appropriée et fiable de prédiction du rendement à l'aide du modèle AquaCrop de la FAO sera élaborée.

Mots clés: Modèle AquaCrop, FAO, tef, disponibilité en eau

Background

Agriculture is the main driving force of the economy and livelihoods in Ethiopia. It is the source of income for about 80% of the labor force in Ethiopia (Bewket and Conway, 2007). Agriculture in Ethiopia is mainly rainfed and therefore very

vulnerable to climate change and water availability. The objective of this study will be (i) to quantify Tef water relationships and (ii) to calibrate and validate the FAO AquaCrop model for predicting Tef yield under various water availability scenarios.

Literature Summary

Rainfall variability has been reported to have significant effect on Ethiopia's economy and food production for the last three decades. Soil water availability refers to the capacity of a soil to retain water available to plants. After heavy rainfall or irrigation, the soil will drain until field capacity is attained. Field capacity is the amount of water that a well-drained soil should hold against gravitational forces, or the amount of water remaining when downward drainage has markedly decreased. In the absence of water supply, the water content in the root zone decreases as a result of water uptake by the crop. As water uptake progresses, the remaining water is held to the soil particles with greater force, lowering its potential energy and making it more difficult for the plant to extract it (Allen *et al.*, 1998).

Enhancing water use efficiency in irrigated agriculture includes increasing output per unit of water, reducing water loses and prioritising water allocation. Howell (2001) emphasized that sustainable use of water has to consider maximising yield per unit of water applied rather than maximum yield per unit of area FAO recently developed a water-driven model for use as a decision support tool in planning and scenario analysis in different seasons and locations (Steduto *et al.*, 2009; Hsiao *et al*., 2009). Once validated, models are easy and need less resources to use (Tsudo *et al.*, 2005; Soltani and Hoogenboom, 2007). The Aqua Crop model simulates the variation in attainable crop biomass and harvestable yield in response to variation in soil moisture in the root zone. This is done in daily time steps by considering the incoming and outgoing water fluxes and by taking into account the daily transpiration rate. The increment in yield depends on the normalised transpiration for the local climate and the separation of yield into biomass and grain. Biomass growth is associated with crop parameters such as stomatal conductance, canopy senescence and harvest index (Steduto *et al.*, 2009).

Models that adequately simulate the effects of water stress on yield can be valuable tools in irrigation management. These models can be used to optimise the allocation of irrigation water

between different crops and/or the distribution of water during the crop season (Cavero *et al.,* 2000).

Such a model could have the potential to minimise the risks related to food insecurity in a country. This is because it can be used to explore and evaluate alternative management that improves water productivity and achieves more efficient water use (Bessembider *et al*., 2005). It might also be applied by extension specialists, relief organisations, and policy makers, to predict yields. The model can also be used as a decision support tool in planning and scenario analysis (Steduto, *et al.,* 2009; Hsiao *et al.,* 2009). The model is also recommended for use in optimising water use (Araya *et al.,* 2010).

Study Description

The study area will be carried out in Woreda RayaAzebo (Longitude $39^0 5'$-$39^0 8'$ and Latitude $12^0 3'$-$13^0 7'$), Northern Ethiopia. This area has a relatively long period of climate change observations but also experiences droughts. The climate in this area is characterised as dry semi-arid climate (Araya *et al.,* 2010). About 180 farmers will be consulted especially to determine their planting date for Tef and their experiences with drought. In addition, more data will be collected from the Bureau of Agriculture, Tigray Research Institutes and the Statistical Authority Offices. Crop related data such as planting date, leaf area index, harvest index, number of tillers, harvest index, biomass yield, and grain yield will be collected. Soil related data like soil moisture content and water balance will be collected. Finally, water use efficiency will be determined and the FAO AquaCrop Model validated.

Research Application

Information generated in this study will be used to develop a simple but reliable method of predicting crop yield under different water management conditions under present and future climate change. The study areas will also provide insight into the Tef yield predicted using the FAO AquaCrop models. Documentation of yield models will be made for Tef and finally will be used for Research purposes.

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