Research Application Summary

Improving rainwater use efficiency in teff for enhancing adaptation to climate variability and climate change in the northern Ethiopia

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Abstract

The main limitation in stabilising food security in Ethiopia is the dependency of the farming system on erratic rainfall. The production of teff, an Ethiopian staple food crop adapted to rainfed farming, has been affected by water stress while it is the principal source of carbohydrate in the diet of Ethiopians and is consumed in various forms. Its production is also critical for national food security and export to international markets. Teff production is expected to lower due to water stress if the current climate change persists. One means of enhancing adaptation to climate change is through improving water management in teff field. Unfortunately, the detailed teff–water relation is not very well known. In this research, four MSc students will be engaged to study the agronomic and physiological characteristics of teff in relation to soil water conservation. The extent of climate change on the changes in teff productivity will be documented. In addition a yield predicting model for Teff will be developed. The study will establish the extent to which water stress resulting from climate variability could be reduced by improving rainwater use efficiency. Appropriate technologies that effectively use rainwater in teff will also be identified.

Key words: Climate variability, northern Ethiopia, Teff, water

Résumé

La principale limitation dans la stabilisation de la sécurité alimentaire en Ethiopie est la dépendance du système d'exploitation agricole sur l'irrégularité des précipitations. La production du teff, une culture vivrière de base en Ethiopie adaptée à l'agriculture pluviale, a été affectée par le stress hydrique alors qu'elle est la principale source des glucides dans l'alimentation des Ethiopiens et est consommée sous diverses

formes. Sa production est également critique pour la sécurité alimentaire nationale et pour l'exportation vers les marchés internationaux. La production du teff est attendue à la baisse à cause du stress hydrique si le changement climatique actuel persiste. L'un des moyens d'amélioration de l'adaptation au changement climatique consiste à améliorer la gestion de l'eau dans le champ des teffs. Malheureusement, la relation détaillée teff-eau n'est pas très bien connue. Dans cette recherche, quatre étudiants de maîtrise seront engagés pour étudier les caractéristiques agronomiques et physiologiques du teff en matière de conservation de l'eau du sol. L'ampleur du changement climatique sur les variations de la productivité du teff sera documentée. En outre, un modèle de prédiction du rendement pour le Teff sera développé. Nous allons également établir la mesure dans laquelle le stress hydrique résultant de la variabilité du climat pourrait être réduit en améliorant l'efficacité d'utilisation des eaux de pluie. Des technologies appropriées qui utilisent efficacement l'eau de pluie dans le teff seront également identifiées.

Mots clés: variabilité climatique, Nord de l'Ethiopie, Teff, eau

Background

The economy of Ethiopia highly depends on agriculture providing income for about 80% of the labor force in the country (Bewket and Conway, 2007). Teff is one of the most important crops grown in Ethiopia. Its productivity is however erratic due to climate change and variability. Thus, analysing the temporal climate data in the study area visa-a-vis the production of teff is important for analysing the drought risk and coming up with appropriate mitigation strategies. The objectives of this research are to: (i) collect data of past climate and satellite data and develop suitable model for assessing teff crop performance in relation to scenarios of climate change and variability; (ii) quantify teff water relations; (iii) calibrate and validate the FAO AquaCrop model for predicting teff yield under various scenarios; (iv) to evaluate and develop suitable and optimal soil water conservation techniques for adaptation and mitigation of climate change and climate variability for teff.

Literature Summary

Water is the major crop production limiting factor in semi-arid environments of Africa (Araya *et al*., 2010). In northern Ethiopia, the uneven distribution of rainfall over the season and the shortening of growing periods due to late start or early cessation of rains have been causing crop failure over the past three decades. Currently, rainy seasons in the northern Ethiopia

are shorter than the length of growing period of crop varieties grown in the region. Therefore, optimising rainwater use has paramount importance. Teff is normally not sown until the peak of the rainy period, which in Tigray is from the 3rd week of July to the 1st week of August (Araya *et al*., 2010). Wet sowing is preferred to avoid false start and to improve seedling establishment as well as reduce shoot fly infestation. Often, the rainy period ends 40 to 50 days after the normal planting time of teff, but the duration of Teff's growing period ranges from 80 to 85 days. Considering a normal season, the occurrences of late-season (after rainfall cessation) dry spells are more pronounced than intra-seasonal (within the rainy season) dry spells. The occurrence of late-season dry spells coincides with the critical crop growth stage, in particular flowering and yield formation stages. Given that rain ceases in the middle of the growing stage, supplemental irrigation is necessary for optimum teff growth. Planting time techniques is known to optimise the rainwater use in the season (Tesfay and Walker, 2004). Identification of the most reliable onset will enable farmers to improve rainwater use and to reduce false start risks and to obtain better crop yield (Mugalava *et al*., 2008). Analysing onset and cessation of growing period has therefore paramount importance in reducing crop failure. Several other rainwater management practices such as the use of in-situ water conservation measures have been recommended to optimise the rainwater use (Araya and Stroosnijder, 2010). These practices prolong the season and mitigates short dry spells. However, the water conservation techniques have not been tested if they could further improve the crop yield when they are combined with optimal planting time. The sustainable use of water must consider maximising yield per unit of water used 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 resource and could be useful to avoid cropping risks (Tsubo *et al*., 2005; Soltani and Hoogenboom, 2007). The AquaCrop model simulates the variation in attainable crop biomass and harvestable yield in response to variation in soil moisture in the root zone. Biomass growth is associated with crop parameters such as stomatal conductance, canopy senescence and harvest index (Steduto *et al.*, 2009).

Study Description

The study site is Tigray region located in northern Ethiopia (39° 5'-39° 8'E; 12° 3'-13° 7'N). The climate of Tigray is characterised as dry semi-arid (Araya *et al*., 2010). The site was chosen due to availability of relatively long periods of climate observations and occurrence of recurrent drought. The farmers in this area have experienced regular drought for a long time, so their perceptions of drought and crop failure would be valuable to consider when analysing climatic data.

Specific places of teff producing areas in the region (LL Raya, HL Raya and ML Enderta) have been selected for the study. These will be used to characterise and classify past growing periods and the major agrometeological factors that have caused crop failure. In addition, data are being gathered from the Ministry of Agriculture and the Statistical Authority Office. The onset, cessation and length of growing period (LGP) are being analysed based on predetermined criteria as well as from the information gathered from farmers. Farmers' information will be compared with the analysed data. Dry spell analysis and inter and intra-seasonal drought analysis will be carried out using various techniques and models. Seasonal water deficit periods and site specific crop water requirements will also be analysed.

Research Application

It is hoped that the information generated will be used to develop a simple but reliable method of assessing drought in the area. The frequency of drought seasons over the past years in the study area will be known. Possible drought mitigation strategies will be established for each site and recommendations for reducing impacts of drought made. Those recommendations will be available and tested together with the Bureau of Agriculture and selected farmers in the region.

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