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Evaluation of Spatio-Temporal Rainfall Variability and its Implications on Pearl Millet Production in Semi-Arid Areas

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Abstract

Improving knowledge on spatio-temporal rainfall variability and its influence on small farmers' agricultural crop production strategies enables mitigating climate change and preparing upgraded adaptation strategies in rainfed agriculture.

We measured rainfall for 50 different spatial locations over the area of 12.5km^2 in Idifu village, in the semi-arid Dodoma region of Tanzania for the season 2015/2016 and 2016/2017. Using K-Means Algorithm for Clustering method and QGIS, existing rain gauges and new rain gauges were positioned to a centroid to cover the area of influence of approximately 250,000m^2. The average distance between rain gauges was approximately 500 m. CROPWAT model was used to calculate the daily and decade crop evapotranspiration (ETc) of pearl millet in that study area for each month during the growing season. The amount of daily rainfall collected at different positions in the village for each month was compared to the calculated crop evapotranspiration to determine the ETc deficits in each particular location.

The results show that the total ETc of pearl millet in the area on average is 527mm which was higher than the average amount of rainfall of the area for both seasons. However, both rainfall and ETc deficits vary spatially in that small agricultural watershed significantly ($p < 0.05$) within a short distance. The daily rainfall variability is by far higher than the monthly and seasonal variability. This explains the high variability and risk of crop failure since the amount of rainfall deficit which highly affects the crop growth and production is the daily rainfall deficits as compared to the monthly and the season rainfall.

Farmers have adapted to these conditions by using crop management strategies such as dry-seeding, re-seeding, transplanting and spatially distributing their fields across larger areas. Still they have been repeatedly suffering from crop failures during the last years. Other strategies are therefore required and are being tested to reduce the effect of daily rainfall variability. Infield rainwater harvesting such as tied ridges and ponding pit cultivation may act as means for extending favourable soil moisture conditions and hence reduce the acuteness of the spatio-temporal rainfall variability.

Keywords: Crop water requirement, CROPWAT model, farmers' management strategies, pearl millet, rainfall, spatio-temporal variability, watershed

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