ISSN 2310-4090

International Journal of Scientific Footprints Open Access

Assessing the Potential of Conservation Agriculture to Off-set the Effects of Climate Change on Crop Productivity using Crop Simulations Model (APSIM)

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Abstract

Agriculture in sub-Saharan African region has depended mainly on rainfall since 1990s and crop production has faced negative impacts of extreme climate events which are believed to be manifestations of long term climate change. In addition, maize (Zea mays L.) productivity has continued to decline over the past years from 2.5 tons ha-1 in 1964 to 1.5 tons ha-1 in 2013. This is largely due to continuous cultivation, often in mono-cropping with little or no inputs and absence of effective Conservation Agriculture practices. A field experiment for this study was setup on the already established CA long-term trial at Msekera Research Station in Chipata Eastern Province of Zambia. The experimental design used was a split plot with CA and CT treatments as main. During the 2014/15 season CA long-term trials was used with fertilizer application rates of 165 kg ha-1 basal and 200 kg ha-1 top dressing. There was a significant difference of 1802 kg ha-1 on observed grain yield in 2014/15 season compared between Conventional Tillage (CPM2) ridge and furrow and Conservation Agriculture (DS-MC) treatments. CA treatments had maize leaves with greener phenological appearances from 24 to 60 days after planting. Furthermore, APSIM model was used to simulate the long-term effect of climate change on maize productivity for 85 seasons using rainfall increase and decrease of 11.3 percent and temperature rise at +1.0 ^{o}C, +2.0 ^{o}C, and +3.0 ^{o}C as climate change scenarios. Root Mean Square Error was used to assess the performance of the model and the prediction were 22.57 percent for grain yield, 73 percent for biomass yield and 8.6 percent for soil water results for both measured and simulated outputs and that represented fair to excellent performance of the model. The APSIM simulated long term results revealed decrease in annual rainfall by 11.3 percent as climate scenario increased maize grain yield under CA treatments by 4 percent. While increasing temperature by 3.0 ^{o}C reduced maize grain yield by 31 percent for CT treatments. The model also predicted that 22 growing seasons out of 85 will experience adverse drought that will affect maize grain yield mostly for CT practices.

Keywords: Conservation Agriculture (CA), Conventional Tillage (CT), APSIM, RMSE.