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## Slope drivers grain yield in the Yunnan Plateau-Mountain areas

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The plateau-mountain areas around the globe are at risk of food insecurity because of its high intensity of soil erosion, limited suitability of land for agriculture and increasing population pressure. Although plant breeding, improved plant-protection techniques, new variety, application of fertilizer promote increases of crop yields, more frequent extremes of climatic events, topography related to soil erosion can lead to progressive instability in crop production. However little consideration is given in relationships between climatic, topographical factors and grain yields in the Plateau-mountain region. In this study, we collected county-level data on the actual grain yield and environmental factors of the 119 counties in Yunnan province over the past 28 years (1985–2012) to explore the controls on grain yield and how they affect grain yields. Our findings showed that actual grain yield (AGY) increased over time with an inter-annual fluctuation. Spatially, our findings revealed AGY were strongly influenced by slope. Regression analysis also showed that slope gradient could explain 26.29% of the spatial distribution variability of AGY. Redundancy analysis revealed that AGY positively correlated with evaporation, TN90p, TK, and pH whereas negative correlations with Apr, RH, R50, C/N, slope, and aspect. However climatic and topographic factors and soil properties exhibited greater impacts on AGY, compared to extreme climate indices. We also found that TK showed a significantly positive effect on AGY, indicating that counties with higher TK content in soils could produce higher actual grain yield. And R50 and aspect also had an indirect effect on AGY through influencing TK. Thus, the application of K fertilizer in northwestern, northeastern, and southeastern Yunnan province where soil TK was relatively low may be the key to improve grain yield.