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Predicting Crop Yield Losses Due to Soil-Water Salinity: Comparison of Traditional and Alternative Approaches

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Abstract. It is estimated that 2,000 ha of cropland are taken out of production daily worldwide due to salinization and sodification. Salinity is estimated to result in economic losses of $27.3 billion U.S. dollars annually. A project funded through the US-Pakistan Center for Advanced Studies in Water aims to jointly develop techniques for quantifying the severity of soil-water salinity and impacts on crop production on surface-irrigated fields in Pakistan's Indus River Valley and in the Lower Arkansas River Valley (LARV) in Colorado. The Fairmont Drainage District study site in the LARV is a furrow-irrigated, tile-drained area of about 200 ha that suffers from salt-affected (primarily gypsum) soils due to shallow water tables resulting from inefficient irrigation practices and inadequate drainage. One of the study objectives was to use electromagnetic induction (EMI) derived bulk apparent soil electrical conductivity data (EC_a: 0 - 1.5m depth) and saturated-paste extract electrical conductivity (EC_e), to model maize relative yield (RY) impact using four approaches and compare results. The first method is a traditional piecewise linear approach developed by Maas and Hoffman (1977) where EC_e predicts RY using a salinity tolerance threshold, and a sensitivity to accrued salinity. The second involved a "modified discount function" that utilized a shape parameter to fit a sigmoidal function relating RY to EC_e. The third and fourth methods were linear and sigmoidal four parameter logistic (4pl) models using EC_a or EC_e to predict RY. Results showed that the sigmoidal 4pl model using EC_a as the predictor yields the greatest accuracy for 80 field data points, with a root mean squared error (RMSE) of ± 8.87 percentage points RY and ± 1966 kg/ha absolute yield. This indicates that EC_a is an effective predictor of RY for this dataset, implying that it might not be necessary to collect and analyze soil samples for EC_e when trying to map salinity impacts on maize yield, saving time, labor, and resources. The fitted RY-EC_e regression relationship, however, indicates that the threshold EC_e value at which significant maize yield loss commences for these gypsum soils is markedly higher than the value reported for halite soils by Maas and Hoffman (1977). Additional data will be collected in 2019 to confirm preliminary findings.