

# Determination of actual crop evapotranspiration (ET<sub>c</sub>) and dual crop coefficients (K<sub>c</sub>) for cotton, wheat and maize in Fergana Valley: integration of the FAO-56 approach and BUDGET

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## Abstract

Determination of the actual crop evapotranspiration (ET<sub>c</sub>) during the growing period is important for accurate irrigation scheduling in arid and semi-arid regions. Development of a crop coefficient (K<sub>c</sub>) can enhance ET<sub>c</sub> estimations in relation to specific crop phenological development. This research was conducted to determine ET<sub>c</sub> values as well as daily and growth-stage-specific K<sub>c</sub> for cotton (*Gossypium hirsutum L.*), winter wheat (*Triticum aestivum L.*) and maize (*Zea mays L.*) for silage at fields in Fergana Valley (Uzbekistan). The soil water balance model - BUDGET with integration of the dual crop procedure of the FAO-56 was used to estimate the ET<sub>c</sub> and separate it into evaporation (E<sub>c</sub>) and transpiration (T<sub>c</sub>) components. An empirical equation was developed to determine the daily K<sub>c</sub> values based on the estimated E<sub>c</sub> and T<sub>c</sub>. The K<sub>c</sub> determination and comparison to existing FAO K<sub>c</sub> values were performed based on 10, 5 and 6 study cases for cotton, wheat and maize, respectively. Mean seasonal amounts of crop water requirement in terms of ET<sub>c</sub> were 560±50, 509±27 and 243±39 mm for cotton, wheat and maize, respectively. Estimated ET<sub>c</sub> for these crops were 1.10-fold, 1.09-fold and 0.73-fold of recommended irrigation norm according to currently used hydromodule zoning (GMR) under semi-hydromorphic reclamation regime in Fergana province. The growth-stage-specific K<sub>c</sub> for cotton, wheat and maize was 0.15, 0.27 and 0.11 at initial; 1.15, 1.03 and 0.56 at mid; and 0.45, 0.89 and 0.53 at late season stages. These K<sub>c</sub> values correspond to those reported by the FAO-56. Development of site specific K<sub>c</sub> helps tremendously in irrigation management and furthermore provides precise water applications in the region. The developed simple approach to estimate daily K<sub>c</sub> for the three main crops grown in the Fergana region was a first attempt to meet this issue.

**Keywords:** Actual crop evapotranspiration, evaporation and transpiration, crop coefficient, BUDGET, Fergana Valley.

## 1. Introduction

Agriculture in Uzbekistan, due to arid climate, relies heavily on irrigation, where about 90% of the water supply is used by agricultural sector for irrigation on roughly 4.2 Mha of land (CAWaterInfo, 2013; Qadir et al., 2009). About 98% of these irrigated lands are practiced by furrow irrigation (Horst et al., 2005; Reddy et al., 2013).