# LESSONS LEARNED FROM 40 YEARS OF INCREASING THE WATER PRODUCTIVITY OF U.S. COTTON

**Edward M. Barnes**
**Cotton Incorporated**
**Cary, NC**

## Abstract

Over the last 40 years, cotton yields have increased by 50% while total irrigation water use has declined by 40% in the United States (USDA-NASS, 2019), resulting in a large increase in cotton's water productivity (CWP, mass of cotton and cottonseed produced per unit of water used). Cotton has always been a heat and drought tolerant crop; thus, it is often grown in water limited areas (e.g., Gowda et al., 2007), and that has led to an inappropriate association of cotton with water shortages. In reality, cotton only represents 3% of global agricultural water use (Hoekstra and Chapagain, 2007). The water removed by a cotton crop is similar to other row crops (e.g., soybeans and corn) and uses less water than a typical grass lawn per year in most environments (Allen et al., 1998). Only approximately 50% of the world's cotton is produced with irrigation water, with the remaining water coming from rainfall (Chapagain. et al. 2006).

Even with cotton's drought tolerance, there has been a consistent research effort in the U.S. to decrease cotton's irrigation water use that has contributed to the significant increase in cotton's CWP over the last 40 years as previously mentioned. Contributing factors to cotton's increased CWP include: improve water delivery systems such as low, energy and pressure application systems (LEPA) and drip irrigation; better irrigation scheduling tools; and an increase in crop productivity without an increase in water use (Barnes et al., 2020). There are opportunities to continue this trend that will include increased adoption of sensors for irrigation scheduling and more use of cover crops where possible to increase rainfall capture and increase the water storage capacity of the soil. The climate models indicate a future with increased volatility and intensity of rainfall for many parts of the world and that will increase the importance of farm ponds to capture rainfall runoff that will likely occur despite the presence of cover crops.

It is also important to review this progress with appropriate metrics. Zwart and Bastiaanssen (2004) determine a global average CWP for cotton fiber (seed excluded) of 0.23 kg $m^{-3}$. The inverse of CWP is an approximation of what is referred to as a water footprint, and in this case the cubic meters of water (irrigation and/or rainfall) for a kg of fiber is 4.3. In addition to CWP, irrigation water productivity is a key metric, defined as irrigation crop yield minus non-irrigated crop yield that is then divided by the total irrigation water used (Howel, 2001). Additional irrigation metrics such as irrigation efficiency and irrigation sagacity are reviewed by Burt et al. (1997). Continued technology developments and cotton growers demonstrated willingness to adopt new technologies points to an optimistic future for cotton's ability to adapt to decreasing global water resources.

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