Integrating Cotton and Beef Production in the Texas Southern High Plains: I. Water Use and Measures of Productivity


ABSTRACT

Texas High Plains agriculture, largely dependent on water from the Ogallala aquifer for irrigation, exemplifies semiarid agricultural regions where irrigation is used at nonsustainable rates of extraction. Integrating crop and livestock systems has been suggested to conserve water and to achieve other environmental and economic goals compared with monoculture systems. From 1998 to 2008, two large-scale systems, with three blocks in a randomized block design, compared irrigation water, productivity, chemical inputs, and specific pests of (i) a cotton (Gossypium hirsutum L.) monoculture, and (ii) an integrated three-paddock system that included cotton in a two-paddock rotation with grazed wheat (Triticum aestivum L.) and ryegrass (Secale cereale L.) and the perennial variety WW-B. Dahl old world bluestem (OWB) [Bothriochloa bladhii (Retz.) S.T. Blake] in a third paddock for grazing and seed production. All paddocks were irrigated by subsurface drip. Angus crossbred beef steers (Bos taurus; initial BW 229 kg; SD = 33 kg) grazed 185 d from January to mid-July each year. During the 10 yr following the establishment year, cotton lint yield was similar and averaged 1370 kg ha–1 for both systems. Bluestem seed yield averaged 25 kg pure live seed (PLS) ha–1. Steers gained 139 kg on pasture and 0.79 kg d–1. Per hectare, the integrated system used 25% less (P < 0.001) irrigation water, 36% less N fertilizer, and fewer other chemical inputs than monoculture cotton. Integrated production systems that are less dependent on irrigation and chemical inputs appear possible while achieving goals of sustainability, fiber production, and food security.

A long-term goal for any nation must be food security—the basis of a stable society and the foundation of national security. Sustainable and secure food and fiber production and an economically and ecologically viable agriculture cannot deplete the resources nor destroy the environment on which they depend. Agriculture today faces global challenges including continued population growth with an increasing food demand, changes in composition of food demand from a grain-based diet toward one higher in meat and milk products, depletion of natural resources, dependence on irrigation, and climate change. These issues, combined with unstable economics, a fossil fuel-based energy system, changing government policies and regulations, and competition for land by nonagricultural uses threaten our capacity for food security and sustainable production.

Monoculture systems in the United States, with economies of scale and advantages of specialization, have been highly successful at providing an abundance of safe and healthful foods. Such monocultures can put unacceptable stress on ecosystems and natural resources and result in unstable economics (Altieri, 2000). Input costs are now such that a single unfavorable growing season can result in financial collapse for the producer and the loss of future opportunities. Water scarcity and municipal and industrial competition for water are becoming a national imperative. Population growth and economic development are projected to have greater impact on water supply by 2025 than projected global climate change (Vörösmarty et al., 2000). Nowhere is this more evident than in the semiarid West Texas High Plains where agriculture accounts for about 28% of the region’s economy (IMPLAN, 2009), but depends heavily on water for irrigation from the Ogallala aquifer at nonsustainable rates of extraction (TWDB, 2007). Once a vast grassland, today this region has about 25% of U.S. cattle on feed and produces about 30% of U.S. cotton, primarily in monoculture systems (USDA-NASS and TDA, 2009). About 70% of this is irrigated cotton. With dependence on irrigation at unsustainable rates of use, the future of agriculture in this region will not be a continuation of traditional practices. Although crop rotations have long been known for complementary benefits, effects of irrigation and the deliberate integration of crops and livestock to achieve complementary benefits on system sustainability is less well known. Kral and Schuman (1996) suggested that integrated crop and livestock systems can represent an ecologically and economically

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Abbreviations: BW, body weight; CP, crude protein; ET, evapotranspiration; OWB, old world bluestem; PLS, pure live seed.