GIS ANALYSIS OF PROXIMITY INFLUENCE OF AGROFORESTRY AND GRASS BUFFERS ON CORN AND SOYBEAN YIELDS

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Introduction

Although agroforestry alley cropping practices have been shown to improve environmental quality (Bharati et al., 2002; Udawatta et al., 2002; 2010; 2011; Dosskey et al., 2007), it could affect the crop yields adjacent to the perennial vegetative buffers due to competition for resources (Singh et al., 1989; Jose et al. ,2000; Reynolds and Simpson, 2007). The objective of this study was to examine temporal and spatial variation in no-till cultivated corn (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.] yields between buffers in watersheds with agroforestry (tree+grass; AGF) and contour grass (CGS) buffers.

Methodology

Yield data were determined in the three adjacent watersheds study (Udawatta et al., 2002) established in early 1991, having areas of 1.65ha (East), 4.44ha (Center), and 3.16ha (West; Fig. 1c), located at the University of Missouri-Greenley Memorial Research Center, Knox County, Missouri. Treatments were randomly assigned in 1997 following a calibration period (Udawatta et al., 2002). In the west and center watersheds, 4.5m wide permanent contour grass-legume strips were established at 36.5m spacing and at 22.8m spacing at the lower slope positions. Grass buffers consist of redtop (*Agrostis gigantean* Roth), brome grass (*Bromus spp*.), and birdsfoot trefoil (*Lotus corniculatus* L.). Pin oak (*Quercus palustris* Muenchh.), swamp white oak (*Q. bicolor* Willd.), and bur oak (*Q. macrocarpa* Michx.) trees were alternately planted at 3m spacing within the grass-legume strips along the center of the grass buffers in the Center watershed.

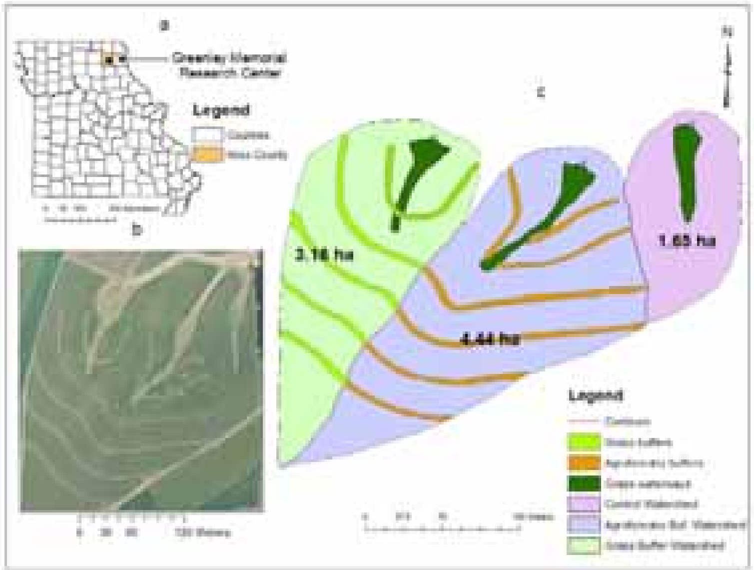

Figure 1. Approximate location of Greenley Memorial Research Center in Knox County, Missouri (a). Aerial view (b) and land management maps (c) showing grass buffers on the contour strip watershed and agroforestry (tree+grass) buffers on agroforestry watershed. The dark green strip represents grass waterways for individual watersheds.

GPS yield data points used for the study were collected with yield monitors attached to combines for corn and soybean. The yields at four different distances from buffers; 0-5, 5-10, 10-15, and 15-20m were extracted for corn and soybean from 2004 to 2009 using GIS software. The yields adjacent to buffers in the center of both CGS and AGF watersheds were used for the analysis to minimize landscape and soil variation in the study area. Summary statistics of mean yield and standard deviation generated by GIS software for the extractions were used for the comparisons. Minimum number of data points used to generate mean yields was 180. Percent change in yield at strips 0-5, 5-10 and 10-15m distant from buffers was calculated with respect to the yield at 15-20m distance as it is the center strip between buffers.

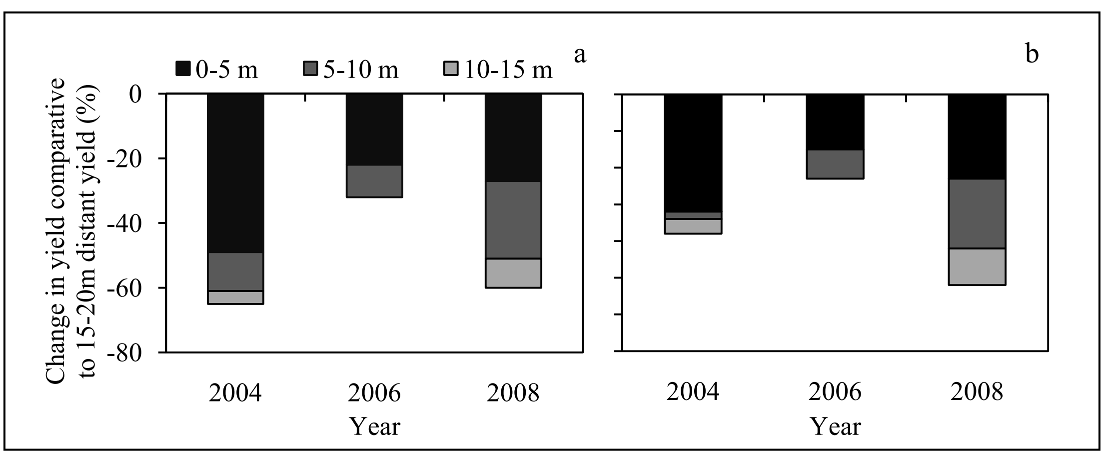

Figure 2. Percentage reductions in corn mean yield at 0-5 m, 5-10 m, and 10-15 m distances from agroforestry (AGF; a) and contour grass buffers (CGS; b) compared to the yield at 15-20 m of the respective watershed at the Paired Watershed study at Greenly Research Center.

Results

Percentage change in corn yields at 0-5, 5-10 and 10-15m compared to 15-20m distance from buffers at AGF and CGS watersheds for the study years are given in fig.2. Corn yields at 0-5m distance from buffers were the mostly affected with reductions in yield by 22 to 49% in the AGF and 15 to 32% in the CGS watersheds, respectively, compared to the yield at 15-20m distance from the buffers in all the years. The extent and magnitude of buffer influence on corn yield varied over the years. The results indicate that the interference at the buffer-crop interface was enhanced in the year 2004 where moisture stress periods prevailed and during the year 2008 where late planting was done. The lowest buffer influence on corn yield was found in the year 2006 which also recorded the overall highest corn yields over the other two years.

As shown in fig. 3 soybean yields were less affected at all distances from both AGF and CGS buffers compared to 15-20m from the buffers. In the year 2009 when the soil moisture was abundant, proximity to buffers was favorable for soybean in both types of buffers. When soil moisture was limited CGS buffers has been less competitive than AGF buffers for soybean.

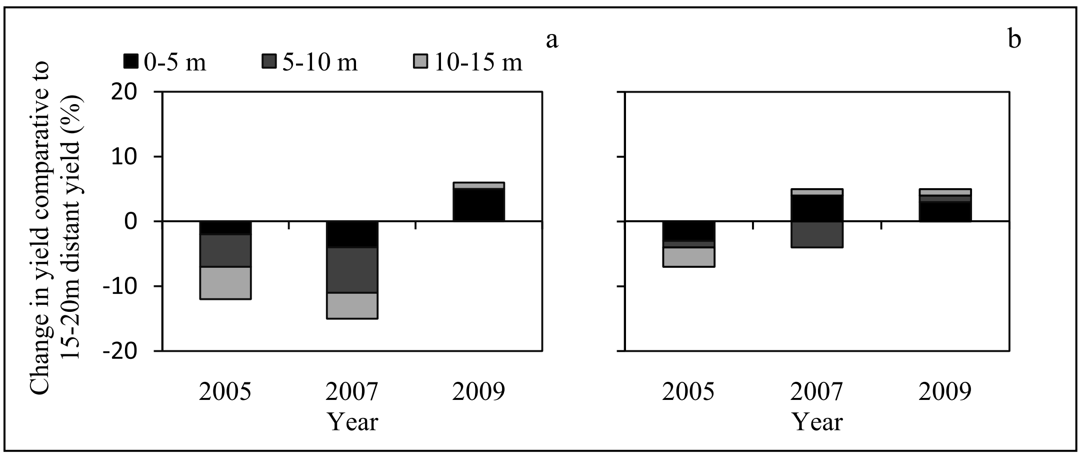

Figure 3. Percentage reductions in soybean mean yield at 0-5 m, 5-10 m, and 10-15 m distances from agroforestry (AGF; a) and contour grass buffers (CGS; b) compared to the yield at 15-20m from AG and GR buffers of the respective watershed at Greenly Research Center.

Summary

Agroforestry and grass buffers adversely affected corn yields with maximum reduction in corn yields at 0-5m from the buffer strips ranging from 15 to 49% reductions compared to that of the center between buffers. The factors favoring higher yields such as early planting, sufficient soil moisture during planting to milk stages coupled with high yielding varieties, tend to lessen the adverse effects on corn yields by buffers. In contrast, soybean yields showed less affected by the buffers and when moisture is not limiting yields were slightly increased at 0-5m distance in the year 2009. Long-term environmental benefits of buffers need to be balanced with yield losses in corn by introducing management practices such as root and tree pruning, establishing root barriers, use of better varieties to withstand competition, early planting, and using economically beneficial plant species in buffers.

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