Cropping System Transitions in Mississippi: Linking Remotely-Sensed Production Patterns with Planting Date Probability Maps

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INTRODUCTION Landscape-level changes in cropping system dominance, such as the shift from upland cotton (*Gossypium hirsutum* L.) to corn (*Zea mays* L.) in Mississippi has caused variably-scaled disruptions in the connectivity of science and the practices of crop care professionals. The "evidence-based agriculture" model prompts practitioners to keep track of a burgeoning knowledge base in a systematic way, however, dramatic shifts in crop sequences and planting intensities have produced inter-related complications challenging producers and extension specialists. In sharp contrast to cotton, long-term corn trials on experimental stations have not occurred; therefore, optimal planting intervals as well as yield penalties for continuous production are unknown. Geospatial integration of a 5-year corn cropping footprint (derived from 2009-2013 Cropland Data Layers) with a series of updated temperature-based planting date probability maps enables Mississippi farmers and other crop professionals to adapt management strategies and minimize early-season risk.

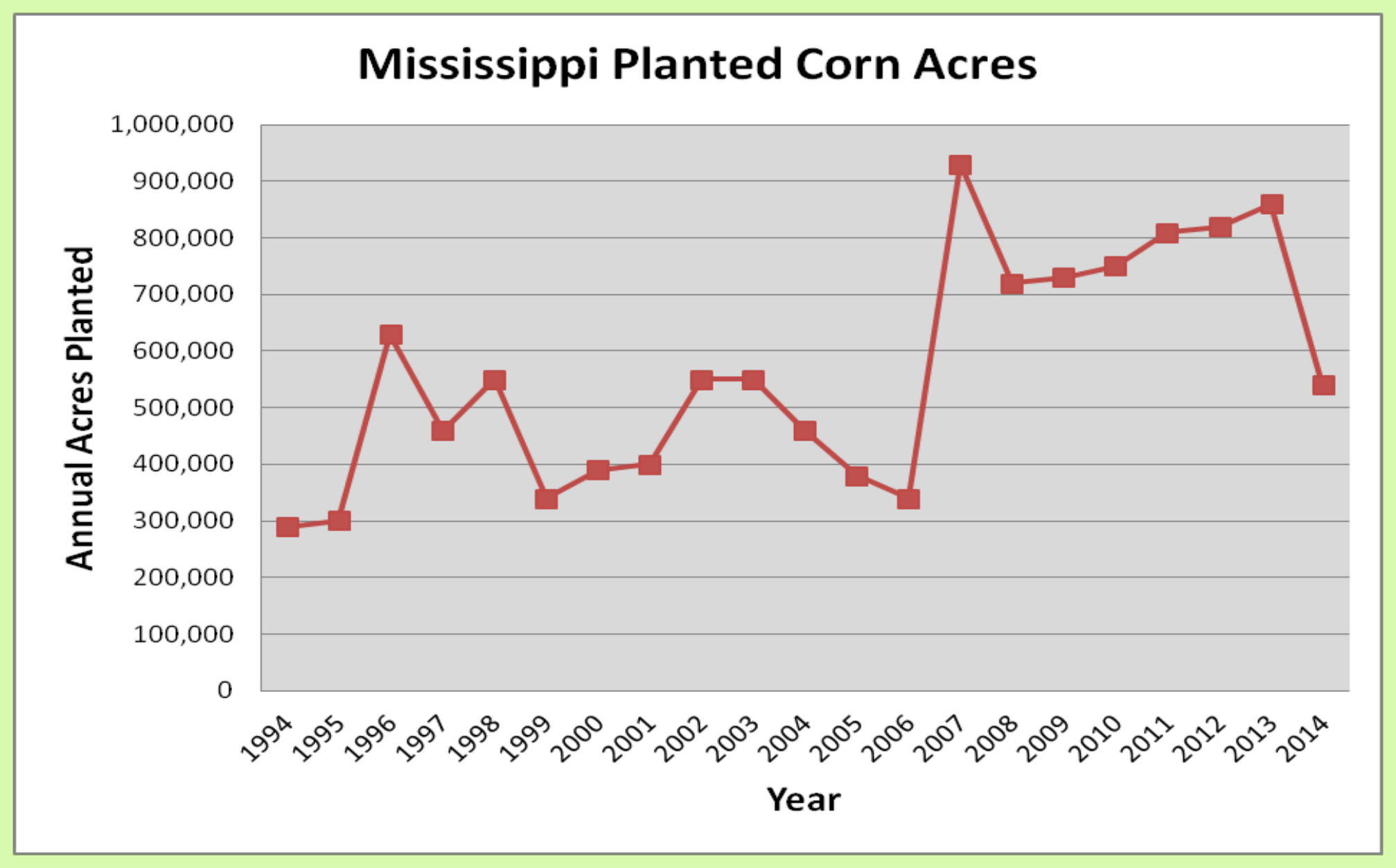


Fig. 1. Historical profile of corn acreage planted in Mississippi. At its peak, in 2007, 930,000 acres were planted to corn. The 5-year interval selected for this study (2009-2013) in all likelihood effectively "captures" the extent of the corn acreage footprint in Mississippi by accommodating for 2-, 3-, and 4-year rotation cycles. *http://www.nass.usda.gov/Quick_Stats/*

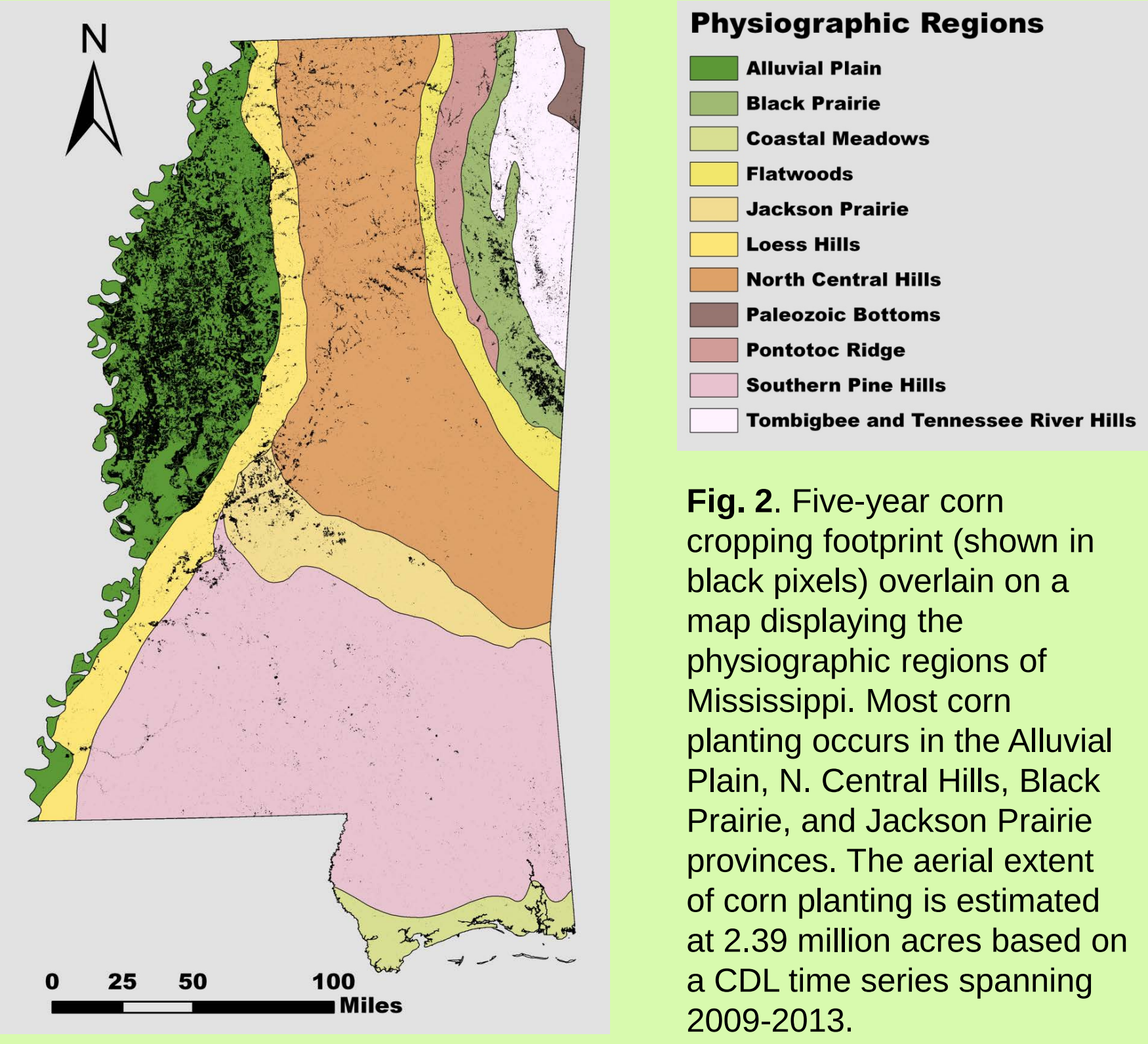


Fig. 2. Five-year corn cropping footprint (shown in black pixels) overlain on a map displaying the physiographic regions of Mississippi. Most corn planting occurs in the Alluvial Plain, N. Central Hills, Black Prairie, and Jackson Prairie provinces. The aerial extent of corn planting is estimated at 2.39 million acres based on a CDL time series spanning 2009-2013.

MATERIALS and METHODS A 5-year corn cropping footprint was constructed from the CDL time series (2009-2013 as posted on CropScape); one dataset (2009) was resampled to 30m to conform to current acquisition standards. Other key crops considered in our geospatial study included soybean, cotton and rice. A "clump and sieve" model was developed to constrain and partially correct remotely-sensed crop recognition errors while retaining corn fields as small as 3 acres. The planting date probability maps were derived from 30-year climate data (1984 to 2013), using 61 stations within the state and 270 stations surrounding the state. Day of the year for the last time the temperature was at or below a specified threshold between January and July were compiled from the 30-year dataset at each station. An inverse probability distribution was used to calculate the dates for a specific risk level. Six sentinel counties were selected based on corn cropping intensities. Methodological details for determining crop intensities and/or crop sequences based on a particular multi-year acreage footprint have been published by several authors (Boryan et al. 2008, DeFauw et al. 2012, Stern et al. 2012, Ebinger 2013). CDL datasets are posted at *http://nassgeodata.gmu.edu/CropScape/*

RESULTS Since Federal incentives started in 2007 (ethanol fuel), more corn has been planted in Mississippi (Fig. 1). The 5-year corn cropping footprint occupies 56% of Mississippi's harvested land base (using the harvested land value reported in the 2012 Census of Agriculture) and has been estimated at 2.39 million acres (Fig. 2). Over half of the counties in the Delta have invested between 60-85% of their arable land in corn across the 5-year interval. Washington, Yazoo and Leflore counties have sustained the largest areas in high intensity corn production with approximately 45,000 to 50,000 acres engaged at least 3 out of 5 years (Fig. 3a). Hot spots in continuous corn (a total in excess of 1,000 acres) were mapped to Washington, Yazoo, Leflore, Sharkey, Coahoma, and Warren. Temperature-based probability maps created at 5 and 10% risk levels reveal 7-21d differences in planting date just spanning the Alluvial Plain (Fig. 4). Cropping intensities for corn as well as their spatial interdependencies with soybean, cotton and rice have been summarized for the six sentinel counties identified in this study (Figs. 3a & 3b). Planting locations and history are revealed by the intensity maps (Fig. 3a); spatial interdependencies of select crops derived from the CDL time series are described in Figure 3b. CropScape may also be used to provide a rapid comparison of land use for any 2-year period (Fig. 5).

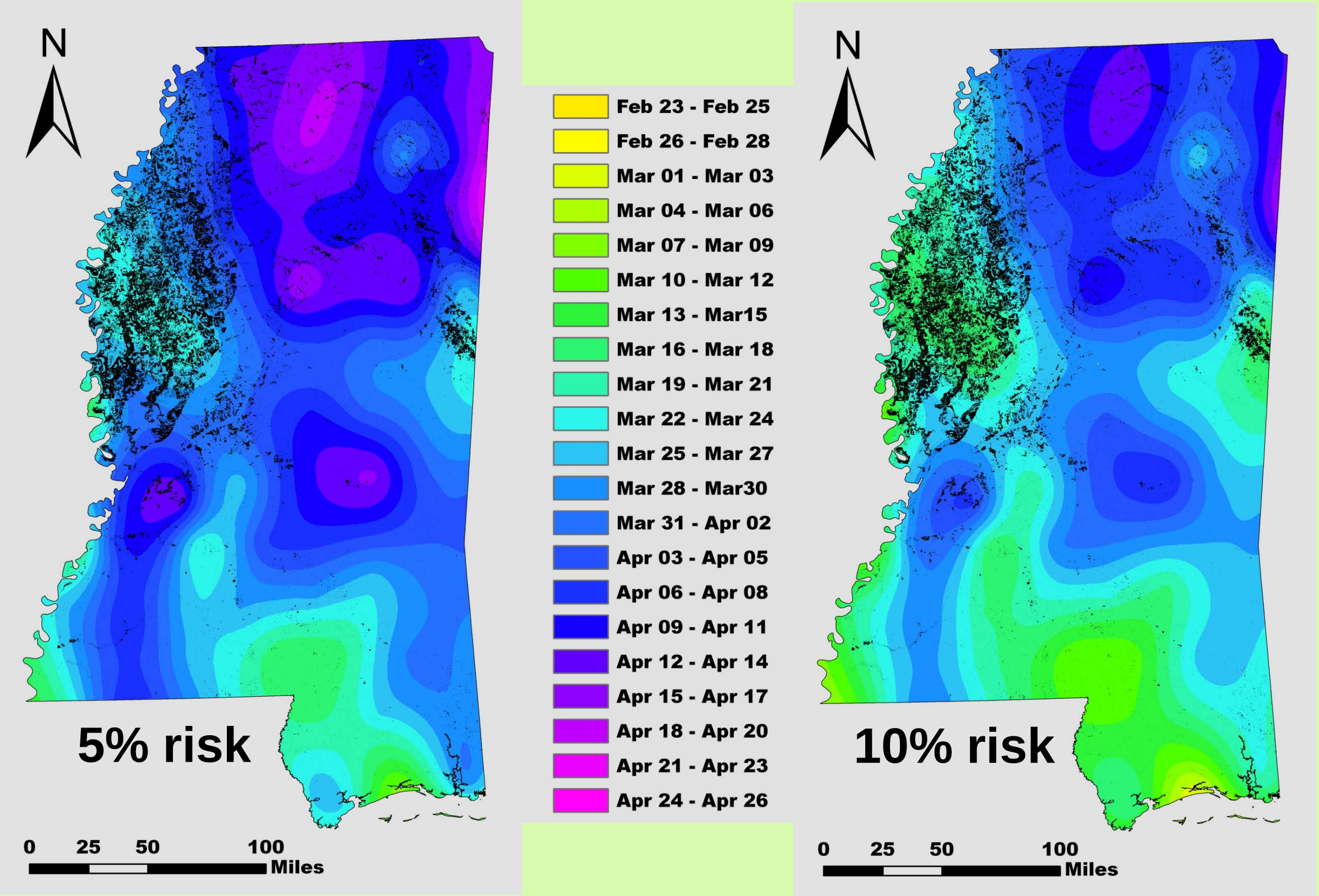


Fig. 4. Corn planting date probability maps with 5-yr corn footprint overlays (the latter shown in black). Color gradients are linked to planting date intervals that display areas with either a 5% or 10% risk of temperatures falling below a critical threshold of 28 °F.

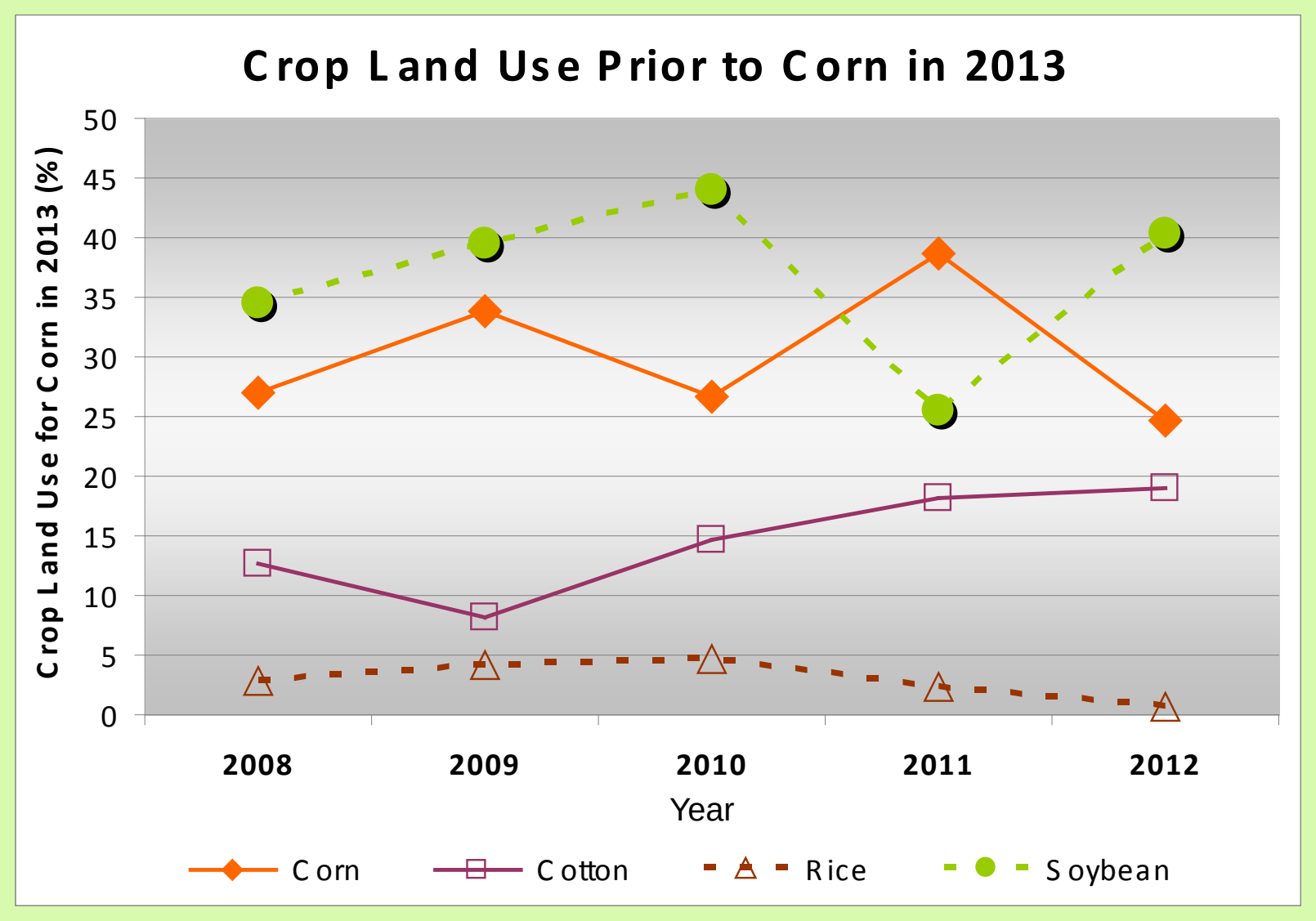


Fig. 5. CropScape was used to quantify land use per year from 2008-12 for Mississippi land planted to corn in 2013. CropScape has on-line tools which allow farmers, extension specialists and other interested parties to obtain profiles of cropping history for an area of interest. This knowledge, at the appropriate scale (i.e., field- or farm-scale), may be used to direct pest, pathogen and/or resistance sampling. *http://nassgeodata.gmu.edu/CropScape/*

CONCLUDING REMARKS Sustainable intensification hinges on the identification of profitable cropping systems with rotations that result in annual yield optimization to improve financial outcomes for farms throughout Mississippi. Development of an interactive, user-friendly, web-based version of these geospatial agronomic models is underway to further resolve the spatial patterns of extreme years where planting dates were delayed by either the persistence of unusually cold weather or heavy precipitation when compared to the 30-year normal dataset. The fusion of planting date maps (at either the 5 or 10% risk level) with cropping intensity maps at the appropriate scale (i.e. field- or farm-scale) may be used to monitor pest, pathogen and/or resistance issues. Some of the maps presented here are available at *http://www.deltaweather.msstate.edu/ag_weather_products/cornplanting.htm*

Fig. 3a. The 5-year cropping footprint for corn (derived from 2009-2013 CDLs) was geoprocessed to reveal planting intensities. Six sentinel counties have been highlighted in red on the statewide map. These sentinel counties were selected based on the aerial extent of the 5-year corn footprint as well as intensities. Corn cropping intensities highlight production "hot spots" where pest and pathogen pressures as well as resistance issues should be more closely monitored by crop care professionals. The scale for each sentinel county is 20 miles.

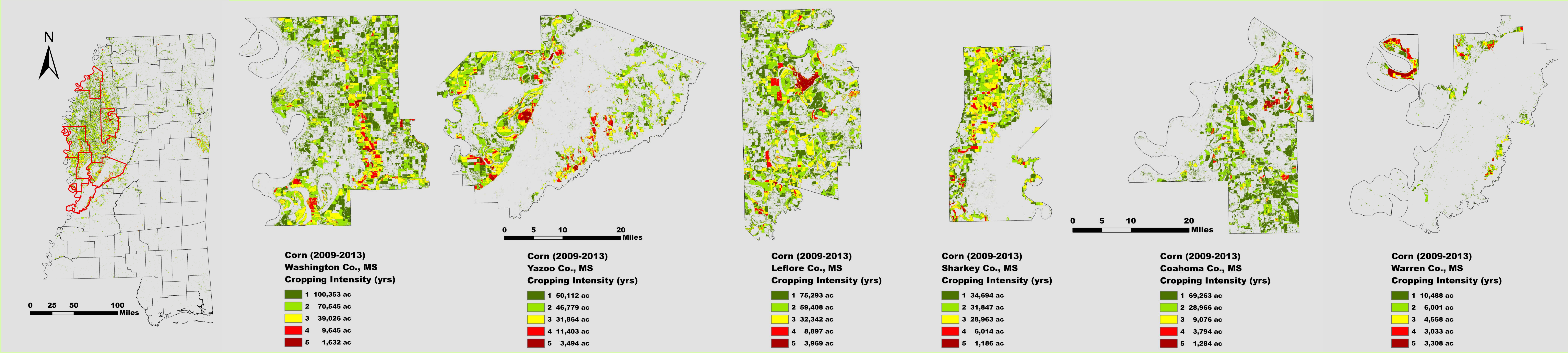
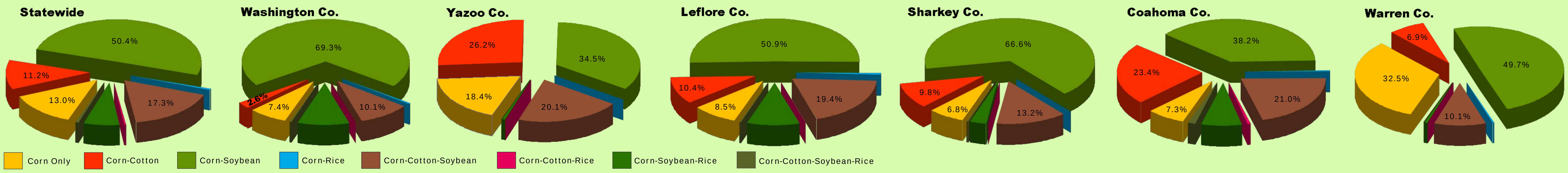


Fig. 3b. Pie charts profile sentinel county-level spatial interdependencies of soybean, cotton and rice with corn. These charts also highlight variations in the aerial extents of 2- to 4-year rotations among the various counties.



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