Economic, Agronomic, and Ecological Costs and Benefits of Field Border Management Practices in Agricultural Systems of Mississippi

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Background

Non-crop field margin habitats provide environmental and agricultural benefits and are important sources of diversity (e.g., shape, type, structure, floristic, and faunal composition) in agricultural landscapes. As policy makers, natural resource professionals, and producers strive to develop incentives, regulations, and policies that encourage sustainable agricultural production, information is needed regarding conservation practices which maintain the function and integrity of agricultural ecosystems while meeting world demands for agricultural commodities. Field borders (upland habitat buffers), as managed components of field margins, produce ecological benefits by providing semi-natural vegetation within the landscape.

Conservation buffer practices, such as field borders, filter strips, and riparian buffers, enhance wildlife habitat and control erosion, and improve water quality through sediment, nutrient, and herbicide retention. However, implementation of conservation practices is dependent upon private individuals who may or may not accrue personal benefit from the practice (e.g., pest management, erosion control). Field borders reduce land available for crop production and may be perceived by farmers as potential sources of weeds and insect pests.

Adoption of conservation practices is often determined by the level of knowledge the farmer has regarding environmental benefits, lost opportunity costs (due to less acreage planted), implementation and maintenance costs, and availability of conservation programs and enrollment procedures. If producers do not perceive benefits to be greater than costs, they are unlikely to adopt conservation practices. However, there may be justification for compensating producers for establishment and opportunity costs if potential public benefits (increased wildlife diversity, improved water quality) outweigh public costs. Development of appropriate agricultural policies and incentives depend upon knowledge of costs and benefits to producers and associated environments.

Objectives

The objectives of this project were to:

1. Estimate the opportunity costs of field border installation as measured by the profitability of cropping relative to enrollment in a subsidized conservation program (Continuous CRP CP33 – Habitat Buffers for Upland Birds).
2. Determine the effect of field borders on infield crop yield.
3. Characterize plant communities in field margins and newly established field borders.
4. Determine the effect of field borders on infield weed competition.
5. Determine the effects of field borders on breeding and wintering grassland songbird populations.
6. Determine the effects of field borders on breeding season and fall abundance of northern bobwhite.
7. Determine the effects of field borders on farm-level habitat suitability for northern bobwhite.

Study Area

Our studies were conducted on 3 privately owned working farms located within the Black Prairie physiographic region in Clay and Lowndes counties, Mississippi. Primary agricultural practices were row crop (approximately 60-80% row crop; soybean and corn), forage, and livestock production. During early spring 2000, experimental field borders (20 ft wide) were established along agricultural field margins (fencerows, drainage ditches, access roads, and contour filter strips) on half of each farm (each ½ ~ 1000 ac). The average percentage of the row crop field area established as field borders was 6%, and field borders comprised about 1% of the land base of each farm. Producers were paid a monetary incentive similar to those used in common USDA conservation buffer programs at the end of each growing season for land placed into field borders. Furthermore, producers were required not to mow, herbicide, or disk field borders during the duration of the study.

Photo 1. Natural revegetation annual weed field border

Figure 1. Study site locations.

Photo 2. Planted partridge-pea field border

Methods

Opportunity Costs: To evaluate opportunity costs associated with a conservation buffer practice (CP33: habitat buffers for upland birds), GPS yield monitor crop data were obtained for 150 fields (corn n = 104, soybean n = 46) from combine operators in Clay, Lowndes, and Noxubee counties, Mississippi for 2000 – 2003 (Figure 2). The yield data were examined for edge effects on yields associated with 3 plant community types (woody, herbaceous, other crop) and 4 sequential swaths of a combine header width (24 feet) relative to field interiors for corn/soybean rotations (Figure 3). Partial budget formats were used to develop break-even analyses comparing crop production vs. enrollment in the Continuous CRP CP33 - Habitat Buffers for Upland Birds practice.

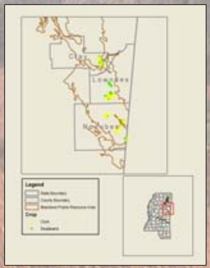


Figure 2. Locations of crop fields included in study of opportunity costs

Figure 4. Sampling design used in study of effects of borders on yield.

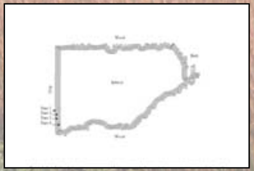


Figure 3. Illustration of 4 combine passes and 3 adjacent community types used in study of opportunity costs of field borders.

Effects of Field Borders on Yield: To evaluate effects of newly established field borders on infield yield, we collected GPS yield monitor data on 9 paired grids within 5 fields on 2 Clay and Lowndes County Farms. Within a grid pair, one was randomly assigned to experimental field border installation, the second had no field border. We collected 11 header passes parallel to the fieldborder/field margin edge. We treated grid pairs as blocks and combine passes as a spatially repeated factor in an ANOVA that compared mean yield within combine passes between bordered and unbordered grids.

Plant Communities in Borders and Field Margins: We characterized field border and adjacent field margin plant community (APC) types (Crop, Herb, and Wood) on 17 sites in 2000 and 21 sites in 2001 & 2002, distributed over 3 farms in Clay and Lowndes Counties, MS. We sampled plant communities within ½ m² frames distributed along field margins/field borders as illustrated in Figure 5.

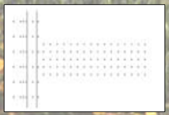


Figure 5. Field border/field margin vegetation sampling design.

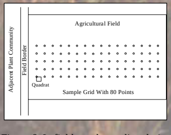


Figure 6. In field weed sampling design.

Effects of Field Borders on Infield Weed Communities:
To determine whether field borders increased the prevalence of agronomic weeds in crops we established 28 pairs of grids, each with 80 sampling points in a 5 x 16 layout on 5m centers (Figure 6). Within each grid pair we randomly assigned field border to one grid and unbordered to the second. At each grid point we measured weed seedling density and occularly estimated canopy cover for each species in 0.25m² (corn) or 0.5 m² (soybeans) sampling frames. We evaluated weed species density in relation to border treatment and proximity to edge.

Effects of Field Borders on Bird Communities:
During 2002 and 2003 we characterized bird communities on experimentally bordered field margins on 3 farms in Lowndes and Clay counties, MS. We classified all crop field edges within these farms by presence/absence of a field border and adjacent plant community (grass block, grass strip, wooded block, wooded strip). From the population of field edges, we randomly selected 10 edge segments from each of the 8 border x adjacent plant community treatment combination. Along each edge we conducted winter and summer bird surveys along 200m transects, under standardized conditions. We recorded all birds observed by species and perpendicular distance from the transect line. We used distance-sampling methodology in Program DISTANCE to estimate bird density (Figure 7).

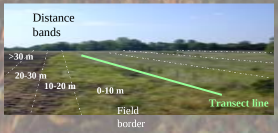


Figure 7. Illustration of bird sampling transects and distance bands.

Results

Opportunity Costs: Competition for sunlight, water, and nutrients, combined with more variable inputs and production practices (e.g. compaction), reduced crop yield at field margins for both corn and soybeans (Figure 8). Yield reduction was greatest next to wood lines, and diminished from the 1st to the 4th combine passes into the field (Figures 9 and 10).

Figure 8. Illustration of reduced corn yield at field margin.

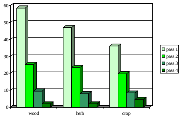


Figure 9. Mean corn yield reduction relative to field interior for 4 combine passes and 3 adjacent edge types.

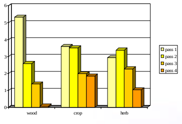
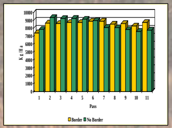
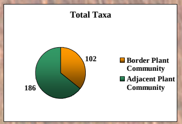


Figure 10. Mean bean yield reduction relative to field interior for 4 combine passes and 3 adjacent edge types.

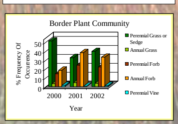
Economics of Production vs. CP33 Enrollment:
On average, if soil rental rates were $59.00/ac, production costs were $320/ac, corn price was $4.00/bu, and expected yield < 150 bu/ac, it would be economically beneficial to enroll up to 30' in CP33 – Habitat Buffers for Upland Birds. If expected yields were below 125 bu/ac, it would be economically beneficial to enroll 60' in this buffer practice. Because soybeans exhibited less yield reduction at the edge, there was less difference in swaths 1 – 4. In soybeans, assuming $150/ac production costs and $8.00/bushel commodity price, CP33 buffers 30 – 100' wide could be more profitable than cropping if expected yields were less than 32 bu/ac.

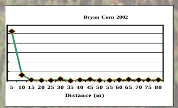
Effects of Field Borders on Yield:
In general, the effect of field border establishment on yield in the first several combine passes adjacent to the border was variable among fields, but relatively small and statistically insignificant relative to observed variation (Figure 11).





Plant Communities in Borders and Field Margins:
Plant communities in experimental field borders were less diverse than adjacent field margins (Figure 12) and dominated by perennial grasses, annual grasses, perennial forbs, annual forbs, and perennial vines (Figure 13).





Effects of Field Borders on Infield Weed Communities:
Although numerous agronomic weeds in the crop fields displayed an edge effect, establishment of experimental field borders did not increase the density of individual weed species or total weeds in either corn (Figure 14) or soybeans.

Effects of Field Borders on Bird Communities
During winter, vegetation in field borders provided thermal cover and food resources for wintering birds and increased local density of grassland sparrows by 10-fold and the conservation value of the wintering bird community by 48%. During the breeding season, field borders doubled the breeding density of several declining songbirds (Figure 15) and increased breeding abundance of bobwhite by 23%. Fall bobwhite populations on landscapes with experimental field borders were 66% greater than those without borders (Figure 16). An average change in land use of 6% increased usable space for bobwhite by 33% (Figure 17).

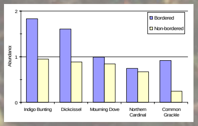


Figure 15

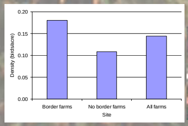


Figure 16

BOBWHITE HABITAT

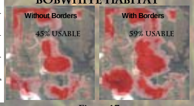


Figure 17

NRCS Natural Resources Conservation Service AGRICULTURAL WILDLIFE CONSERVATION CENTER

FWRC Mississippi State Extension Mississippi State University GRI Sustainable Agriculture Spotlight