Row Crop Response to Topsoil Restored on Borrow Areas

Supplemental Report
of
Project HR-186

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Row Crop Response to Topsoil Restored on Borrow Areas

by

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Abstract

Borrow areas are created where soil is needed to provide fill for construction projects. This research evaluated (1) the changes in row crop productivity resulting from removal of soil for highway construction in Iowa and (2) restoration methods which included: depth of topsoil, subsoil tillage, manure application, and two years of legume growth prior to row cropping. The research was carried out from 1977-1981 at four locations. Corn and soybean yields from borrow areas have been below, equal to, and greater than yields from undisturbed, neighboring farmland. Little or no yield increase was noted from restored topsoil at coarse textured sites. At finer textured sites, a marked yield increase of both crops occurred after the addition of 6 inches of topsoil but little added yield increase resulted from restoring 12 inches of topsoil. Subsoil tillage has shown little or no beneficial effect on crop yields. The manure treatment has resulted in a corn yield increase but only in the first year after application.

Background

Borrow areas are created where soil is removed from one place to provide fill material needed at another place. The material removed from these borrow areas where this research was conducted was used for highway embankment construction. In all instances, the borrow needed for construction had to be obtained from beyond the right of way, and the land would be returned to private ownership. All the borrow areas used in this study had been used for agricultural land use after the borrowing was completed.

When a site is selected to provide borrow material, there are generally two questions to be answered: the suitability of the soil for construction, and the proximity of the borrow to need area.

For this research project, four borrow area sites were selected. At each site highway construction was underway. The sites were selected so they represented a wide range of soil conditions that might be encountered in Iowa. The locations (figure 1) of the sites are: Audubon County, representing the deep loess soils of western Iowa; Buchanan County, representing coarse-textured or sandy soil; Lee County, where soil had developed on several feet of loess deposited over pre-Illinoian glacial till; and Hamilton County, where soil had developed on late Wisconsin glacial till.

Research was begun at the Audubon and Buchanan County sites in 1978. The sites in Lee County and Hamilton County were used for research starting in 1979. The experimental plan called for plots to receive 6 or 12 inches of salvaged topsoil, and these plots were to be compared to others that received no topsoil. In order to replace the desired depth of topsoil, trenches were cut in the subsoil to either 6 or 12 inches. At the Hamilton County site, each trench was 40 feet wide and 400 feet long. After the trench was filled with topsoil, the research area was finished to a 2% grade to provide surface drainage. In addition to topsoil replacement, the research plan called for comparisons of manure applications versus none; subsoil tillage versus none; and corn and soybean production following two years of alfalfa growth or none. Of these additional treatments, only the response to alfalfa will be included in the results presented here.

A row crop rotation consisting of corn alternated with soybeans was followed at each borrow area research site. The replications were divided so that corn and soybeans were grown each year. A similar division of plots was employed where alfalfa was grown for two years, and that allowed both corn and soybeans to appear in the same year on those plots.

Both corn and soybeans were grown using conservation tillage practices. Fertilizer was applied according to soil test recommendations and herbicides were also applied according to label recommendations. Weeds germinated abundantly in the topsoiled plots and that required the use of herbicides.

Results

Three years of research data have been collected at each of the four borrow sites selected to be representative of major soil materials in Iowa.

Audubon County

At the Audubon County borrow site (figure 2 and figure 3), corn and soybean yields equaled or exceeded county average yields during the last two years of the three-year study. This was done without topsoil replacement. Topsoil was deleted from this site because the site was too small to include this treatment. Secondly, topsoil was not salvaged at this site. Previous research work done by Iowa State University has shown that excellent crop yields can be achieved on loess subsoil in western Iowa if it is properly fertilized and managed. The other treatment variables were included in the research at this site, but their effects were non-significant or short-lived, as in the case of the manure application. The alfalfa treatment resulted in greatly depressed yields of row crops because it removed nearly all the plant-available water the year before row crops were planted and there was not enough precipitation to grow corn and soybeans without the subsoil moisture reserve.

Buchanan County

Corn and soybean yields exceeded county average yields (figure 4 and figure 5) in only one of three years at the Buchanan County borrow site. The first year's yields were greatly reduced as a result of the poor seedbed that was prepared only a few days after the site was restored by heavy earth-moving machinery. All other sites used in this research were restored in the fall before the first year of crop production. In the second year of research, 1979, excellent corn and soybean yields were measured at the borrow area and they exceeded the county averages. The results of the third and final year were disappointing because heavy rains, wind, and hail damaged the corn and soybean plots so much that the yields suffered greatly. The most important result from this research site was the lack of response by corn and soybeans to topsoil replacement.

Hamilton County

Corn yields (figure 6) have equaled county average yields at the Hamilton County borrow site in two out of three years where topsoil was restored. Only the second year's results showed no response to topsoil, and corn yields were greatly reduced compared to the county yield. Drought severely affected all plots in 1979 and there was a differential in pollination date between plots with and without topsoil. Corn grown without topsoil pollinated two weeks later than corn grown on topsoil. The stress from the drought was much more severe during the earlier pollination period and a greater percentage of barren plants resulted. Alfalfa treatment tended to increase corn yields slightly, but the effect was not significant.

Soybean yield (figure 7) results at the Hamilton County site were of some interest. In the first year, yields from plots receiving topsoil were twice as great as yields from plots without topsoil. The county's average soybean yield was equaled by soybeans grown on topsoil, but there was no significant difference in yield between plots receiving 6 or 12 inches of topsoil. In the second year of the study, drought greatly reduced soybean yields at the borrow site compared to the county, but unlike corn, the yields from plots receiving topsoil were twice as great as the yields from plots receiving no topsoil. In 1981 the effect of alfalfa growth on soybean yields could be evaluated and it was significant. Soybean yields where no topsoil was restored were three times as great following two years of alfalfa growth. The yield increase on plots receiving topsoil was nearly 20 bushels per acre. The explanation for the yield increase from previous alfalfa growth was a lesser occurrence of Phytophtora root rot infection. This disease organism probably became established when the first crop of soybeans was grown in 1979 and became severe in the second crop grown in 1981. Restoration of topsoil lessened the severity of the disease somewhat, but not enough to prevent a yield reduction of approximately 20 bushels per acre.

Lee County

Corn yields (figure 8) have been disappointing at the Lee County borrow site. There has been a significant response to topsoil replacement, but little difference has been found between the 6- and 12-inch depths. Two years of alfalfa growth appeared to increase corn yields, but the response was not significant.

Soybean yields (figure 9) are reported for only the last year of the study. Topsoil replacement accounted for a large yield increase, but the difference between 6 and 12 inches of topsoil was not significant.

Two years of alfalfa growth did not improve soybean yields as it did in Hamilton County. However, there was no infection of soybeans by Phytophtora root rot at the Lee County site.

Weather probably accounted for much of the variability in yields at this site by injuring the crop or causing other management problems. In 1980, heavy rains in excess of 7 inches over 24 hours washed away plants, fertilizers and herbicides. In 1981, the planting date was greatly delayed by wet weather and only the plots that had received topsoil were in a good condition when seed was planted. Consequently, plant density at harvest was greatly reduced on the subsoil plots because of poor seed germination and emergence of seedlings. However, this did serve to point out topsoil was a superior material when seedbeds were prepared.

Conclusions

This research showed that topsoil replacement is not always necessary at borrow areas. At coarse-textured sites which include deep loess and sandy materials, excellent yields may be obtained without topsoil replacement. Where finer-textured soil materials occur over glacial till, one foot of topsoil should be salvaged before borrowing and replaced when the borrow area is reclaimed. By salvaging the top foot of soil, this will ensure that at least six inches of topsoil will be restored to the borrow area because losses of up to 50% of the topsoil may occur through handling and shrinkage.

Alfalfa or other suitable legumes should be grown in the years immediately after a borrow area is reclaimed. Where topsoil is not restored, this practice should be mandatory to prevent erosion. When these areas are row cropped, conservation tillage practices should be applied to continue to minimize erosion. Another benefit of conservation tillage will be a reduction in soil crusting where organic matter is low, especially when topsoil was not applied. Alfalfa treatment appears to lessen the severity of Phytophtora root rot infection in soybeans. This benefit from alfalfa is still being studied at the Hamilton County borrow site.

Subsoil tillage generally was not beneficial for row crops. The tillage equipment used for this research could not penetrate beyond 20 inches into the soil. This same zone is also greatly affected by freezing and thawing and wetting and drying. The advantage of subsoil tillage, in the first year after reclamation, is to loosen the soil when construction equipment compacts the soil, particulary when borrow is removed during wet conditions.

Manure application was beneficial to corn grown the first year after application. This is generally expected. However, excellent corn yields can be achieved without manure. Farmers with available manure will generally apply it to lands that they wish to improve, and borrow areas are no exception. Many of the benefits of manuring may be duplicated with good conservation tillage programs where crop residues are left at the surface. Manures can also provide a mulching effect, but other materials can serve equally well where mulch is needed.

Finally, some conclusions regarding productivity can be drawn from this research. Row crop yields may be greatly reduced in the first year after a borrow area is restored. Yields were greatly reduced if row crop production was initiated immediately after reclamation without the benefit of a winter freezing and thawing. After a period of one to several years, yields from these areas can equal or exceed county average yields. Certain sites, such as those developed on glacial till, will require the replacement of at least six inches of salvaged topsoil and may equal county-wide yield in a period of two years.

Acknowledgment

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Henning, S. J. and Dolling, H. D.

Figure 1. Borrow Area Research, Project Number HR-186.

Figure 2. Corn yield response at a loess borrow area in Audubon County, Iowa.

Figure 3. Soybean yield response at a loess borrow area in Audubon County, Iowa.

Figure 4. Corn yield response to restored topsoil at a coarse-textured borrow area in Buchanan County, Iowa.

Figure 5. Soybean yield response to restored topsoil at a coarse-textured borrow area in Buchanan County, Iowa.

Figure 6. Corn yield response to restored topsoil and alfalfa treatment at a late Wisconsin glacial till borrow area in Hamilton County, Iowa.

Figure 7. Soybean yield response to restored topsoil and alfalfa treatment at a late Wisconsin glacial till borrow area in Hamilton County, Iowa.

Figure 8. Corn yield response to restored topsoil and alfalfa treatment at a Kansan glacial till borrow area in Lee County, Iowa.

Figure 9. Soybean yield response to restored topsoil and alfalfa treatment at a Kansan glacial till borrow area in Lee County, Iowa.

Figure 1. Borrow Area Research, Project Number HR-186

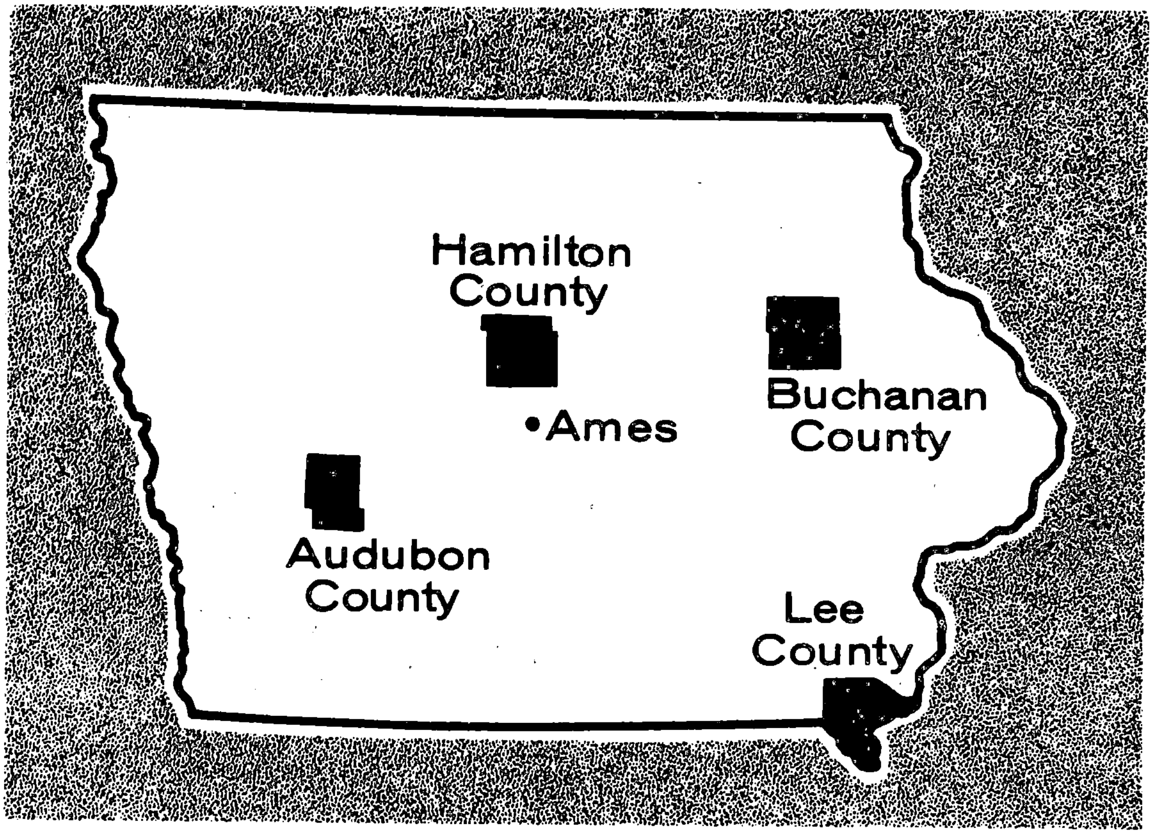


Figure 2. Corn yield response at a loess borrow area in Audubon County, Iowa.

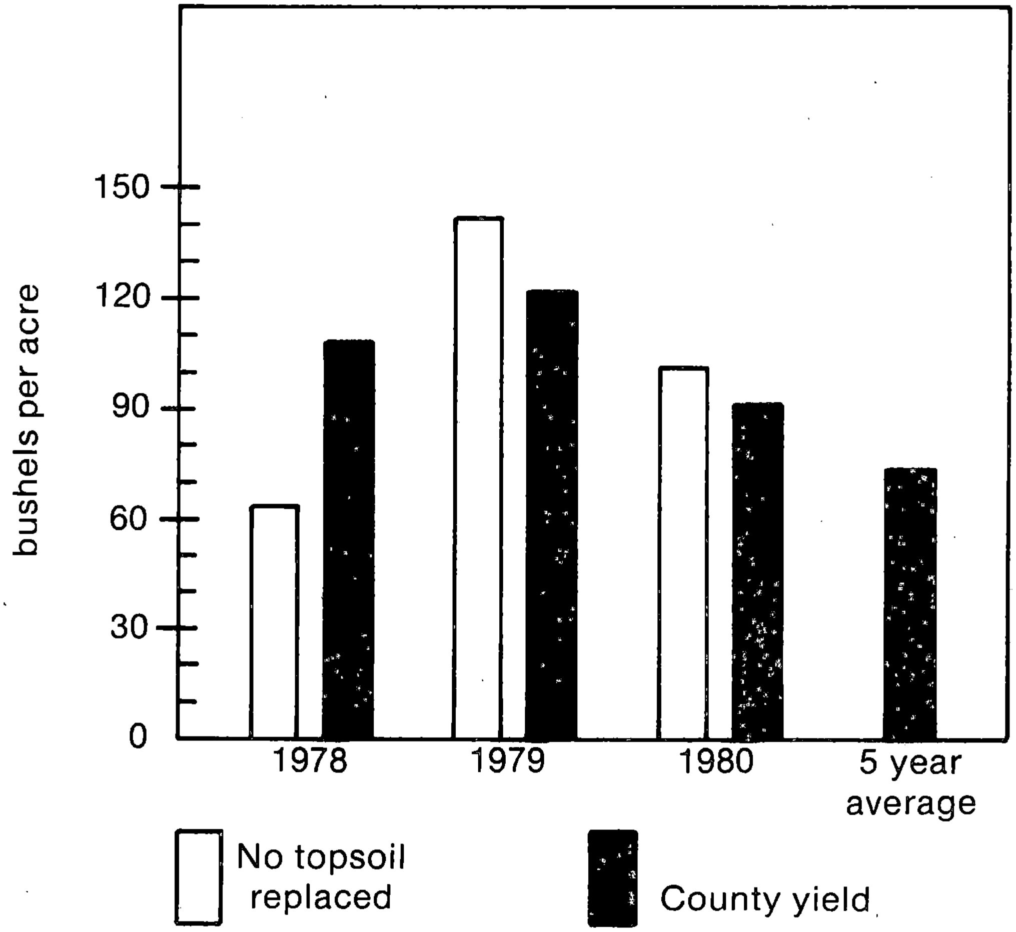


Figure 3. Soybean yield response at a loess borrow area in Audubon County, Iowa.

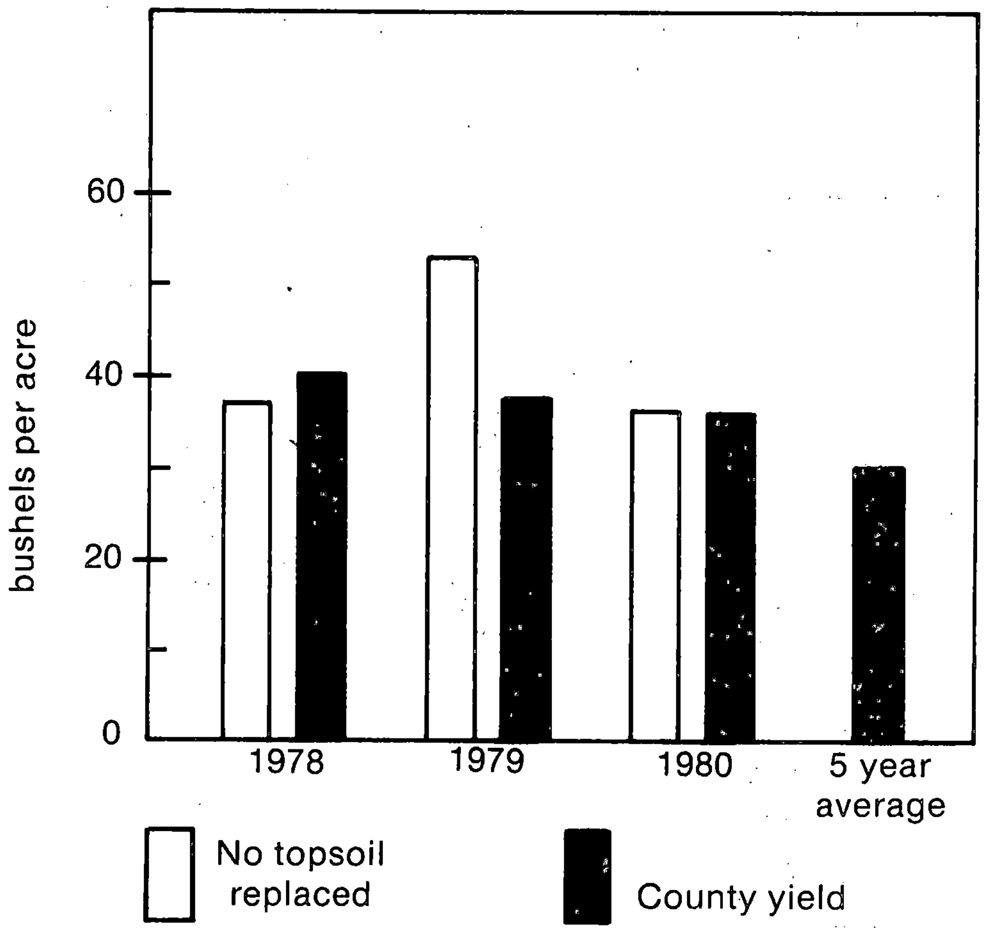
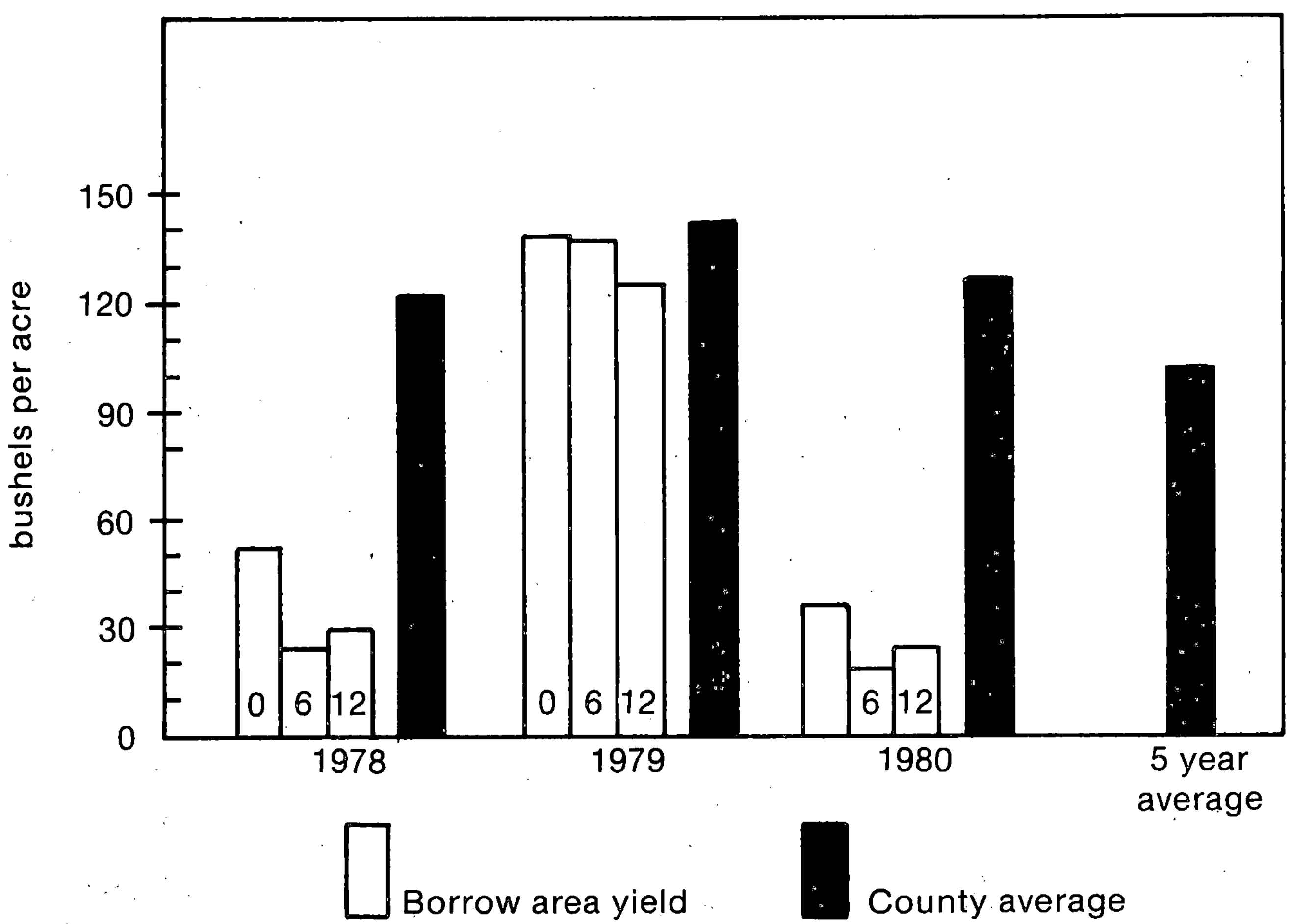


Figure 4. Corn yield response to restored topsoil at a coarse-textured borrow area in Buchanan County, Iowa.



Note: 0, 6, 12 refers to depth of topsoil in inches.

Figure 5. Soybean yield response to restored topsoil at a coarse-textured borrow area in Buchanan County, Iowa.

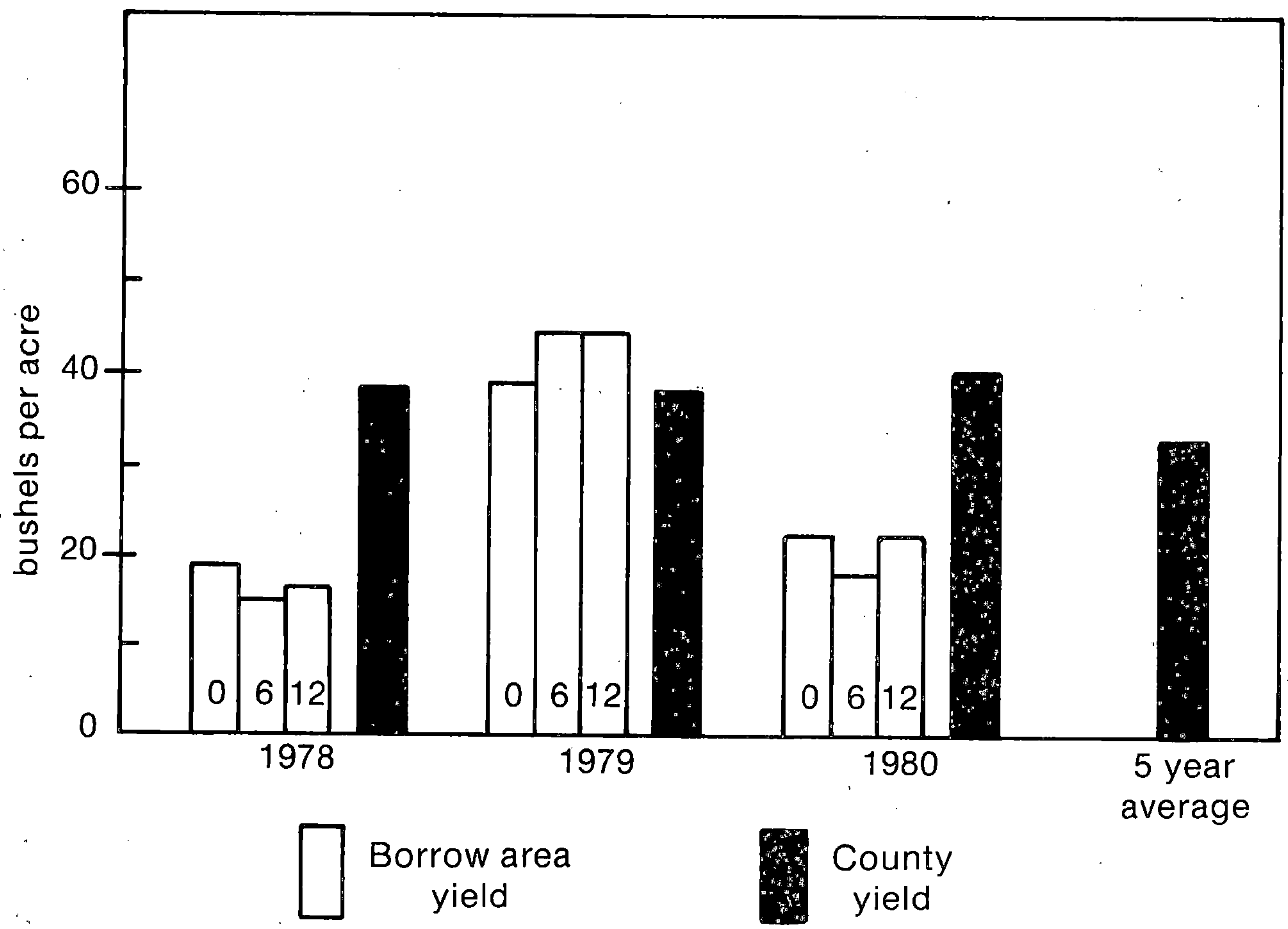


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Figure 6. Corn yield response to restored topsoil and alfalfa treatment at a late Wisconsin glacial till borrow area in Hamilton County, Iowa.

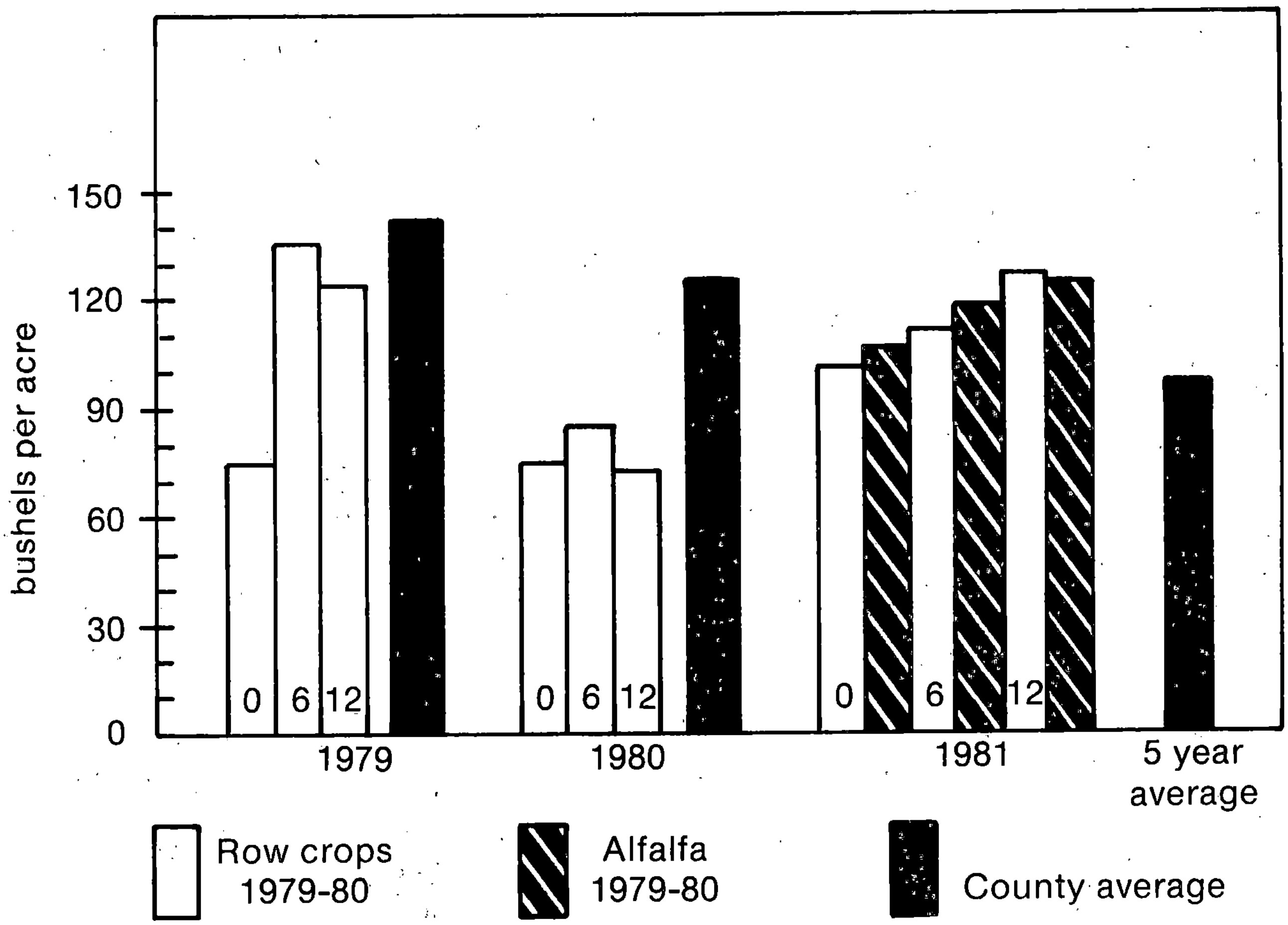

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Figure 7. Soybean yield response to restored topsoil and alfalfa treatment at a late Wisconsin glacial till borrow area in Hamilton County, Iowa.

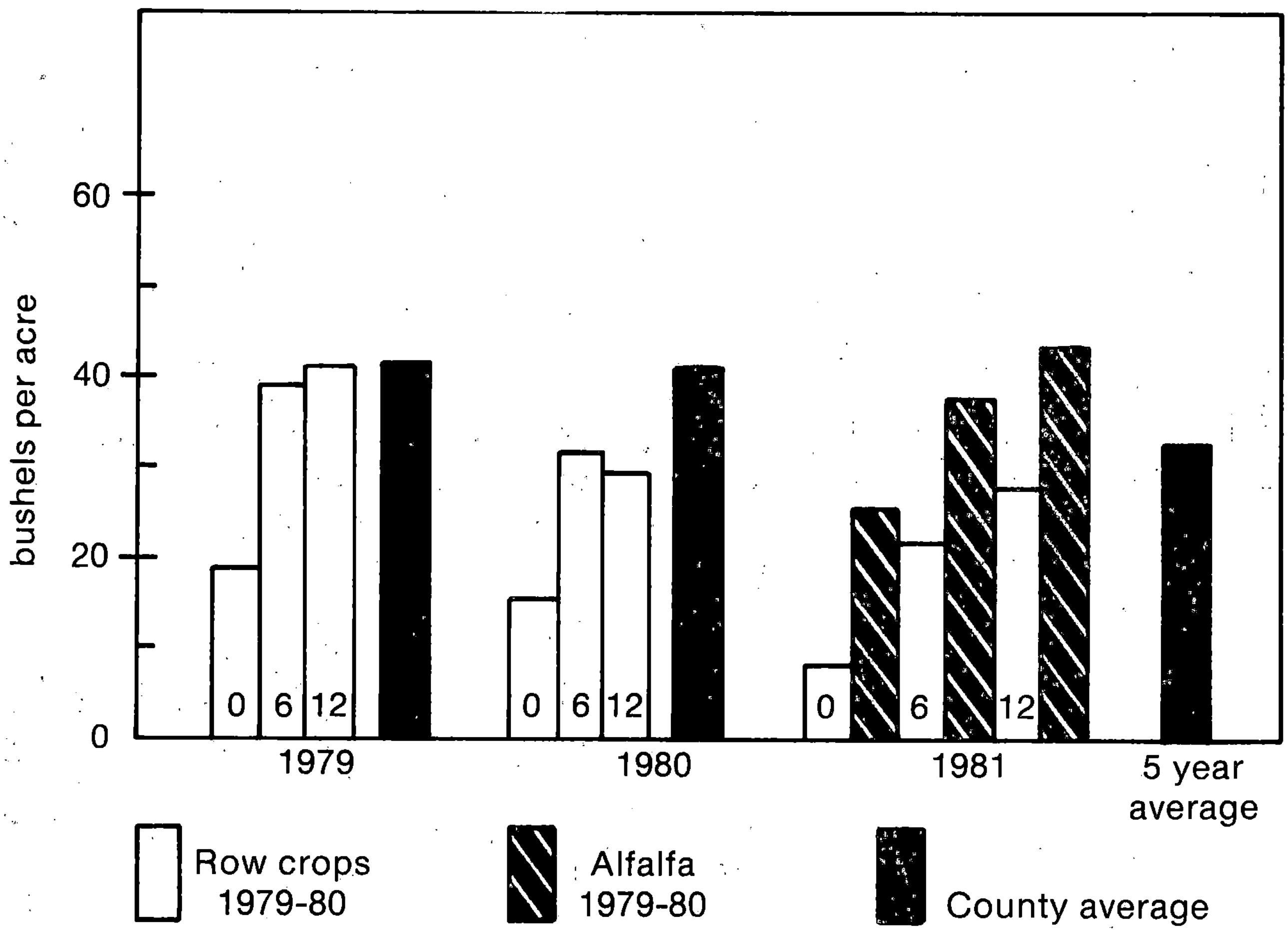

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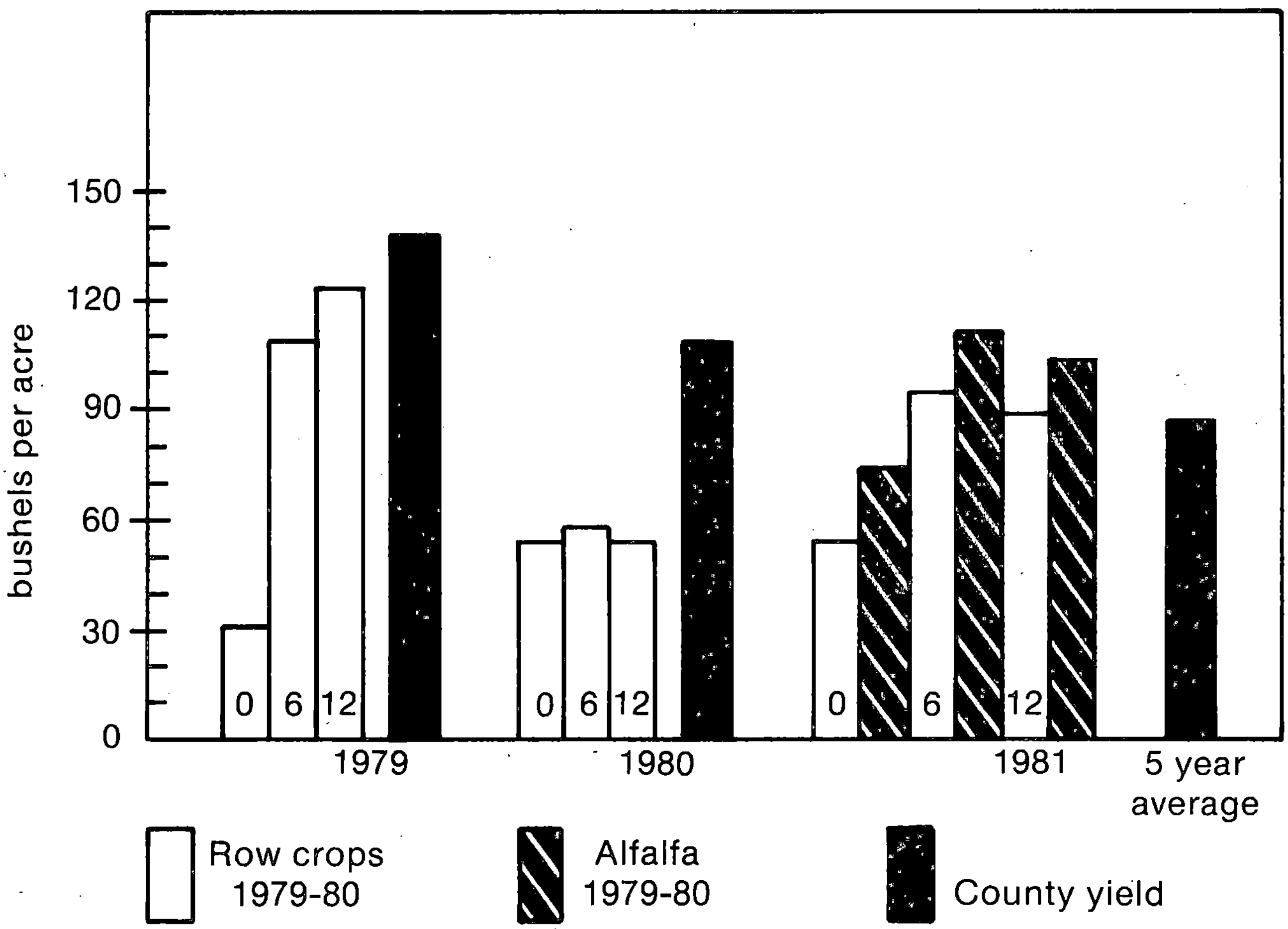
Figure 8. Corn yield response to restored topsoil and alfalfa treatment at a Kansan glacial till borrow area in Lee County, Iowa.



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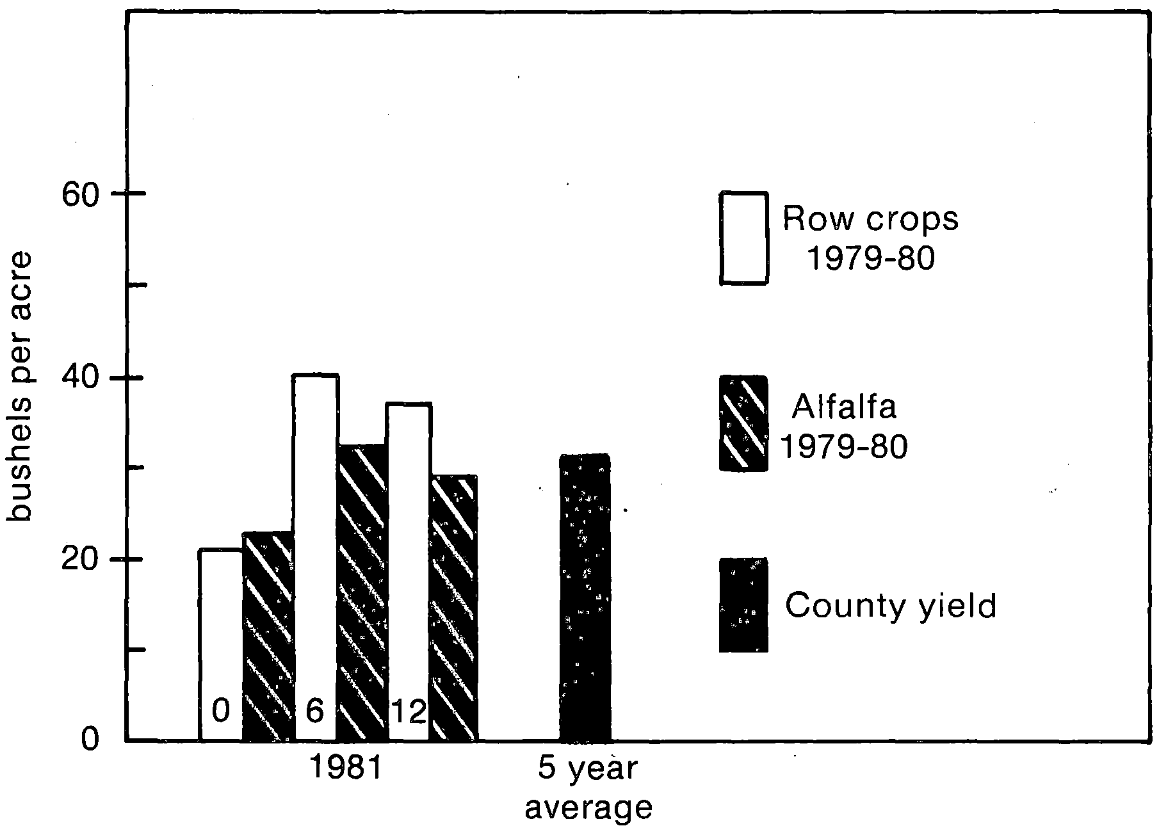

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