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The Economic Impact of Field Shelterbelts in the Northern Great Plains

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Abstract: The purpose of this research effort was to preliminarily assess the economic contribution field shelterbelts make to the economy of the Northern Great Plains Region. Results indicate field shelterbelts may positively impact the regional economy provided they do not occupy more crop acres than is necessary for their proper functioning.

Introduction

Trees play an important role in the agricultural ecosystems of the Great Plains. This historically treeless grasslands has been transformed by agricultural development; islands and corridors of forest now dot the landscape. Trees provided fuel, fencing and building materials while protecting homesteads and livestock. Riparian forests control soil erosion and stabilize banks. Field shelterbelts control wind erosion, influence snow deposition and provide valuable habitat, shade and beauty.

The massive federal shelterbelt program begun in the 1930's and continued for many years had as one of its primary goals the prevention of soil erosion (Droze, 1977). Today this remains one of the most widely recognized benefits of field shelterbelts. However, with the advent of irrigation technologies and the increased use of conservation tillage and other practices, field shelterbelts have come to be seen as more of a liability than an asset to many producers. Though field shelterbelts were credited with improving crop yields as far back as the 1930's (Stoeckeler, 1962) and more recent research literature is filled with supporting evidence (Kort, 1988), their contribution in this area often remains overlooked. While producers value the protection of shelterbelts around their homes and feedlots, when it comes to protecting their crops many see only lost production acres.

One goal of our current effort is to reacquaint producers, researchers and agricultural technicians with the many economic benefits provided by field shelterbelts. Recent research efforts detail the economic advantages to individual producers and show that the increased yield benefit more than offsets the production lost on acres occupied by shelterbelts (Brandle et al., 1984; 1992).

Above all these considerations lies a concern with the uncertainty of future climate patterns. Several climate change models predict a trend towards a hotter and dryer climate in the Northern Great Plains region (IPCC 1990). This leads to the questions: how will shelterbelts modify field conditions under these scenarios? Will the economic advantages to the producer in terms of improved yields and reduced risk of crop failure remain?

The concern over climate also introduces a regional perspective to our examination of field shelterbelts. While the improved crop yields and economic benefit to individual producers have been detailed in the past (Kort, 1988, Brandle et al., 1992), no previous effort has been made to quantify their regional impact. Should agricultural production in this region decrease as a result of climate change, how might a system of shelterbelts ameliorate this impact?

As a first step to answering these questions, this current research effort seeks to quantify the regional economic contribution of existing field shelterbelts. The results which follow should be viewed as a preliminary estimate. While they suggest the order of magnitude of shelterbelt benefits, they tend to pose more questions than they answer. The refinements to the model necessary to reach a higher level of accuracy will be part of the continuing effort of this overall project. In this regard, we ask your help in identifying additional issues and components which need attention.

Methods

Several modeling techniques could be useful in providing the answers we seek. For this preliminary assessment, *IMPLAN*, an input/output model developed by the USDA Forest Service was chosen. *IMPLAN* is a demand driven model while the impacts modeled are supply driven. It was assumed that the level of change in output relative to total commodity production in the region is sufficiently small to leave prices unchanged (Olson and Lindall, 1994). It has the advantage of providing estimates without the laborious necessity of creating a new model. It has the further advantage of accommodating regionally specific refinements to the inter-industry relationships, making possible more reliable measurements of the economic impacts. It is also a useful tool in uncovering industry linkages that warrant further examination as the project unfolds.

National Resource Inventory (NRI) data (USDA-SCS 1987) from the 1987 census were used to determine the number of acres, average width and total length of existing field shelterbelts in North Dakota, South Dakota, Nebraska and Kansas. From these data, the number of crop acres protected by shelterbelts was calculated by multiplying their total length by a factor of 15H where H is the average height of the windbreak (assumed to be 30 feet)(Table 1).

Yield data from numerous field studies were used to calculate the impact of field shelterbelts on production (Table 2). This yield data along with the number of crop acres protected was used to estimate the proportion of total production attributable to shelterbelt protection.

Prices received for the crops studied were obtained from the 1992 Census of Agriculture, published by the U.S. Department of Commerce. Statewide averages, by crop, for each state, were calculated for the years 1991 through 1993 and used to obtain a regional average.

Table 1. NRI census data on the number, acres and miles of shelterbelts in four states and calculations on average width and protected acres.

State	Number	Acres	Miles	Avg Width [1]	Acres Protected
ND	93,546	156,131	40,588	31.8	2,212,255
SD	28,444	79,462	8,362	78.4	456,109
NE	43,382	109,026	9,876	91	538,691
KS	49,348	84,645	16,750	41.7	913,636

[1] Average shelterbelt width calculated by converting area (in acres) to square feet and dividing by total length (in miles) converted to feet.

Table 2. Yield response data for crops included in the model and the number of acres of each crop assumed to be protected. (Baldwin, 1988; Kort, 1988)

Crop	Avg Yield Increase	# Protected Acres Assumed
Corn	19	506699
Spring Wheat	8	1,328,157
Winter Wheat	23	599,176
Barley	25	300,500
Oats	6	99,914
Hay	20	629,176
Soybeans	20	303,187
Sorghum [1]	7	198,339
Sunflower [1]	7	152586
		Total 4,177,704

[1] Yield data are not available. A 7% yield increase was assumed.

In modeling impact scenarios, input demands are automatically adjusted according to the level of commodity output. It is important to recognize that one of the benefits of shelter to the individual producer is an increase in production with fewer input requirements. These demand changes and their relationship to other parts of the model are not considered in this first effort.

Three impact scenarios, dealing only with changes in grain production, have been modeled for this estimate. The first scenario models the gross, yield-based benefits resulting from the influences of the existing field shelterbelts. The second scenario models the net impact of deleting the gross benefits, as determined in scenario one, and adding back in the benefits that would accrue from planting all of the acres occupied by field windbreaks back to crops. The third scenario hypothesizes an alternative shelterbelt system design and simulates the economic impact of modifying the existing shelterbelts to a narrower design that would maximize their net contribution. None of the scenarios include soil protection, wildlife habitat or other values.

Results

In the first scenario the gross contribution to the regional economy of existing shelterbelt protection was determined. Removing this production from the appropriate model sectors reduced total economic activity in the region. The difference between economic activity with and without shelterbelts signifies their gross benefit (Table 3).

Table 3. Summary of the economic activity which can be attributed to the existing shelterbelt network.

Scenario One				
	Direct Effects	Indirect Effects	Induced Effects	Total Effects
Gross Regional Product [1]	183	0	71	253
Total Industrial Output [1]	183	64	91	337
Employee Cmpnsation Income [1]	5	14	28	46
Property Income [1]	80	15	20	115
Employment [2]	1427	839	1686	3952
Population [2]	2320	1363	2739	6422

[1] millions of dollars [2] individuals

Scenario two assumes that the absence of shelterbelts would result in those acres now occupied by shelterbelts being returned to crop production, and thus, is an estimate of the amount of production foregone when shelterbelts occupy those acres (Table 4). These values are negative and indicate that there would be greater economic activity if shelterbelt acres were converted to crop acres.

Table 4. Summary of the economic activity foregone with the existing network of shelterbelts.

Scenario Two				
	Direct Effects	Indirect Effects	Induced Effects	Ttl Effects
Gross Regional Product [1]	-12	0	-4	-17
Total Industrial Output [1]	-12	-4	-6	-22
Employee Cmpnsation Income [1]	-0.3	-1	-2	-3
Property Income [1]	-6	-1	-1	-8
Employment [2]	-83	-56	-103	-242
Population [2]	-135	-90	-167	-393

[1] millions of dollars [2] individuals

The average width of existing field shelterbelts (Table 1) is wider than would normally be recommended for the sole purpose of protecting crops. Typically, field shelterbelts should be one or two rows with a width of 25 to 35 feet. Using a shelterbelt width of 30 feet, the number of crop acres and shelterbelt acres were adjusted in the model.

Modeling the net impact was then carried out as in scenario two where the impact was equal to the gross benefit of shelterbelts minus the opportunity cost of production foregone. In this scenario the opportunity costs were smaller and the results indicate a positive net impact (Table 5).

Table 5. Summary of economic activity assuming 30 foot shelterbelt widths.

Scenario Three				
	Direct Effects	Indirect Effects	Induced Effects	Total Effects
Gross Regional Product [1]	38	0	15	53
Total Industrial Output [1]	38	12	19	69
Employee Cmpen-sation Income [1]	1	3	6	10
Property Income [1]	17	3	4	24
Employment [2]	312	161	351	823
Population [2]	506	261	570	1,338

[1] millions of dollars [2] individuals

In comparing the results (Tables 4 and 5), it is clear that the effect on the regional economy is dependent on shelterbelt design. Wide multiple-row shelterbelts entail too great an opportunity cost for the amount of crop benefit provided. Some caution should be emphasized in using these numbers. As was mentioned previously, several simplifying assumptions have been made. These include: 1) an average shelterbelt height of 30 feet, 2) constant commodity prices, and 3) all the benefits of shelter accrue to the crops considered in this study. Future efforts will address these limitations.

There are a number of other benefits of shelterbelts that have not been considered. Most obvious are those benefits associated with wildlife habitat. A Kansas study of hunting activities indicated that hunters spent over 40% of their time hunting in or adjacent to field shelterbelts (Cable and Cook, 1990). This activity contributed over $30 million, or approximately $1700 per shelterbelt mile, to the state economy. While this is only an estimate, it emphasizes the need to include these types of benefits in the final analysis. Other benefits such as carbon sequestration, air quality and aesthetic values may not be as easily marketable but, are nevertheless, important considerations in determining the societal value of a system of shelterbelts and must be included in the analysis.

Future Efforts

Our next step in the project is to adjust the relationships between sectors to more accurately reflect the use of shelterbelts in the agricultural system. We then need to expand our concept of shelterbelts to include other types of linear forests and incorporate the other benefits of linear forests into the model. The final stage of the project will consider the effects of climate change on the crop production sector and recalibrate the regional economic model. This will allow us to assess the importance of Great Plains forests to ameliorate the effects on the regional economy of potential climate change.

Citations

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