ENVIRONMENTAL AND ECONOMIC IMPACTS OF METHODS OF BRUSH CONTROL ON WESTERN OKLAHOMA RANGELAND[1]

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Investigation of adverse environmental impacts in western Oklahoma revealed that use of pesticides on rangeland caused only minor damages during the study period. Benefits from pesticide use on rangeland include increased grazing capacity, reduction of erosion, reduction of ticks, improved vegetative growth for wildlife, and savings for consumers on beef purchases. Alternative methods for brush control on rangeland were also investigated through use of an environmentnal impact matrix.

Modern agriculture depends upon the use of pesticides (insecticides, herbicides, and fungicides) to control insects and weeds. Use of pesticides in Oklahoma increased tremendously during the 1960's, and ranchers in Oklahoma have substantially increased the carrying capacities (number of cattle per acre) of their rangeland by chemically controlling brush and weeds with herbicides. Thousands of acres of rangeland have been converted to productive pasture land in recent years.

The general objective of this study was to determine the level of herbicide use and the extent of environmental damages and benefits under alternative strategies for controlling brush and weeds on rangeland. The specific objectives were (a) to determine the relationships between the present use of herbicides and environmental quality in Oklahoma, and (b) to analyze present and alternative methods of controlling brush and weeds on rangeland with respect to economics and the quality of the environment.

METHODS

Benefits to consumers from pesticide use on rangeland were estimated by demand analysis. Changes in consumers' surplus due to added farm output were estimated by using the elasticity of demand, the average output, and price. Alternative methods for controlling weeds and brush on rangeland were analyzed with an environmental impact matrix (Table 1). The effect of alternative methods of control on environmental quality, social well-being, and economic parameters and sub-parameters was determined by use of this environmental impact matrix. The sub-parameters in the matrix were developed specifically to fit this study of pesticide use.

Parameter weights and raw scores for the alternatives were assigned by a multidisciplinary panel of researchers at Oklahoma State University. The weights were assigned according to the parameter's value in the decision-making process. An effort was made to establish weights that represent the value society as a whole places on the sub-parameters. A more detailed discussion of the methodology is presented in the thesis by Richardson (1).

Woodward County was selected as the study area because there has been extensive brush and weed control in this county over the past 20 years. Information on the extent of pesticide use, application rates, and the effect of pesticide use on the environment was obtained from farmers, technical advisers, and licensed applicators who have treated rangeland in the study area. Information concerning environmental damage was also obtained from reports made by the State Board of Agriculture fieldmen, who are charged with investigating all reported cases of pesticide damage or misuse.

RESULTS AND DISCUSSION

Economic and environmental impacts of herbicide use

Extent of herbicide use. Over the past 20 years the practice of controlling weeds and brush on rangeland in Oklahoma has

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TABLE 1. *Analysis of selected alternative methods to control shinnery oak on rangeland in Oklahoma.*

Parameters	Parameter weights	Reduce application rates[1]		Deep plow and establish love grass[2]		No controls on brush and weeds, reduce cattle numbers[3]	
		Raw score	Weighted score	Raw score	Weighted score	Raw score	Weighted score
I. Impact on Economic Factors	10.00						
A. Change in quantity of output	1.00	0	0	-0.50	-0.50	-1.50	-1.50
B. Change in quality of output	0.50	0	0	0	0	0	0
C. Change in cost of goods for consumers	2.50	0	0	0	0	-5.00	-12.50
D. Change in farm income	2.50	1.00	2.50	1.00	2.50	1.00	2.50
E. Change in employment in the region	0.50	0	0	1.00	0.50	-1.00	-0.50
F. Change in the number of farms	1.00	0.50	0.50	0	0	-5.00	-5.00
G. Change in the number of acres farmed	2.00	0	0	0	0	0	0
Economic impact			3.00		2.50		-17.00
II. Impact on Environmental Factors	10.00						
A. Effect on rare and endangered species	2.00	1.00	2.00	-1.00	-2.00	-1.00	-2.00
B. Plant and animal habitat	3.00						
1. Change in number of acres available for wildlife	1.00	0	0	0	0	0	0
2. Change in soil erosion	1.00	1.00	1.00	-1.50	-1.50	-3.00	-3.00
3. Change in food and cover	1.00	0	0	-1.00	-1.00	-2.00	-2.00
C. Diversity and Stability	2.50						
1. Change in aquatic environment	1.25	2.00	2.50	-1.00	-1.25	-1.00	-1.25
2. Change in vegetation	1.25	0	0	-0.50	-0.60	-1.00	-1.25
D. Direct Effect on Fish and Wildlife	2.50						
1. Change in the type of fish wildlife in ecosystem	0.75	1.00	0.75	-0.50	-0.40	-1.00	-0.75
2. Change in acute effects on fish and wildlife	1.00	0.50	0.50	2.00	2.00	4.00	4.00
3. Change in chronic effects on fish and wildlife	0.50	0.50	0.25	1.00	0.50	0.50	0.25
4. Change in parasites on animals	0.25	1.00	0.25	-0.50	-0.10	-1.00	-0.25
Environmental impact			7.25		-4.35		-6.25
III. Impact on Social Well-Being	10.00						
A. Recreational Opportunities	3.00						
1. Change in water-based recreation	1.50	0	0	-0.80	-1.20	-1.00	-1.50
2. Change in land-based recreation	1.50	2.00	3.00	-1.00	-1.50	-2.00	-3.00
B. Anxiety Factors	3.50						
1. Change in anxiety due to pesticide residues in food	0.70	0.50	0.35	2.00	1.40	2.00	1.40
2. Change in air pollution	0.70	0.50	0.35	-1.00	-0.70	1.00	0.70
3. Change in drift damage	0.70	1.00	0.70	5.00	3.50	5.00	3.50
4. Change in stream water quality	0.70	0.50	0.35	-1.00	-0.70	-2.00	-1.40
5. Change in number of pests in the environment	0.70	0	0	-1.00	-0.70	-1.00	-0.70
C. Other Human Life Considerations	3.50						
1. Change in aesthetics	0.75	0	0	1.00	0.75	2.00	1.50
2. Change in number of poisonings (not fatal)	1.25	1.00	1.25	5.00	6.25	5.00	6.25
3. Change in number of deaths from pesticides	1.50	1.00	1.50	5.00	7.50	5.00	7.50
Social well-being impact			7.50		14.60		14.25
Overall impact			17.75		12.75		-9.00
Rank			1		2		3

[1] Reduce application rates of phenoxy herbicides to 1/8 or 1/16 pound/acre and use a ground rig to spray brush annually.

[2] Deep plow and establish love grass; involves plowing 1/5 of a ranch's brush and planting it to forage for two years and planting it to love grass the third year.

[3] Reduce cattle numbers to level the range can handle and use no controls on brush.

grown from 20,000 acres to over 500,000 acres treated annually. The number of rangeland acres in Woodward County treated for brush quadrupled (9,000 to 36,000 acres) between 1961 and 1972 (1). Ranchers and licensed applicators controlling brush and weeds on rangeland reported using application rates that were less than or equal to the rates recommended by the Department of Agronomy at Oklahoma State University.

Economics of herbicide use. The carrying capacity of native rangeland has been doubled and even tripled after chemical brush and weed control. The extent of the increase depended upon the type and density of the brush and the amount of grass originally in the field. Ranchers' net returns to land, labor, capital, and management have increased as a result of brush and weed control. In Woodward County the increase in net returns was estimated at $5.62 per acre (1).

The number of acres used for grazing cattle remained constant whether or not ranchers used herbicides to control brush. However, if brush were not controlled, the amount of soil erosion probably would increase and the quality of lakes, rivers, and rangeland would decrease. It has been shown, in Oklahoma, that the amount of erosion from brushland plots is about twice that of plots where brush has been controlled (2).

In Oklahoma as a whole the increased beef production due to weed and brush control has increased consumers' surplus, i.e., this control has provided consumers a net savings of about $15,880,000 in 1971 and about $13,494,000 in 1970 (1).

Environmental quality and herbicide use. The damaging effects of 2,4-D and 2,4,5-T (the primary herbicides used on rangeland) on livestock and wildlife apparently were of little consequence in Oklahoma. There were no reported deaths of livestock or humans from these herbicides in the study area. Research by others has indicated that these herbicides are rapidly eliminated from animals and, hence, the chance of human consumption of these chemicals in meats is reduced (3, 4).

Phenoxy herbicides used on rangeland have been responsible for slight damage to non-target vegetation in the study area. The majority of the damage was to shade trees, ornamental plants, and gardens. In 1972 no damage in Woodward County was reported to the State Board of Agriculture; previously the damage had been estimated to average $2,500 per year for the period 1966-1971.

Some of the external benefits from phenoxy herbicides used on rangeland have been reduced tick populations, reduced soil erosion, increased soil moisture, increased palatability of grasses and weeds, and an increase in wildlife numbers (5, 6, 7).

According to *Tabulations from Oklahoma Death Certificates for 1962-1972* (prepared by the Public Health Statistics Division of the Oklahoma State Health Department), the number of human deaths in Oklahoma from agricultural pesticides has been relatively low considering the state's population. Between 1962 and 1970, 20 persons were killed by agricultural pesticides and eight of these were farm residents. None of the poisonings resulted from use of 2,4-D or 2,4,5-T.

In Oklahoma, five years of water sampling and analysis have failed to show any accumulation of phenoxy herbicides or other pesticides used on state rangeland. Pesticide residues of 2,4-D and 2,4,5-T in the water samples have not been greater than the maximum safe levels established by the federal government for water quality (8).

Analysis of alternative control methods

The present method of using herbicides to control shinnery oak in western Oklahoma was compared with other methods, including (a) reduction of the present rate of herbicide application, (b) deep plowing with subsequent establishment of love grass, and (c) reduction in the number of cattle. Sand sage has also been controlled by dormant-season mowing. Based on an environmental impact matrix analysis of these alternatives, the best alternative from an economic and environmental standpoint was reduced application rates (1). This alternative results in an overall impact of 17.75 compared to 14.75 for deep plowing and −9.00 for no controls (Table 1).

The reduced application rate alternative involved using a ground sprayer to apply 1/16 lb of 2,4,5-T per acre, instead of 2 lb per acre sprayed from an airplane. This alternative has a positive economic impact (+3.00 in Table 1) which is due primarily to the increase in net returns of $13.72 per acre (1, p. 87). The resulting environmental quality was estimated to be better than under the present system (+7.25 in Table

1) because of the reduced amount of pesticide used per acre, reduction in soil erosion, reduction in sedimentation of streams and lakes, an increase in wildlife in treated (over untreated) areas, and decrease in chances of ill effects on fish and wildlife (1, p. 91). The reduction in herbicide use under the reduced application rate alternative would improve the level of social well-being (+7.50 in Table 1) over the current method of brush and weed control.

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