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ECONOMIC ANALYSIS OF HERBICIDE USE
RESTRICTION POLICIES ON NEBRASKA CASH-GRAIN FARMS

by

Herman W. Delvo

A DISSERTATION

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Department of Agricultural Economics

Under the Supervision of Professor Glen J. Vollmar

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TITLE

Economic Analysis of Herbicide Use

Restriction Policies on Nebraska Cash-Grain Farms

BY

Herman W Delvo

APPROVED	DATE
Orvin C Burnside	Sept. 30, 1971
A W Epp	Sept. 30, 1971
James B. Hassler	Sept. 30, 1971
John Richard Felton	Sept. 30, 1971
Glen J. Vollmar	Sept. 30, 1971

SUPERVISORY COMMITTEE

GRADUATE COLLEGE **UNIVERSITY OF NEBRASKA**

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H.W.D.

TABLE OF CONTENTS

Chapter Page

LIST OF TABLES

Table		Page

Table | Page

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Selective chemical weed control has been practiced extensively for about 25 years. Since the discovery of 2,4-D in 1944, the use of selective herbicides on field crops has expanded dramatically, both in the number of herbicides being used and the number of acres treated.[1]

The quantity of synthetic organic herbicides sold in the United States (farm and non-farm use) increased from 95 million pounds in 1962 to 319 million pounds in 1968.[2] In 1969, the quantity sold decreased to 311 million pounds.[3]

Farm Use of Herbicides

Farm use of synthetic organic herbicide materials in the United States increased 63 percent between 1964 and 1966 (Table 1). The acreage treated with these herbicide materials during the same period increased 23 percent. The increased quantity used and acreage treated occurred primarily on corn, grain sorghum, and soybeans. The average

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[1]"A Story of Growth - Pesticides," Farm Technology, XXV (Fall, 1969), 12-16.

[2]The Pesticide Situation for 1964-1965, United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Washington, D.C., p. 2 and The Pesticide Review - 1969, United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Washington, D.C., p. 9.

[3]The Pesticide Review - 1970, United States Department of Agriculture, Agricultural Stabilization and Conservation Service, Washington, D.C., p. 9.

application rate per acre (active material) increased from 0.74 pounds per acre in 1964 to 0.99 pounds per acre in 1966. The major reasons for this increase were the substitution of atrazine for 2,4-D on corn and grain sorghum and the rapid adoption of amiben and trifluralin by farmers for use on soybeans.

The farm use of synthetic organic herbicides in the Northern Plains (which includes Nebraska) followed the same pattern as for the United States (Table 1). The quantity of herbicide material used increased 39 percent between 1964 and 1966 while the acreage treated increased 18 percent. The average application rate between 1964 and 1966 increased from 0.43 pounds to 0.59 pounds per acre. This increase was primarily a result of substituting atrazine and other preemergence herbicides for 2,4-D on corn and grain sorghum and the increased acreage of these two crops treated with herbicide materials.

Data on the quantity of herbicide materials used by Nebraska farmers are not available. The acreage treated with herbicides for the major row crops grown in Nebraska increased from 29 percent in 1964 to 50 percent in 1966 (Table 2). The use of preemergence herbicides, other than 2,4-D, is a relatively new practice for Nebraska farmers. These herbicides were first recommended by the Agronomy Department, University of Nebraska, for corn and soybeans in 1961 and for grain sorghum in 1963. Winter wheat acreage treated with herbicides ranges from one to three percent annually.

The specific herbicide materials used by Nebraska farmers between 1964 and 1966 followed the same pattern as for the United

Table 1. Farm use of synthetic organic herbicides in the United States and Northern Plains, 1964 and 1966.

Year	United States	Northern Plains
1964:		
Pounds	66.7 million	9.0 million
Acres	89.8 million	21.1 million
Rate per acre	0.74 pounds	0.43 pounds
1966:		
Pounds	109.1 million	14.8 million
Acres	110.9 million	25.0 million
Rate per acre	0.98 pounds	0.59 pounds

Sources: Theodore Eichers, *et al.*, *Quantities of Pesticides Used by Farmers in 1964*, Agricultural Economic Report No. 131, Economic Research Service, U.S. Department of Agriculture, January, 1968.

Theodore Eichers, *et al.*, *Quantities of Pesticides Used by Farmers in 1966*, Agricultural Economic Report No. 179, Economic Research Service, U.S. Department of Agriculture, April, 1970.

Table 2. Herbicide use on selected crops as reported by farmers included in a survey of 13 selected Nebraska counties, 1964 and 1966

Crop	Percent of acreage treated 1964	1966
	----- percent ----	
Corn	28	50
Grain Sorghum	41	58
Soybeans	12	32
Average for row crops	29	50
Winter wheat	3	1

Source: Unpublished data from the "1964 and 1966--National Pesticide and General Farm Survey," conducted by the Economic Research Service, U.S. Department of Agriculture.

States. Atrazine was substituted for 2,4-D on corn and grain sorghum acreages. Amiben and trifluralin were the predominant herbicides used on soybeans.[4]

Definitions

Before proceeding it is useful to define a few terms associated with the use of selective herbicides:

1. Pesticide: Any substance or mixture of substances intended for controlling insects, rodents, fungi, weeds, or other forms of plant or animal life that are considered to be pests.

2. Herbicide: A chemical used for killing plants or interrupting their normal growth.

3. Selective herbicide: A chemical that is more toxic to some plant species than to others. Thus, weeds may often be controlled without significant damage to the crop, by selective herbicidal action.

4. Active ingredient: The chemical compound in a product that is responsible for the herbicidal effects.

5. Band application: A treatment to a continuous restricted area such as in or along a crop row rather than broadcast over the entire field area.

6. Broadcast application: Herbicide treatment over an entire area.

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[4] Herman W. Delvo, "Herbicide Use on Selected Row Crops in Nebraska, 1964 and 1966," Quarterly, College of Agriculture and Home Economics, University of Nebraska, Fall, 1968, pp. 17-20.

7. Emergence: The breaking through the soil surface by the germinating seedling. This often is a preferred stage for selective herbicide application, with chemicals such as 2,4-D.

8. Postemergence: Applying herbicide after emergence of specified weed or crop.

9. Preemergence: Applying herbicide prior to emergence of specified weed or crop.

10. Preplant: Applying herbicide any time before the crop is planted.

Statement of Problem

Society has become concerned in recent years with the environmental pollution aspects from herbicides and other pesticides. Several states and the Federal Government have proposed and in some cases passed legislation to prohibit the use of certain pesticides or provide stricter regulation of their use.[5]

On November 25, 1969, the Agricultural Research Service, USDA, cancelled the Federal registration of DDT for the protection of crops, livestock, forests, and public health unless continued use is justified by documentation.[6] On May 1, 1970, the USDA cancelled the use

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[5] "Box Score on Pesticide Legislation," Farm Chemicals, September, 1969, pp. 24-26.

[6] Release by the United States Department of Agriculture and published in The Federal Register on November 25, 1969.

of 2,4,5-T on food crops.[7]

The restriction on DDT and 2,4,5-T use had little impact on Nebraska agricultural production. However, as herbicide use increases there may be some restriction which could significantly affect Nebraska farmers. As long as the farm use of herbicide materials is restricted on a product or crop basis the decision faced by a farmer is relatively simple and centers on the availability of an effective substitute for controlling weeds. For example, if a farmer is currently using atrazine to control weeds in corn he would probably shift to some other preemergence herbicide if the use of atrazine in corn production is restricted. This problem can be analyzed by partial budgeting.

On the other hand, if the restriction of herbicide materials occurs on a broader front the problem of analyzing the impact becomes more complex. For example, a farmer may have organized his farming operation based on the availability of preemergence herbicides for weed control. If the use of preemergence materials was restricted the farmer would have to use either postemergence herbicides and/or cultivation to control weeds. These alternatives may not give as effective weed control as the preemergence herbicides. Thus, crop yields would be reduced and the farmer might need more labor or machine capacity because of the increased cultivation. The net result

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[7] C. S. Williams, The Status of 2,4-D, 2,4,5-T, Silvex and MCPA Herbicides. Proceedings: North Central Weed Control Conference, Lexington, Kentucky, December 8-10, 1970, pp. 15-18.

might be that he would restrict his cropping pattern to crops that are less labor intensive.

Therefore, the general objective of this study is to evaluate the economic impact of the following herbicide use restriction policies:

Policy A: Herbicides applied preplant or banded preemergence at the recommended rates, with all acres being treated. Cultivation used to control weeds between rows. This will serve as a "benchmark" for comparative purposes.

Policy B: Restriction on the use of preplant or preemergence herbicides. Postemergence herbicides and cultivation used to control weeds.

Policy C: Restriction of all herbicide materials. Use cultivation only to control weeds.

The specific objectives for each policy are:

1. To determine the change in farm organization (crop enterprises) from herbicide restriction.

2. To determine the farm labor requirement for different methods of weed control.

3. To determine the impact on net farm income and resource returns from herbicide restriction.

Description of Study Area

The study area consists of 17 counties in central and east central Nebraska (Figure 1). The area is primarily cash-grain farming with about 40 to 60 percent of the farms being in this category (Table 3).

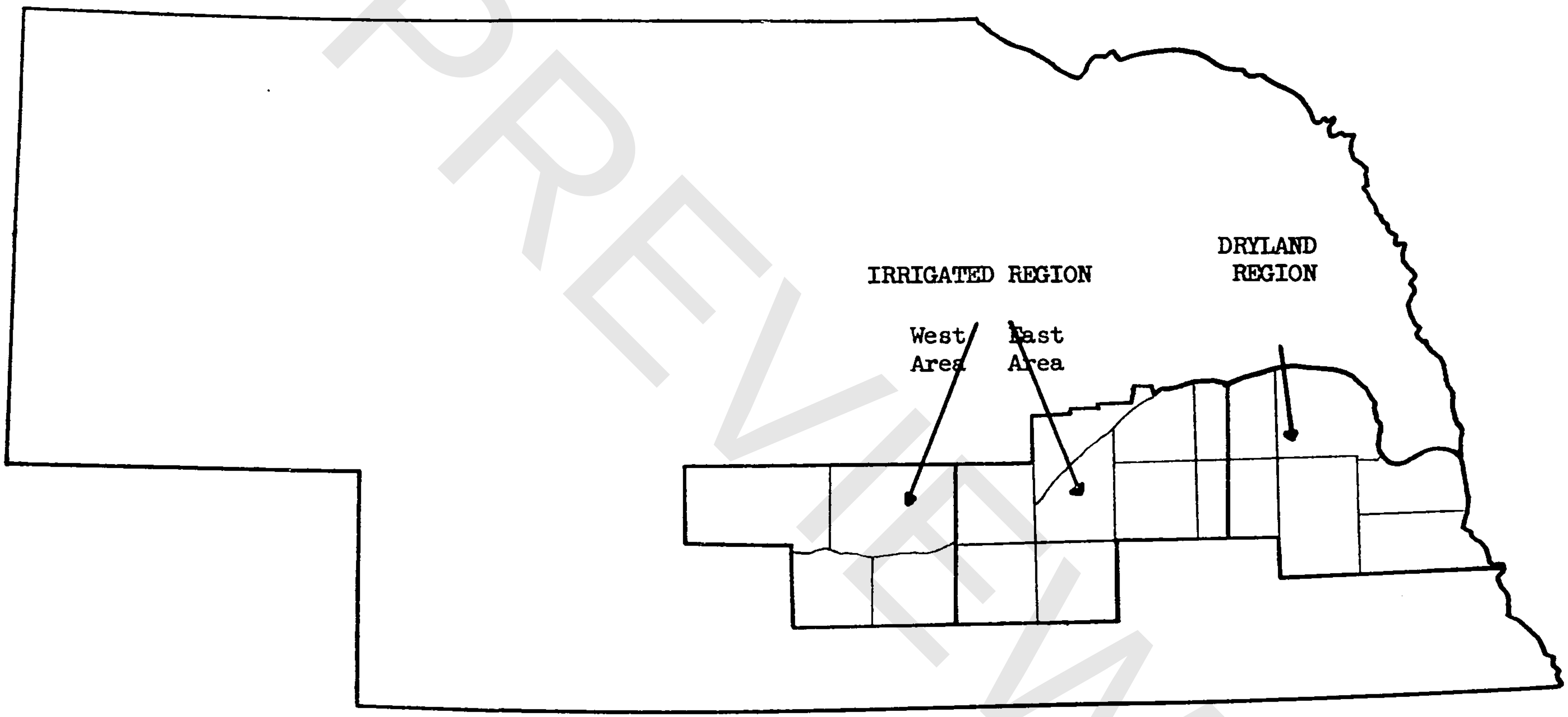

Figure 1. Location of counties included in the study area, Nebraska.

Table 3. Percentage distribution of farms by value of products sold (type) for counties included in the study area

Item	Type[a]			
	Cash-grain	Livestock	General	Other
	---percent---			
Dryland region				
Butler	54	28	7	11
Cass	49	26	5	20
Lancaster	36	27	17	20
Otoe	40	32	8	20
Saunders	53	26	7	14
Seward	40	32	8	20
Average	46	29	9	16
Irrigated region				
East area:				
Hall	44	31	8	17
Hamilton	61	25	5	9
Merrick	37	35	9	19
Polk	51	35	6	8
York	52	30	5	13
Average	50	31	6	13
West area:				
Adams	68	14	4	14
Buffalo	26	44	11	19
Clay	62	20	5	13
Dawson	23	39	26	12
Kearney	54	28	8	10
Phelps	53	31	7	9
Average	44	31	11	14

[a]To be classified as a particular type, a farm had to have sales of a particular product or group of products amounting in value to 50 percent or more of the total value of all farm products sold during the year.

Source: United States Department of Commerce, Bureau of the Census, 1964 United States Census of Agriculture, Volume 1, Part 20, Nebraska.

Exceptions are Buffalo and Dawson Counties where only 25 percent of the farms were classified as cash-grain in 1964. However, in these two counties only those townships with 20 percent or more of farming land irrigated were included in the study area. Although there are some large cattle feeding operations in these two counties, the type of farming is predominantly cash-grain. In that portion of Buffalo and Dawson Counties included in the study area, only 22 and 28 percent, respectively, of the farms had cattle on feed in 1968.[8]

Irrigated and Dryland Regions

The study area was divided into irrigated and dryland regions. The criterion used for selecting those counties included in the irrigated region was that at least 50 percent of the farms had to have irrigation (Figure 1). Two Counties, Butler and Seward, failed to meet this criterion on a county-wide basis; however, within these counties there were townships with considerable irrigation. If 20 percent or more of the land in a township in Butler and Seward Counties was irrigated that township was included in the irrigated region.[9]

[8]Calculated from unpublished data, State-Federal Division of Agricultural Statistics, Lincoln, Nebraska.

[9]Ibid.

Review of Literature

Headley estimated the productivity of expenditures of agricultural pesticides in the United States for the 1963 crop year.[10] He used an aggregate production function analysis and found that the marginal value of $1.00 spent for pesticides was about $4.00. Some of the limitations of his study are:

1. Data were per-farm averages for each state.

2. The aggregate production function assumes homogeneity in production technology throughout the nation.

3. The pesticide input was measured as an expenditure, thus assuming a direct relationship between the cost of a pesticide and its productivity.

4. The analysis considered only the 1963 crop year.

The marginal productivity figure ($4.00) is not useful for decision making at the farm level because different pesticides are used on various crops and on a particular crop the pesticide used varies geographically. The data are not useful for estimating the impact of restricting certain pesticides because total expenditures were used in the study with no distinction being made between the productivity of insecticides, herbicides, or fungicides.

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[10] J. C. Headley, "Estimating the Productivity of Agricultural Pesticides," _Journal of Agricultural Economics_, L (February, 1968) 13-23.

Carlson evaluated decisions involving the timing and use of fungicides to control brown-rot on peaches in California.[11] A survey of California peach growers showed that 44 to 66 percent (depending on variety grown) were not applying fungicides regardless of the disease forecast. Carlson used a Bayesian statistical model to combine disease and weather forecasts with farmers' subjective probability of losses from brown-rot to determine the optimal spraying program. He found that individual growers could increase their returns by $5.00 to $25.00 per acre by following the Bayesian strategy rather than a no-spray strategy. Carlson estimated that the net gain to California peach growers would be $1.1 million annually.

Edwards used a modified consumers'-producers' surplus model to study alternative agricultural pesticide policies in Dade County, Florida.[12] He divided the benefits and costs of pesticide usage into (1) internal to the farming industry and (2) external to the farming industry. Internal benefits or costs from pesticide usage were reflected in the demand and supply functions for a commodity. External costs or benefits were not included in the consumers'-producers' surplus model but were handled in the analysis by developing an objective function for externalities for each pesticide usage policy and then

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[11] Gerald A. Carlson, "A Decision Theoretic Approach to Crop Disease Prediction and Control" (unpublished Ph.D. dissertation, University of California-Davis, 1969).

[12] William F. Edwards, "Economic Externalities in the Agricultural Use of Pesticides and an Evaluation of Alternative Policies" (unpublished Ph.D. dissertation, University of Florida, 1969).

subtracting (cost) or adding (benefit) external values to the value calculated for the consumers'-producers' surplus model.

Current pesticide usage practices were used as a basis for evaluating alternative policies. The alternative policies consisted of substituting organic phosphate insecticides for 50 percent (in quantity) of the chlorinated hydrocarbons at 0.3, 0.4, and 0.5 pounds per acre of organic phosphates for each 1.0 pound of chlorinated hydrocarbons. Present crop quality and yields were maintained.

Edwards found that there was no satisfactory way to estimate empirically the functional relationship between dollar cost of externalities and the quantity of pesticides used. The major problem centered on collection of data for the external costs and/or benefits. Where someone was hospitalized or animals died from insecticide poisoning the dollar cost could be determined. However, the dollar cost of chronic effects of insecticides on man and animals as well as the effect on wildlife or environmental contamination, is not available and almost impossible to estimate.

The limitations of this study are that it considered only one county and insecticides were still being used to maintain crop quality and yields. It would have been interesting to see what the value of the objective function would have been if a no-insecticide use policy had been evaluated. The competition from crops grown in other areas of the state or regions of the country was not included in the analysis. The study was useful in pointing out the difficulties of securing data, especially for the externality function.