The Cost of Misapplication of Herbicides

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ABSTRACT

A field survey of 103 private herbicide applicators was conducted during the spring of 1986 in 12 central and eastern Nebraska counties. The results showed that only 30% of the cooperators were applying herbicides within 5% of their intended application rate. Twenty-six percent of the cooperators over-applied herbicides during a single application, with an average cost due to misapplication of \$3.11/ha (\$1.26/a). If these values were extended over Nebraska, \$4.26 million are expended for extra herbicides which were not necessary. The average cost of over application was in excess of \$570 per application. Forty-four percent of the cooperators under-applied herbicides spending \$3.06/ha (\$1.24/a) less than anticipated. However, neither of these values include the potential cost of crop or environmental damages, or possible crop yield reductions due to improper rate of herbicide application.

INTRODUCTION

Crop yield and quality depend heavily on the effective application of pesticides (Ozkan, 1987). In some cases, chemical costs can exceed one-third of the total cost of crop production (Urbain, 1987a). Additionally, the cost of some active ingredients has risen from 30 to 60% over the last five years. All these factors emphasize that proper chemical application can save money.

Over application of pesticides causes increases in production costs, potential crop damage, pollution and possible residue carryover. For example, a 10% over application of chemicals costing \$37/ha (\$15/a) would add \$450 to the cost of treating 120 ha (300 a). This figure represents only the overcharge for excess chemical, and does not include other potential damages.

Under application of pesticides can be just as costly because the chemical may not effectively control the target pest (Hoehne and Brumett, 1982). This might require an additional application, which means more fuel and labor due to extra trips across the field. In addition, the chemical may not be applied at an effective time in the pest's growth cycle which can result in yield losses due to uncontrolled pests. Probably the most difficult area to assess is the potential reduction of yield because of under application of chemicals. Hawkins et al. (1977) showed that corn yields from a no herbicide treatment were about 20% less than from similar plots receiving herbicide. Also, if pests are able to accumulate and mature, yields can be negatively affected in subsequent growing seasons.

The pesticide label specifies the application rate that will produce the best results. According to the Guide for Commercial Applicators (USEPA and USDA, 1975), the actual application rate should be within 5% of the recommended label or intended rate. Accurate calibration will enable an operator to establish the correct ratio at which pesticides and carrier must be added to the spray tank, so that the intended application rate specified by the pesticide label can be achieved for the target pest and crop/soil conditions.

Applying chemicals at the proper rate is essential for satisfactory pest control. Proper application rate will be attained when the operator controls the sprayer properly and the sprayer is calibrated correctly. Several investigators (Grisso et al., 1988; Ozkan, 1987; Rider and Dickey, 1982) have assessed the accuracy of pesticide applicators. Grisso et al. (1988) found that only one out of three applicators applied pesticides within 5% of their intended application rate. The major source of error was incorrect calibration (55%) while tank mixing errors were detected in 19%.

Limited information is available concerning what these application errors cost the applicator. Reichenberger (1980) estimated a misapplication cost from \$5.00 to \$30.00 /ha (\$2.00 to \$12.00/a) from added chemical expense, potential crop damage and threatened pest competition. He also estimated that nationwide, these additional expenses could cost farmers one billion dollars per year.

Objective

The objective of this study was to determine the chemical costs incurred because of herbicide misapplication in Nebraska fields.

PROCEDURE

Observations were made on 103 randomly selected farm sites as cooperators were either calibrating a sprayer or applying herbicides to a field. The survey was conducted during the spring of 1986 in 12 central and eastern Nebraska counties. Many of the cooperators had no prior notice of the observer's visit. All the cooperators

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were applying liquid herbicide solutions. On-site observations consisted of a short interview followed by a measurement of sprayer performance.

During the interview, information was obtained concerning; the operator, sprayer set-up, system pressure, nozzle type, the chemical(s) used, intended chemical application rate(s), amount of chemical(s) added to the tank, tank size, intended spray volume, estimated travel speed, and the method and frequency of calibration procedures. Measured items were: nozzle delivery rates, nozzle spacing nozzle heights, and travel speed.

ANALYSIS OF DATA

From these measurements, the spray volume (V) was calculated as:

$$V = \frac{K\,Q}{S\,W} \quad \text{[1]}$$

where

V = spray volume, 1/ha (gpa)
K = conversion constant, 60,000 (5940)
Q = average measured nozzle flow rate, 1/min (gpm)
W = nozzle spacing, cm (in)
S = travel speed, km/h (mph).

From the spray volume, the application rate (Vc) of the chemical was determined from:

$$V_c = \frac{V\,A}{T} \quad \text{[2]}$$

where

V_c = application rate, 1/ha (pt/ac or qt/ac)
A = amount of herbicide added to the tank, 1 (pt or qt)
T = volume used in spray tank, 1 (gal).

These measured values were then compared with those that the cooperator intended. The percent error was calculated as:

$$\%\ \text{Error} = \frac{[\text{Measured Rate} - \text{Intended Rate}] * 100}{\text{Intended Rate}} \quad \text{[3]}$$

Costs were calculated in three forms; the total cost of the chemicals applied per unit area (C_c), the cost of chemicals misapplied per unit area (C_a) and the cost of misapplication over the entire treated area(C_t). These costs were calculated as:

$$C_c = C_v(V_c) \quad \text{[4]}$$

$$C_a = C_v(V_c - V_i) \quad \text{[5]}$$

$$C_t = C_a(T_a) \quad \text{[6]}$$

where

C_c = cost of the chemical per unit area, \$/ha (\$/a)
C_a = cost of misapplication per unit area, \$/ha (\$/a)
C_t = accumulated cost of misapplication over the treated area (\$)
C_v = cost of herbicide per unit volume, \$/1 (\$/pt or \$/qt)
V_i = intended application rate, 1/ha (pt/ac or qt/a)
T_a = total area of applictaion, ha (a).

Herbicide costs per unit volume (C_v) are presented in Table 1. Cost calculated from equations [5] and [6] will be positive if herbicides were over applied, and negative if they were under applied. Note the cost data reflect only calibration and mixing errors, but do not include other potential damages.

SURVEY RESULTS

A total of 103 private applicators cooperated in the survey. Of these, 87 gave complete information allowing the calculation of the total cost of misapplication (C_t). Sixteen cooperators preferred not to disclose the total area of chemical application.

The total area for a single application treated by the 87 private applicators was 28 000 ha (69,250 a) and averaged 318 ha (787 a), with a range from 17.8 ha (44 ac) to 1 052 ha (2,600 a). These cooperators applied over \$570,000 worth of herbicides which averaged about \$6,500 worth of herbicides per applicator.

The type and cost of the herbicides used are shown in Table 1. Forty-four applicators tank-mixed two or more chemicals. These herbicides were applied on a variety of crops including corn, soybeans, grain sorghum and

TABLE 1. Approximate Retail Prices of Herbicides Used

Herbicide	Price (\$)*	Price (\$)*	No. of Users†
AAtrex 4L	\$ 2.54/l	\$ 9.60/gal	19
AAtrex 80W	\$ 4.19/kg	\$ 1.90/lb	8
Banvel	\$13.42/l	\$50.80/gal	5
Bicep	\$ 5.71/l	\$21.60/gal	11
Bladex 4L	\$ 4.97/l	\$18.80/gal	14
Bladex 80W	\$ 7.94/kg	\$ 3.60/lb	1
Brominal 3+3	\$19.02/l	\$72.00/gal	1
Command 4EC	\$15.85/l	\$60.00/gal	2
2,4-D Amine	\$ 2.11/l	\$ 8.00/gal	3
2,4-D Ester	\$ 2.64/l	\$10.00/gal	12
Dual 8E	\$13.21/l	\$50.00/gal	3
Eradicane	\$ 5.15/l	\$19.50/gal	1
Genate Plus	\$ 4.81/l	\$18.20/gal	1
Lasso	\$ 5.71/l	\$21.60/gal	20
Lasso-Atrazine	\$ 4.23/l	\$16.00/gal	5
Lorox 4L	\$13.32/l	\$50.40/gal	2
Prowl	\$ 4.86/l	\$18.40/gal	2
Ramrod-Atrazine	\$ 3.83/l	\$14.50/gal	8
Ramrod Flowable	\$ 4.44/l	\$16.80/gal	3
Roundup	\$21.66/l	\$82.00/gal	1
Sencor/Lexone 4L	\$26.63/l	\$100.80/gal	5
Sencor/Lexone DF	\$41.89/kg	\$19.00/lb	7
Sutan†	\$ 4.81/l	\$18.20/gal	2
Sutazine	\$ 4.65/l	\$17.60/gal	1
Treflan	\$ 5.39/l	\$20.40/gal	10

*Price Source: Furrer et al. (1987).
†More than one chemical may have been used by an applicator.

pasture. The herbicide cost per unit area (C_a) ranged from $1.00/ha ($.40/a) to $122/ha ($49.50/a) for a single application. Over 66% of the cooperators (Fig. 1.) spent under $24/ha ($10/a) for a single chemical application. This cost was about half of that reported by Reichenberger (1980).

Application errors can result from incorrect calibration, incorrect ratio of the herbicide and carrier or a combination of both. Over 70% of the 103 cooperators had a calibration and/or mixing error in excess of 5% (Fig. 2). If an error occurred, there was a tendency to under apply. Grisso et al., (1988) provided additional discussion relating to application errors, spray equipment and calibration procedures.

A total of 31 applicators (30%) were within 5% of their intended application rate (Fig. 2) and were considered excellent applicators. Fourteen of these applicators over applied between 0 and 5% of their intended rate and had an average misapplication of $.72/ha ($.29/a). Seventeen applicators under applied and were within the 5% range and spent $.42/ha ($.17/a) less on chemicals than they intended.

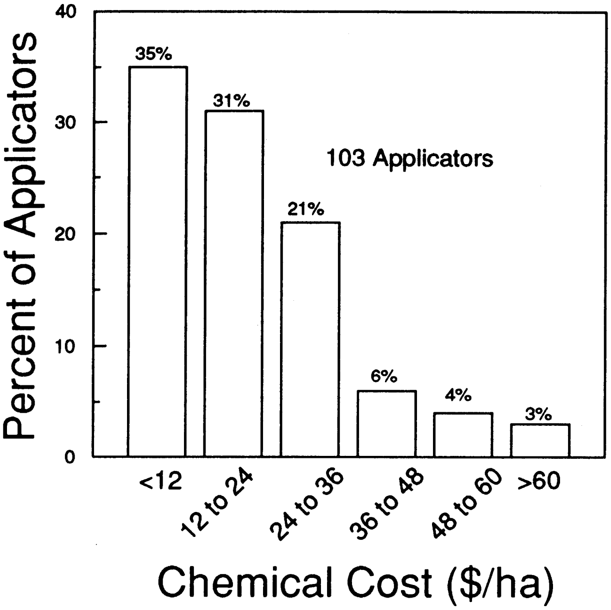

Fig. 1—Distribution of applicators and cost of herbicides applied.

Fifty-percent of the applicators (Fig. 3) had a misapplication cost between $1.50/ha and -$1.50/ha ($.60/a and -$.60/a) which can be considered insignificant in light of the cost of crop production. But as the misapplication costs and treated area increases, the cost accumulates.

Twenty-seven applicators (26%) over-applied herbicide by more than 5% of their intended rate and had an average overcharge cost of $3.11/ha ($1.26/a) with one applicator having an overcharge of $18.29/ha ($7.40/a). Of those 87 applicators who provided the total area treated, the average cost due to over-application was $573 with a range from $12 to $2,220 per application (Fig. 4). Additional costs would be accrued from damages due to excessive chemical residue if rates are excessive.

The Nebraska Dept. of Agriculture in 1986 estimated there were 57,000 Nebraska farms with an average size of 335 ha (828 a). Corn, soybeans, winter wheat and sorghum were Nebraska's leading crops and used over 5.25 million ha (13 million a) of cropland. If the survey estimates of 26% of the applicators having an overcharge of $3.11/ha ($1.26/a) were representative of the state's applicators, an estimated cost of $4.26 million dollars was incurred due to excessive application of herbicides.

According to Grisso et al. (1988), most application errors are due to improper calibration. Most calibration procedures and necessary adjustments can be completed in less than an hour (Urbain, 1987b). Thus, those individuals who over applied herbicides could receive a quick return on investment time if calibration procedures were followed. From this survey, an hour spent in calibration would reduce the chances of losing $570 per application.

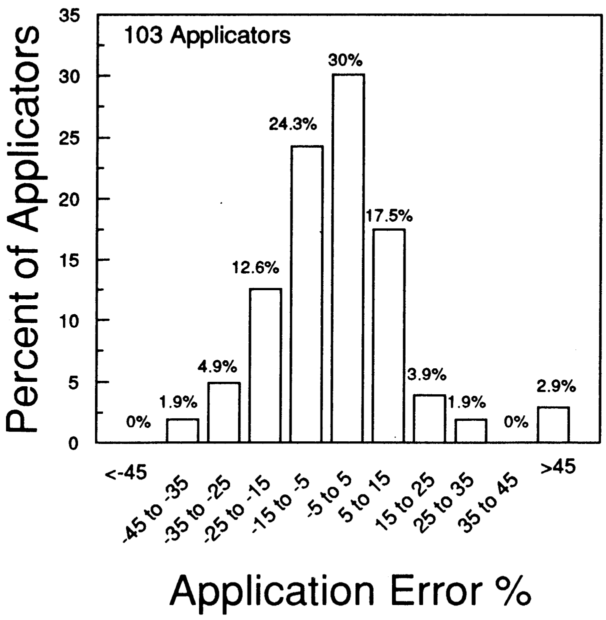

Fig. 2—Distribution of applicators and herbicide application errors. Errors are the result of improper mixing ratio, calibration, or a combination of both.

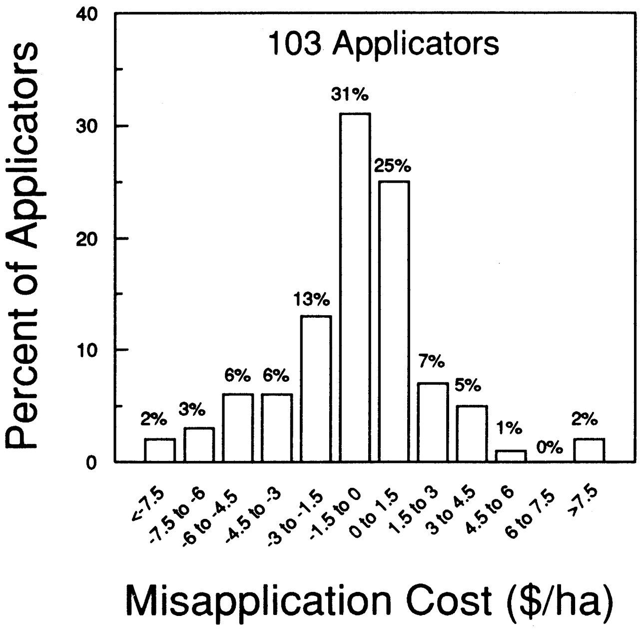

Fig. 3—Distribution of applicators and the cost of misapplication. The cost is a result of improper mixing ratio, calibration, or a combination of both. A negative cost indicates under application.

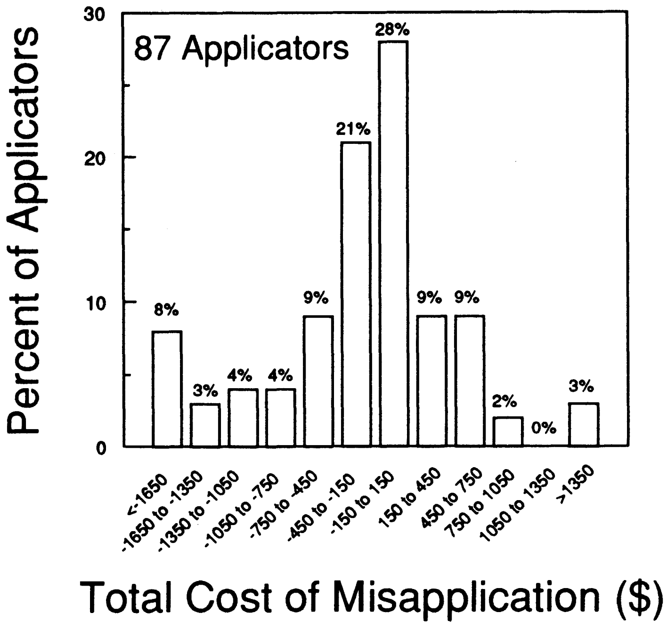

Fig. 4—Distribution of applicators and the total cost of misapplication over the treated area. The cost is a result of improper mixing ratio, calibration or a combination of both. A negative cost indicates under-application.

Mowitz (1988) observed that most farm sprayers can be completely retrofitted with new equipment (nozzles, hoses, pumps, main-line filters, pressure gauges, etc.) for less than the cost incurred due to over application. Thus, if retrofitting is necessary, this investment can be recovered in less than a single application.

Forty-five applicators (44%) were under applying greater than 5% of their intended rate. These applicators spent \$3.06/ha (\$1.24/ac) less on chemicals than anticipated. The 87 applicators who provided the total area treated, "saved" chemical costs of \$1,053 per application. However, these values do not reflect the potential yield reduction, and poor crop quality due to reduced weed control and increased weed pressure. Since the misapplication costs were based on the operator's intended rate (which may not have been label rate), losses due to insufficient weed control probably occurred.

CONCLUSIONS

Only 30% of the cooperators surveyed in Nebraska applied liquid herbicides within 5% of their intended application rate. Over two-thirds were misapplying herbicides. Twenty-six percent over applied herbicides and the average cost due to misapplication was \$3.11/ha (\$1.26/a) which accumulated to an average of over \$570 per application. If these values were extended across Nebraska, \$4.26 million are expanded for extra herbicides which were not necessary. Forty-four percent under applied herbicides and spent \$3.06/ha (\$1.24/a) less than anticipated. Neither of these values include potential costs due to crop or environmental damages from improper application. In many cases, the time spent calibrating, or the cost of retrofitting an existing sprayer with new components can be rapidly recovered by the improved accuracy of application.

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