ASSESSING DEER DAMAGE IN YOUNG FRUIT ORCHARDS

by Jay B. McAninch, Mark R. Ellingwood,* Michael J. Fargione and Peter Picone**
Institute of Ecosystem Studies, The New York Botanical Garden
Millbrook, New York 12545

ABSTRACT

Evaluations of systematic damage assessments of 5, 10 and 20 percent of all apple trees in 12 orchards were compared. The 10% assessment technique was selected as the most accurate and efficient in estimating summer and fall damage. Analysis of several parameters of tree vigor found significant differences between browsed and unbrowsed trees for tree basal diameter and central leader diameter over 2 successive years. These subtle yet important differences in tree development were felt to severely limit the possibilities of relating browsing to growth and, later, yields. Methods and considerations for making control decisions on a per acre basis are discussed.

INTRODUCTION

Assessing and controlling deer damage in apple orchards has been a topic of concern for many years (Berry, 1948; Morse and Ledin, 1958; Harder, 1968; Katsma and Rusch, 1979). Assessments of the extent and severity of damage have been evaluated (Harder, 1970; Katsma and Rusch, 1979) and have proved difficult to both quantify and express in terms of tree maturation and yields. Although methods for assessing damage have been proposed (Berry, 1948; Katsma and Rusch, 1979), the use of these techniques in making damage control decisions has been very limited. As most control decisions are made during the early years of tree development (Forshey, 1976), a useful damage assessment technique and some criteria for making control decisions during the first 5 years of orchard development were considered essential to farmers, extension agents and agents for damage reimbursement programs.

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Current addresses: *Connecticut Department of Environmental Protection, North Franklin, CT 06254; **Southington, CT 06489

METHODS

Assessment Study

In January 1985 12 orchard blocks located in Southeastern New York were evaluated for the presence of summer and fall deer damage. Blocks contained from 251 to 692 trees and ranged in age from 1 to 4 years (Table 1). Trees were recorded as damaged if at least one browsed limb was observed. The location of each tree in each block was mapped for later use in deriving simulated assessment data. Actual damage ranged from 1.1% to 89.7% for the summer and from 0.2% to 77.0% in the fall. Using the mapped tree data for each block, systematic assessments of 5, 10 and 20 percent of the total number of trees in each block were generated. Assessments were summed and compared to actual damage rates. Finally, equations for estimating damage rates from sample data were generated with 90% prediction intervals.

Growth Study

A stratified sample of 210 semi-dwarf apple trees, ranging in age from 1 to 2 years and consisting of 3 varieties was selected and tagged in Southeastern New York orchards. Tree growth parameters were evaluated during the fall of 1982 and 1983. Damage assessments were conducted after leaf fall and during March of both years. Data collected from each tree included basal diameter, limb diameter, and the percent of at least 1 browsed twig. In addition, the annual growth increment of the central leader and 3 systematically selected limbs were taken from each tree. Basal

Table 1. A description of 12 young orchard blocks evaluated for deer damage in January 1985.

ORCHARD BLOCK	AGE (yrs)	NUMBER OF TREES	ACTUAL DAMAGE (100%) SUMMER	FALL
A	4	335	63.9	60.0
B	4	251	53.0	32.3
C	3	334	5.1	1.8
D	3	350	35.4	9.1
E	3	369	89.7	74.0
F	2	479	65.8	77.0
G	2	506	50.4	1.2
H	2	284	67.3	52.8
I	2	357	11.2	50.7
J	1	462	54.5	0.2
K	1	362	1.1	30.7
L	1	692	18.1	21.0

Table 2. Summer damage assessment comparisons based on deer damage surveys conducted in 12 young orchard blocks during January 1985.

SAMPLE RATE	F VALUE	R^2	COEFFICIENT OF VARIATION	MEAN SQUARE ERROR	SUM OF SQUARED RESIDUALS
5%	242.22	.96	13.83	5.94	352.72
10%	312.31	.97	12.23	5.25	270.01
20%	180.72	.95	15.90	6.83	466.45

diameter was recorded as the average of 2 measurements taken 10 cm above the ground surface. When the scion graft was above the 10 cm height, basal diameter was taken at 15 to 20 cm above the graft, depending on scar swelling of the bole.

Limbs, defined as stems 10 cms or more in length and attached directly to the tree bole, were systematically selected by starting with the bottom limb, and counting upward, selecting limbs 1, 3 and 5 for measurement. Limb diameters were measured approximately 2 cm from bole attachment. The growth increment of each selected limb was the length for all the most recent summer growth on all twigs (excluding spurs). Leader diameter and leader length were measured at the point of recent growth initiation.

Damage counts included the frequency of browsing on the past season's growth and, as such, occasionally resulted in a single twig having been browsed more than once. For this analysis, the occurrence of 1 browsed twig was used to classify trees as browsed.

RESULTS

Assessment Study

Analysis of the variation in the 3 sampling methods used was derived from significance values, coefficients of determination, coefficients of variation, mean square error and the sum of the squared residuals. The analysis of summer damage data resulted in the selection of the 10% sample assessment methods as the most accurate of the three methods tested (Table 2). The 10% method had the largest F value and highest degree of association with the actual damage values. In addition, the 10% method had the lowest coefficient of variation as well as the least amount of variation about the predicted line (Fig. 1). Finally, the equation for deriving deer damage rates from 10% samples of fruit trees damaged in summer was generated with a 90% prediction interval.

The fall damage assessment analysis found the sampling methods increased in significance and prediction accuracy with increased sampling rates (Table 3). Despite this trend, the relative gains in accuracy from the 20% sampling method over the 10% sampling method were considered to be less than the value of the labor needed to sample the additional trees. In fact, the analysis of variation and accuracy found very slight differences between the 10% and 20% methods. The prediction equation and 90% interval were developed (Fig. 2) and were similar to the summer prediction relationship.

Growth Study

Analysis of variance (Table 4) indicated significant differences ($p < 0.0001$) existed in almost all growth parameters when compared between orchards. This was likely a result of age and varietal differences, varying management practices and site quality.

When browsed and unbrowsed trees were compared, significant differences ($p < 0.02$) existed for tree basal diameter in both years (Table 4). Basal diameter, which has been traditionally considered a good indicator of tree vigor, was considerably less variable than other tree growth parameters. Central leader diameter was notably different ($p < 0.06$) between browsed and unbrowsed trees during both sample years (Table 4). Trends for average limb diameter measurements were that browsed trees had greater diameters than unbrowsed trees. This latter result could be evidence of growth stimulated by deer browsing. Field observations suggested that browsing appeared to result in more net annual limb growth due to the release of laterals and the continuation of terminal growth at a time when unbrowsed twigs appeared to be hardening off.

DISCUSSION

Based on this study, a 10% systematic sampling of fruit trees would result in a predicted damage rate with acceptable accuracy. Surprisingly, the prediction interval was not wider at low damage levels and narrower at high damage levels, as might be expected by sampling theory.

The significant differences encountered between browsed and unbrowsed, 1- and 2-year-old fruit trees were unexpected, in view of the lack of differences reported by Harder (1970). As many trees were not judged to be severely browsed, the fact that overall tree vigor differed across all browsed trees suggests that the impact of deer browsing over the first years of tree development were subtle yet important. Since browsing can occur at irregular intervals during summer and winter of

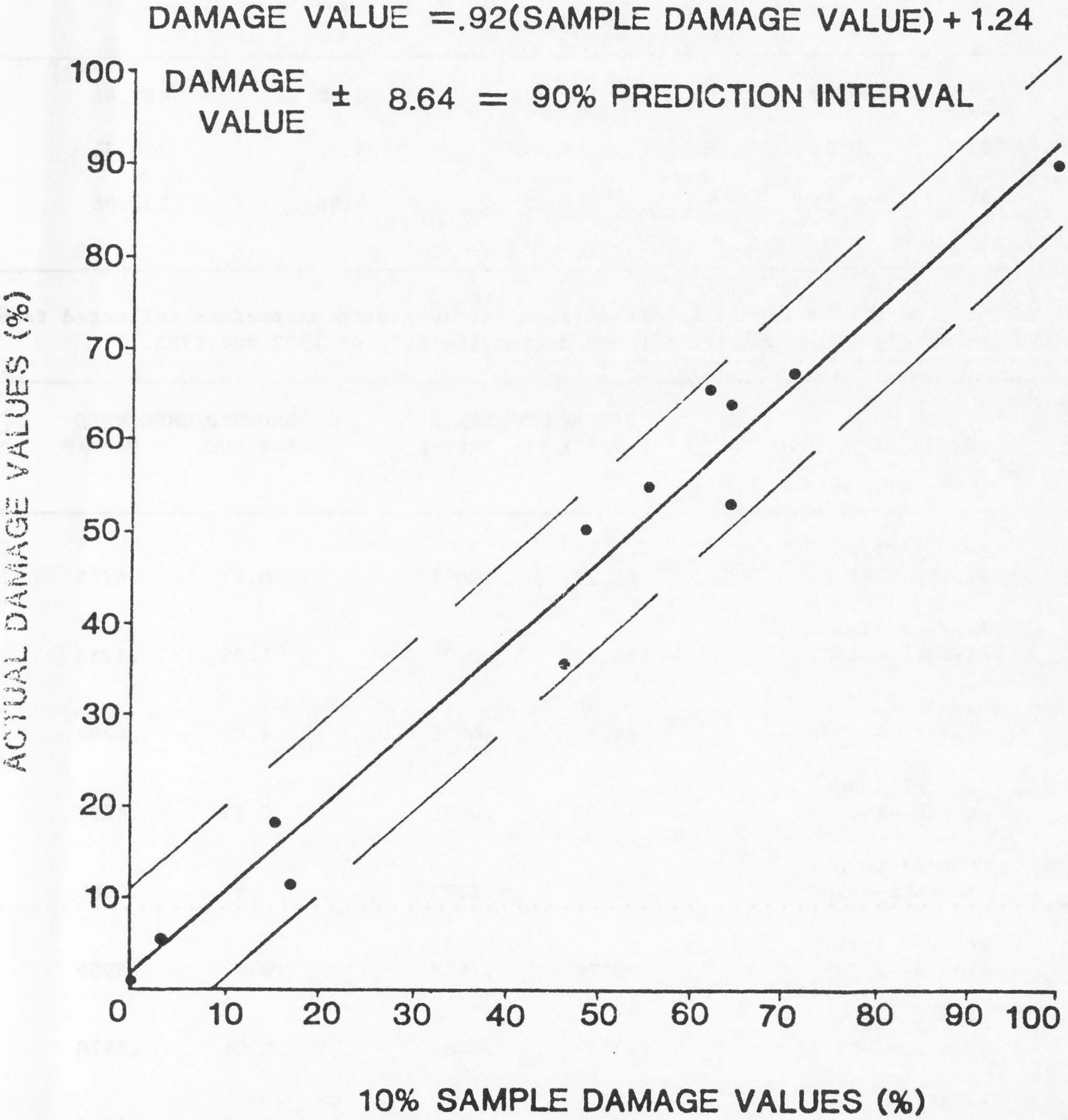

Figure 1. The relationship between sample and actual summer damage values for 12 fruit orchards assessed in January, 1985.

Table 3. Fall damage assessment comparisons based on deer damage surveys conducted in 12 young orchard blocks during January 1985.

SAMPLE RATE	F VALUE	R^2	COEFFICIENT OF VARIATION	MEAN SQUARE ERROR	SUM OF SQUARED RESIDUALS
5%	180.40	.95	19.88	6.80	462.96
10%	350.21	.97	14.45	4.95	244.71
20%	360.55	.97	14.25	4.88	237.88

Table 4. Results of analysis of variance for 10 growth parameters collected from approximately 210 young fruit trees during the fall of 1982 and 1983.

	BETWEEN ORCHARDS		BROWSED/UNBROWSED	
GROWTH PARAMETER	F-VALUE	PROB>F	F-VALUE	PROB>F
Average limb growth—1982	64.29	.0001	0.17	.6785
Average limb diameter—1982	125.19	.0001	1.86	.1738
Basal diameter—1982	164.74	.0001	4.89	.0282
Central leader growth—1982	11.36	.0001	0.63	.4270
Central leader diameter—1982	2.26	.1072	3.41	.0664
Average limb growth—1983	0.29	.7482	0.02	.8956
Average limb diameter—1983	13.39	.0001	0.04	.8478
Basal diameter—1983	70.98	.0001	5.16	.0242
Central leader growth—1983	3.81	.0237	1.16	.2830
Central leader diameter—1983	4.47	.0126	3.59	.0596

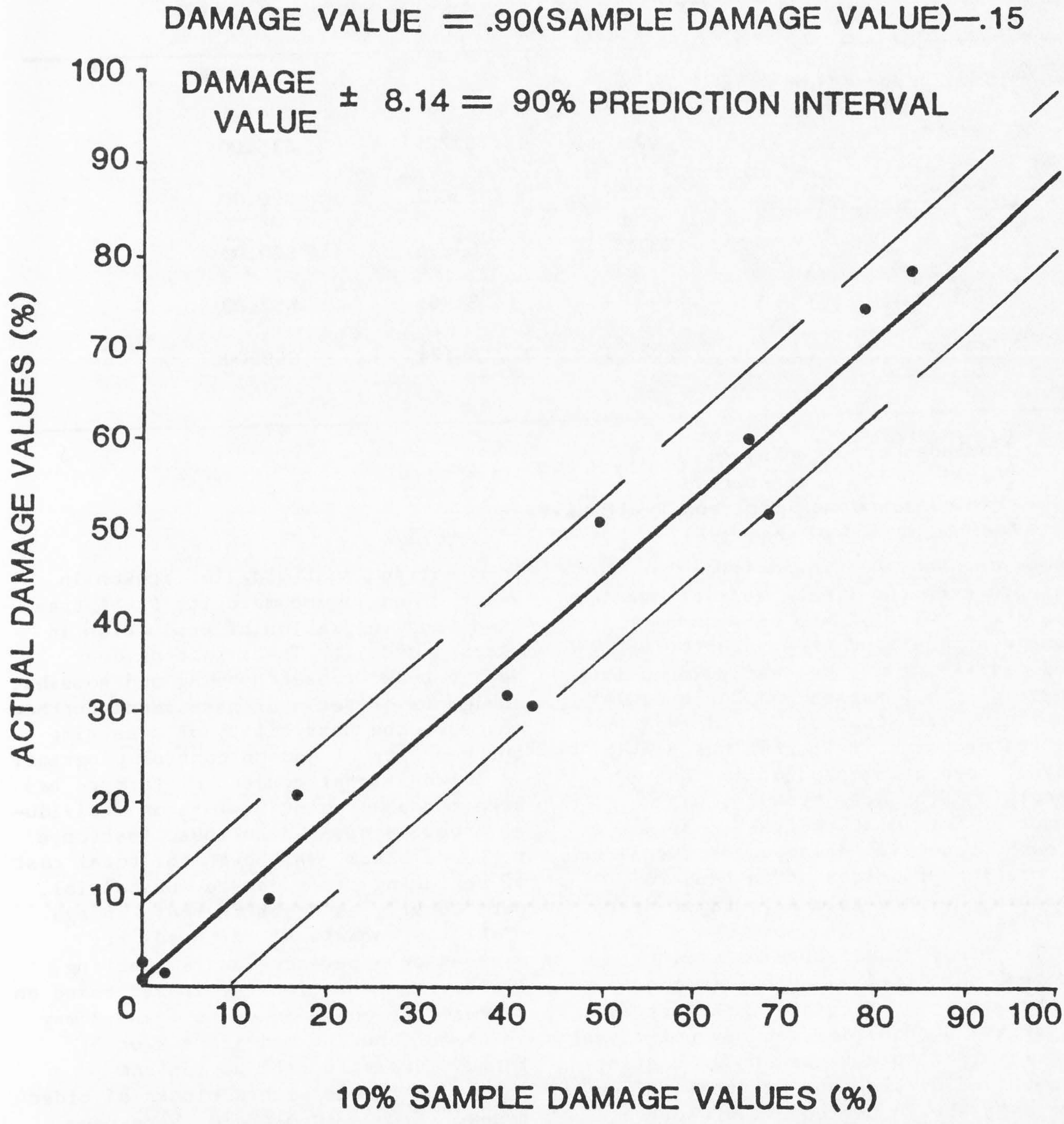

Figure 2. The relationship between sample and actual autumn damage values for 12 fruit orchards assessed in January, 1985.

Table 5. Summary of annual per acre costs of the first five years of apple orchard establishment.

	MANAGEMENT COST[1]	CUMULATIVE COST	REPLACEMENT COST[2]
Site preparation	$745		
Year 1	$1554	$2299	$15.00
Year 2	$733	$3032	$20.00
Year 3	$875	$3096	$25.00
Year 4[3]	$1059	$4965	$32.00
Year 5[3]	$1029	$6174	$40.00

[1]Includes opportunity cost.
[2]Based on 155 trees/acre.
[3]Excludes income lost from fruit havrest.
Adapted from Gerling, 1981.

each year and then in an irregular pattern over the first years of development, the relationship between deer damage and delayed tree maturity or reduced yields may be nearly impossible to establish. Katsma and Rusch (1979), in their evaluation of deer damage in mature orchards, felt that the possibility of predicting production loss resulting from deer browsing was remote. For immature trees, rapid growth, recurring damage, and the nature of pruning practices often tend to obscure the long-term effects of deer browsing.

The preceding discussion would suggest that precise quantification of browsing may accurately reflect deer activity in orchards, yet may not reveal the level of tree vigor and subsequent growth and development of trees suffering damage. In the course of several repellent, fencing and damage assessment studies in Southeastern New York, the authors have concluded that farmers seem to be assessing the impact of deer damage in terms of tree establishment (good vigor and terminal growth in year 1), development of tree structure (good terminal and scaffold limb growth in years 2 and 3) and maturity (full tree shape and initiation of production in years 4 and 5). The impact of deer damage under these changing and somewhat ambiguous criteria of assessment further obscures the possibility of measuring the benefits of damage control programs.

An additional concern of farmers has been the assessment of loss on individual trees as opposed to those lost on a per-acre basis. Although the total cost of replacing trees can be substantial, particularly as trees increase in age (Table 5), nearly all orchards are managed on a per-acre basis (Gerling, 1981). Compensation for losses based on replacement costs in years 1 and 2 may be useful, but beyond years 2 or 3, farmers are reluctant to replant individual trees within blocks of older trees. Even aged orchards have been easier and less costly to manage than interplanted orchards (Forshey, 1976).

Assessment techniques that result in damage estimates on a per-acre basis allow for more direct comparisons of damage with the costs of various damage control measures. In the absence of

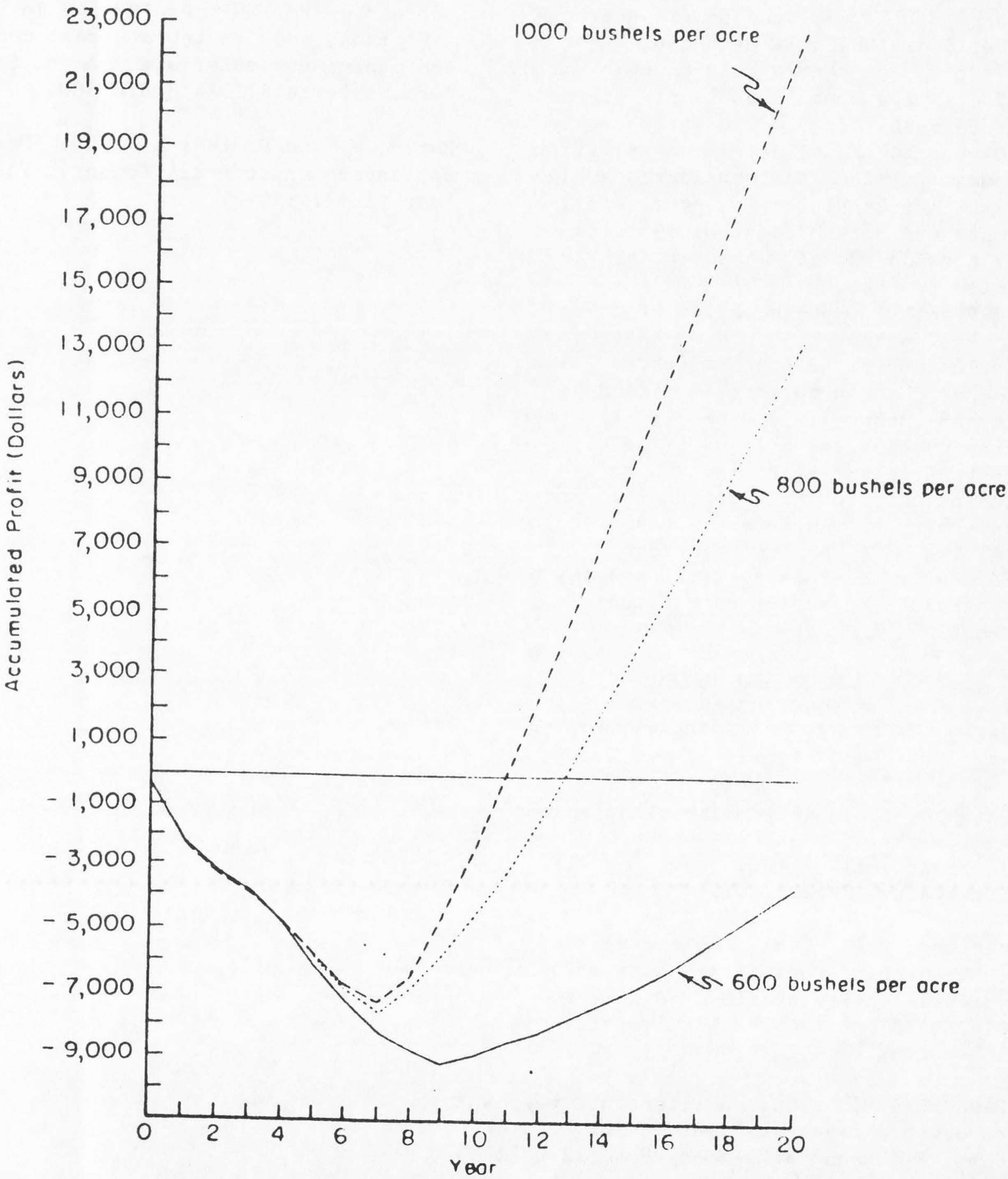

Figure 3. Potential accumulated profit at three different mature yield levels at $4.50 per bushel (Gerling,1981).

precise loss estimates (or benefit projections), farmers might be advised to assess the extent of damage across blocks, judge economic risk from experience, and evaluate the cost of damage control measures against potential returns. Using projections of potential accumulated profit per acre (Gerling, 1981), farmers could, for example, see that a reduction in yield of only 200 bushels on 1 acre of trees could result in $10,000 in loss over the 20-year period (Fig. 3). Thus, if the damage per acre was considered a high risk to potential gains, the relative costs per acre of control measures could be considered against potential accumulated profits.

Finally, implementation of damage control measures should be based on dollars spent to protect future gains rather than on dollars justified by losses incurred. For nearly all other crop damages suffered by farmers, control measures are invoked before losses occur or are substantial, and generally are implemented based on the results of a monitoring effort. Hopefully, deer damage will someday be controlled by action rather than reaction.

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