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SAMPLING OF CORN TO ASSESS BIRD DAMAGE: A Preliminary Review of a Comprehensive Study

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A Preliminary Review of a Comprehensive Study

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"How large a sample is needed to survey the bird damage to corn in a county in Ohio or New Jersey or South Dakota?" Like those in the Bureau of Sport Fisheries and Wildlife and the U.S.D.A. who have been faced with a question of this sort we found only meager information on which to base an answer, whether the problem related to a county in Ohio or to one in New Jersey, or elsewhere. Many sampling methods and rates of sampling did yield reliable estimates but the judgment was often intuitive or based on the reasonableness of the resulting data. Later, when planning the next study or survey, little additional information was available on whether 40 samples of 5 ears each or 5 samples of 200 ears should be examined, i.e., examination of a large number of small samples or a small number of large samples.

What information *is* needed to make a reliable decision? Those of us involved with the Agricultural Experiment Station regional project concerned with the problems of bird damage to crops, known as NE-49, thought we might supply an answer if we had a corn field in which *all* the damage was measured. If all the damage were known, we could then sample this field in various ways and see how the estimates from these samplings compared to the actual damage and pin-point the best and most accurate sampling procedure. Eventually the investigators in four states became involved in this work[1] and instead of one field we were able to broaden the geographical base by examining all the corn ears in 2 half-acre sections of fields in each state, 8 sections in all. When the corn had matured well past the dough stage, damage on each corn ear was assessed, without removing the ear from the stalk, by visually estimating the percent of the kernel surface which had been destroyed and rating it in one of 5 damage categories. Measurements (by row-centimeters) of the rows of kernels pecked by birds also were made on selected ears representing all categories and all parts of each field section. These measurements provided conversion factors that, when fed into a computer, were applied to the more than 72,000 visually assessed ears. The machine now had in its memory and could supply on demand a map showing each ear, its location and the intensity of the damage[2].

With the detailed information stored in the computer, a program was devised to simulate sampling and determine how close each sample came to the known damage. So far, two plans of sampling have been analyzed. One plan simulates an observer moving along the corn rows and the other plan when he moved in a line across or perpendicular to the rows. For instance, we had the computer take a sample of 20 ears from one of the sections, compare this to the known damage for the section, take another sample and make this comparison, and repeat this process 1000 times. As shown in Table 1, for one of the Maryland half-acre sections, 667 of these samples fell within 50% of the known damage of that section. Next the computer ran a group of five 20 ear samples 1000 times, followed by groups of 10, 15 and 20, up to 50, of the 20 ear samples. A figure of 950 indicates a probability of 95 percent. From Table 1 we can see that the sample sets representing 5 of these 20 ear samples exceeded 950, thus these data indicate that a little less than 5 samples, about 4 of 20 ears each, are needed to achieve an estimate within 50 percent of the actual damage.

Table 1, The number of simulated 20 ear sample sets of 1000 that yielded a damage estimate within the accuracy indicated (based on field section No. 4, using perpendicular method of sampling)

Number of	Percent of Actual Damage				
Samples per set	±1	±5	±10	±25	±50
1	0	56	140	390	667
5	26	173	317	695	964
10	44	219	432	874	994
15	67	272	500	926	998
20	56	309	580	962	1000

The 4th column shows that slightly less than 20, about 19, samples would be needed to achieve an estimate within 25 percent of actual damage with 95% probability. Note how few sample sets out of the 1000 fell with in the first 3 columns representing 1 percent, 5 percent and 10 percent of actual damage. The number of samples at 95% probability which would be needed at these levels would probably be too large (considerably over 20) for practical assessment.

Similar simulation sample sets were taken of the following sample sizes: 1, 5, 10, 20, 50, 100 and 500 ears and for the 2 sampling procedures: a print-out total of 96 tables resulted. The three tables which follow, summarizing some of the resulting data, refer only to estimates within 25 and 50 percent of actual damage. The first of these, Table 2 (Number of Samples Needed), contains the crux of the whole study. For instance, the table indicates that an investigator who desires estimates

Table 2. The number of samples needed. Based on all 8 field sections (½ acre each) using perpendicular method of sampling.

Desired Accuracy	5	10	20	50	100	500
		Sample Size (ears)				
(Percent of actual,)						
± 25	42	29	19	6	4	2
± 50	12	8	4	2	2	1

within 25 percent of actual damage can take four-100 ear samples or twenty-nine-10 ear samples. Other sample sizes as indicated in this table might suit his purposes better. Note the reduced requirements for estimates at ± 50 percent as compared to ±25%. Note also that fewer sample numbers are needed as the sample size increases.

Table 3 (Relationship Between Number of Samples and Method of Sampling) shows that sampling in a line perpendicular to the rows was more efficient than sampling ears along the row. For instance, only 4 samples of 20 ears each would be required when the ears are examined in a line across the rows as compared to 7 when the ears are examined along the row.

Table 3. The relationship between the number of samples needed and method of sampling. Based on all 8 field sections (½ acre each) and a ±50% accuracy.

Sampling Method	Sampling Size (ears) 5	20	100
Linear	15	7	3
Perpendicular	12	4	2

Table 4 (Relationship Between Number of Samples and Intensity of Damage) indicates that a preliminary examination of a field for bird damage may aid the investigator. Fewer number of samples are likely to be required in field sections having high levels of damage than fields with less damage. In the case of sample size 20, about one-third as many samples would be required in a half-acre section having high damage as compared to a field section with relatively low damage (10 vs. 29).

Table 4, Relationship between number of samples needed and intensity of damage in the corn being sampled.[1]

Damage Intensity [2]	Sampling Size (ears) 5	20	100
High	25	10	2
Low	54	29	6

[1] Based on ± 25% accuracy and perpendicular sampling method.
[2] Based on the 4 field sections with greatest damage="high"; and, on the 4 field section with lowest damage = "low".

This study indicates that a higher rate of sampling will be needed for only limited levels of accuracy than our previous survey planning decisions indicated. We probably can and should, when time and money is available, obtain information on other sampling procedures that the computer can simulate. This work has some practical merit enabling us now to answer some questions which we could not do heretofore. For example, using this data and estimates of time involved in laying out and getting to plots, we calculated that if we conducted a survey of bird damage corn in several Eastern states using 3000 plots of a half-acre each and if we are satisfied to determine the damage to within + or -50% of actual damage, we can take 5 ear samples and it will require 86 people to do the field work, or we can take 500 ear samples and it will require 28 workers. Now we can begin to answer those questions posed earlier on what size and how many samples are needed to achieve the accuracy required for study or survey purposes. This basic information can be related, as necessary, to other considerations such as the economics involved with assessing damage.

[1] Philip Granett and Robert Fringer of New Jersey, Don Messersmith of Maryland, Tom Stockdale of Ohio and John Linehan of the Delaware Wildlife Research Field Station, Bureau of Sport Fisheries and Wildlife.
[2]The statistical work has handled by the Rutgers State University Statistics Center, initially thru Dr. Ron Snee, later Dr. Dan Chilko and presently Dr. Richard Trout.