FIELD LOSS FROM SUGARBEET HARVEST OPERATIONS

John A. Smith, C. Dean Yonts, and Karen L. Palm
Machinery Systems Engineer, Irrigation Engineer, and Research Technician
University of Nebraska Panhandle Research and Extension Center
Scottsbluff, NE 69361

INTRODUCTION

Sugarbeet growers and the entire sugarbeet industry are examining sugarbeet production practices to improve production efficiency. One area of the cropping system that has received relatively little attention is that of field harvest loss. How much sugarbeet root do growers leave in the field after harvest? Is harvest loss a consistently low 0.5 ton/A and relatively unimportant, or is it 2 ton/A and a significant economic loss for growers? Data-based answers to these questions about current sugarbeet harvest loss are not found in published literature.

A study conducted in grower's fields in the early 1970's in Great Britain (Maughan, 1974), found that losses from sugarbeet roots left in the ground or on the surface were more than 1.3 ton/A on 30 percent of the fields surveyed. A loss of 7.6 ton/A was the worst situation measured. Recent studies related to U.S. harvest loss focus on comparison of models of harvest equipment or on operating practices such as field speed. One such study conducted by Smith (1993) in Minnesota evaluated the effect of defoliator flail type, number, configuration, and speed of operation on resulting sugarbeet yield and quality.

To determine whether harvest loss in grower fields is an important sugarbeet production problem that requires effort by the sugarbeet industry, current data is needed on the quantity of harvest loss occurring under typical grower harvest situations.

OBJECTIVE

The objective of this study was to determine the sugarbeet harvest field loss in typical grower's fields in Nebraska.

METHODS

Fields of 15 Nebraska growers were sampled during each of the 1992, 1993, and 1994 harvest seasons. Three of the growers sampled in 1993 were included in the 1992 study. One grower sampled in 1994 was also sampled in 1992 and 1993. Growers were selected on the basis of diversity of the harvest situation (soil condition, harvest equipment, size of operation, and irrigation method), availability of a field being currently harvested, and location within the Nebraska growing area. Fields were selected that had been harvested within the previous 24 hrs to maintain freshness of roots. Fields or growers were not selected on the basis of expecting certain harvest loss or of being a "good" or "average" grower.

Eight sites, randomly located within each field, were selected for sampling. Each site was 89 in. wide by 89 in. long and was centered on three 30 in. rows or four 22 in. rows. One site was located near the field ends, but the rest were away from ends and sides, to be representative of the field. These eight sites provided a total sampling area of 1/100 acre per field. Harvestable roots or root parts were collected from the surface of the site first. The row area was then excavated by hand shoveling to a depth of at least 12 in. to search for beet roots and root parts. The roots and root parts found were categorized as:

- whole roots greater than 2 1/2 in. at the largest diameter
- whole roots less than 2 1/2 in. at the largest diameter
- sliced roots or root parts
- tails greater than 1 in. at the largest diameter
- tails less than 1 in. but greater than 1/2 in. at the largest diameter
- miscellaneous root parts

The roots and root parts from each site of each field were categorized, counted, bagged, washed, air dried, weighed, and then taken to the Western Sugar Tare Lab for analysis of sugar content.

RESULTS AND DISCUSSION

The location and type of irrigation for each field sampled are listed in Table 1 for each of the three study years. All fields were judged to have ideal or nearly ideal moisture conditions for harvesting in 1992. Soil moisture conditions ranged from ideal to "wetter than preferred" in 1993, although none of the fields sampled required harvest equipment or trucks be pulled with auxiliary tractors. Fields 16-19 were sampled before the severe freeze on October 30 which froze the top 1-2 in. of soil, sugarbeet leaves, and exposed portions of the sugarbeet root. Defoliation, scalping, and lifting were expected to be more difficult because the leaves and tops of the roots had been frozen. Fields 20-30 were sampled after October 30. Leaves and roots had thawed prior to the harvest of all fields except Field 27 which still had some frost in both leaves and exposed tops of the roots. Soil moisture in fields sampled during 1994 ranged from ideal for sugarbeet harvest to so wet that trucks had to be pulled through the field. The soil moisture level in most fields sampled in 1994 was considered wetter than preferred.

Harvest loss categorized as "recoverable roots and root parts", those whole roots and root parts that should be delivered to the factory, are summarized in Figure 1. There were seven fields out of the 45 total fields that had "recoverable" field loss that equalled or exceeded 1.0 ton/A. One of those fields had a "recoverable" loss of almost 4 ton/A. Twenty of the 45 fields had less than 0.5 ton/A "recoverable" harvest loss.

Total harvest loss, including all six categories of harvest loss components, is shown in Figure 2. Five fields exceeded 1.5 ton/A total harvest loss, while 15 fields had 0.5 ton/A total field loss or less. Small whole roots and small tails that would not normally be desired in the factory storage piles, comprised an average of 16%, 30%, and 19% of the total harvest loss found in 1992, 1993, and 1994, respectively.

The average contribution of each category of roots and root parts found is shown in Figures 3 and 4. When averaged over all 45 fields, large tails contributed 40% of the total field loss, while the other five categories each accounted for 10-15% of harvest loss. It was obvious in many of the fields with high losses of large tails that the digger wheels were not deep enough in the soil to lift the root without breaking the tail.

When averaged over only the five fields with greater than 1.5 ton/A total harvest loss, sliced roots and large tails each contributed 30% to the total loss. Small tails and small roots each contributed less than 8% of total harvest loss in these fields. Sliced roots in these fields were often caused when the sugarbeet plants were not centered on the soil ridge during the last cultivation or last ditching operation. The digger row finder mechanism centered the digger wheels on the soil ridge, not the sugarbeet roots, and sliced the roots.

Tables 2, 3, 4, and 5 list the number of pieces found for each root category, percent sugar of each component, sugar per acre for each category, and percent of total loss for each category in each field, respectively. Small tails, large tails, and miscellaneous root parts had the greatest number of pieces found per unit area, although of these categories only large tails contributed a significant weight of field loss. Many of the miscellaneous root parts were dropped from "ferris wheel" elevators. Generally, large beets, small beets, and large tails contained the highest percent sugar of all categories. The percent sugar of all categories was less in 1993 and 1994 than in 1992. Large tails contributed at least twice as much sugar per acre left in the field than any other harvest loss component, when averaged over all 45 fields.

Harvest losses tended to be greater in 1992 than in 1993 or 1994, even though harvest conditions were nearly ideal in 1992 and generally not good in 1993 and 1994. Several fields in 1993 presented difficult harvest conditions with excessive soil moisture, frozen soil, and frozen plant tops. Most fields in 1994 had very wet soil. This suggests that field losses can be maintained at an acceptable level even with difficult harvest conditions.

Fields 23 and 24 were harvested in 1993 by the same grower who in 1992 harvested field 4 which had 4 ton/A field loss. This grower, with a large acreage of sugarbeets, made management changes in his harvest operation in 1993 and reduced his field loss to a more acceptable level. Field 38 was also harvested by this same grower in 1994. Two causes were attributed to the loss in this 1994 field. The plant population was very low which contributed to large roots that protruded from the soil surface and were poorly anchored. A large number of these big roots were dislocated from the row during the defoliation operation and could not be recovered with the digger. The second problem was that the digger tended to drift on sidehills causing a large number of sliced roots.

We did not see any general trends that would suggest field loss differences between pivot and furrow irrigated fields, large and small operations, or different models of equipment. Three of the 45 fields had been harvested at night. This is not sufficient data to make any conclusions on night harvest or 24 hr. harvesting, but it appears that operator care is a much larger factor than day vs. night harvesting. Wide defoliators and diggers (8 row 30 in.) did present problems in several cases for maintaining accurate lifter wheel depth, accurate height control for the defoliator, and alignment of the digger on the row when operating on side hills.

Growers were not aware of the magnitude of their losses. They could not see most of the field loss on the surface of the soil and they did not have a feel for how much loss they had when they did see roots or root parts. An educational effort must be maintained to raise awareness of these issues.

CONCLUSIONS:

- Harvest loss was not a major problem when care was taken during harvest operations and operations prior to harvest. Harvest loss <u>was</u> a problem in approximately 10% of the fields, where loss exceeded 1.5 ton/A. One field had 4 ton/A loss! Thirty percent of the fields had total field loss less than 0.5 ton/A.

- Average <u>total</u> loss was 0.9 ton/A. Average <u>recoverable</u> loss (excluding small whole roots and small tails) was 0.7 ton/A. Thus, small roots and small tails were not a major problem

- Equipment model, weather and field conditions were not a major factor in field loss.

- You cannot see most field loss. Most loss was composed of large tails and sliced roots below the soil surface.

- Most loss from large tails was caused by inadequate depth of lifter wheels. A major field loss from sliced roots was caused when digging roots that were not centered in the soil ridge.

- Poor plant spacing and low plant population caused high loss of large roots in several fields.

- Growers must intentionally check for field loss. An educational effort is needed to teach operators how to recognize acceptable and unacceptable harvest loss levels. With good management, harvest loss can easily be maintained at an acceptable level.

REFERENCES

Maughan, G. L. 1974. Too many beet left in our fields. British Sugar Beet Review 42(3):158-163.

Smith, L. J. 1993. The effect of defoliator flail type, number, configuration, speed of operation, and crown removal under pre- and post-frost conditions on sugarbeet yield and quality. (Abstract) Appearing in Agriculture Proceedings from the 27th Biennial Meeting of the ASSBT, Anaheim, CA March 3-6, 1993, pg 94.

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Table 1. Location and type of irrigation for the fields sampled for sugarbeet field harvest loss in 1992, 1993, and 1994.

1992			1993		
Field No.	General Location	Irrigation Method	Field No.	General Location	Irrigation Method
1	Scottsbluff	furrow	16	Minatare	furrow
2	Minatare	furrow	17	Minatare	furrow
3	Minatare	furrow	18	Minatare	furrow
4	Alliance	pivot	19	Minatare	furrow
5	Alliance	pivot	20	Bayard	furrow
6	Melbeta	furrow	21	Bayard	furrow
7	Minatare	furrow	22	Bayard	pivot
8	Mitchell	furrow	23	Alliance	pivot
9	Mitchell	furrow	24	Alliance	pivot
10	Alliance	pivot	25	Alliance	pivot
11	Alliance	pivot	26	Alliance	pivot
12	Alliance	pivot	27	Alliance	pivot
13	Bayard	pivot	28	Alliance	pivot
14	Bridgeport	furrow	29	Scottsbluff	furrow
15	Bridgeport	furrow	30	Scottsbluff	furrow

1994		
Field No.	General Location	Irrigation Method
31	Bridgeport	pivot
32	Bridgeport	pivot
33	Bayard	furrow
34	Minatare	furrow
35	Alliance	pivot
36	Alliance	pivot
37	Alliance	pivot
38	Alliance	pivot
39	Scottsbluff	furrow
40	Scottsbluff	furrow
41	Scottsbluff	furrow
42	Gering	furrow
43	Gering	furrow
44	Gering	furrow
45	Gering	furrow

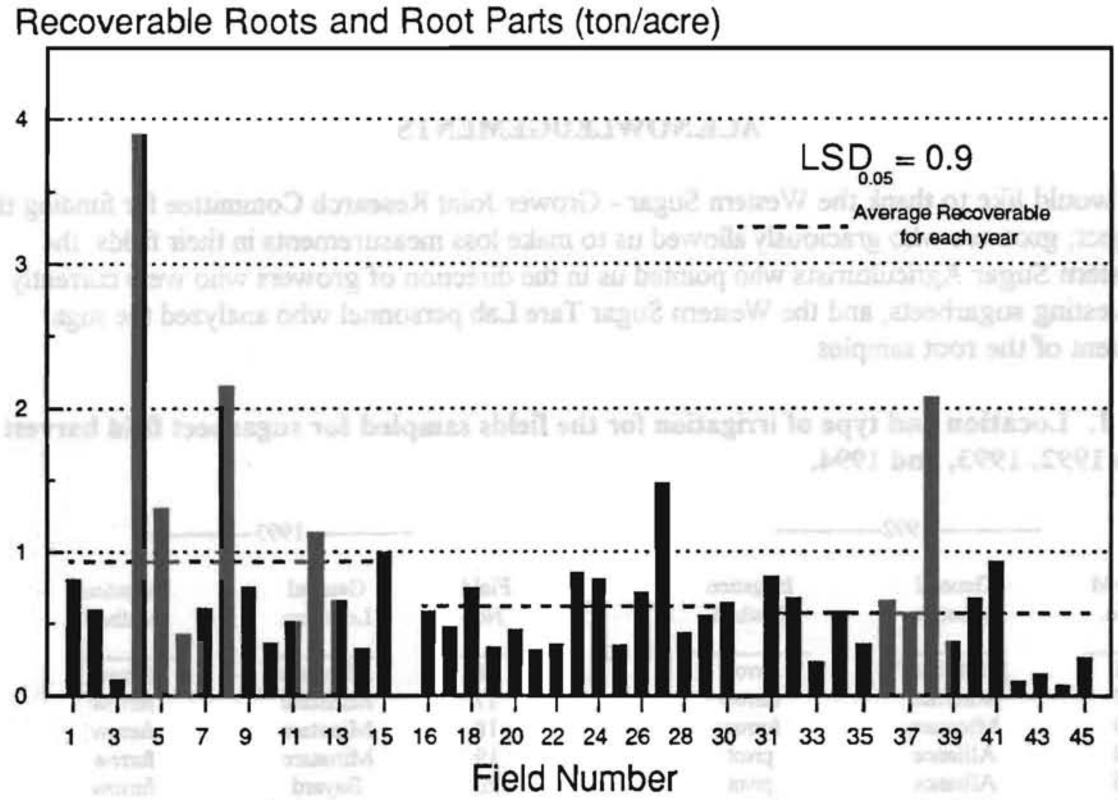

Figure 1. Field havest loss that would be accepted by the processing factory. These recoverable roots and root parts include whole roots greater than 2 1/2 in. at largest diameter, sliced roots, tails greater than 1 in. at the largest diameter and miscellaneous parts.

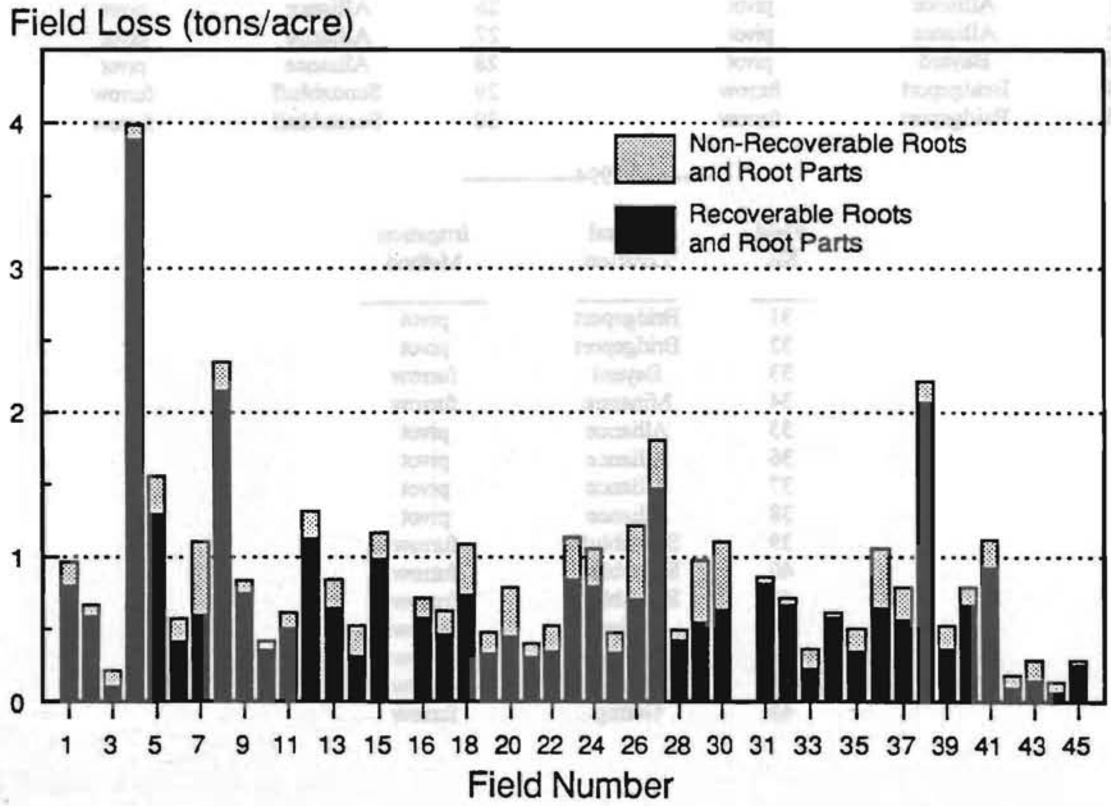

Figure 2. Total field harvest loss. Non-recoverable roots and roots parts include tails less than 1 in. but greater than 1/2 in at the largest diameter, and whole roots less than 2 1/2 in. at the largest diameter.

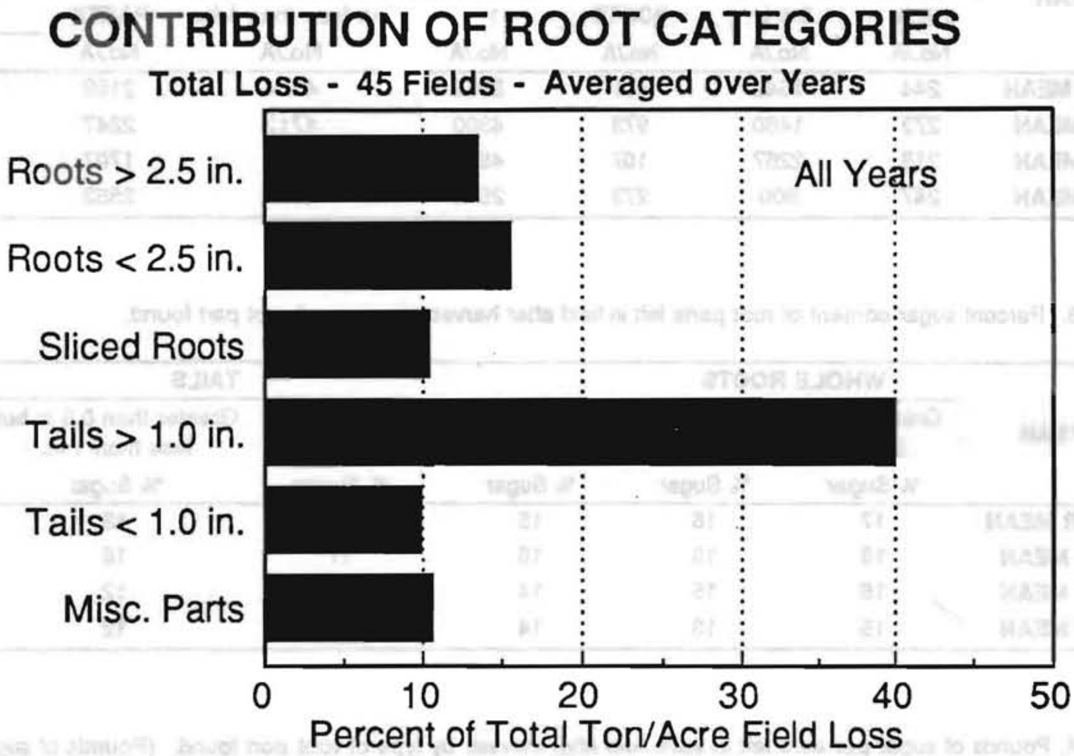

Figure 3. The contribution of each category of roots or root parts to the total field loss, averaged over all 45 fields sampled during the three year study.

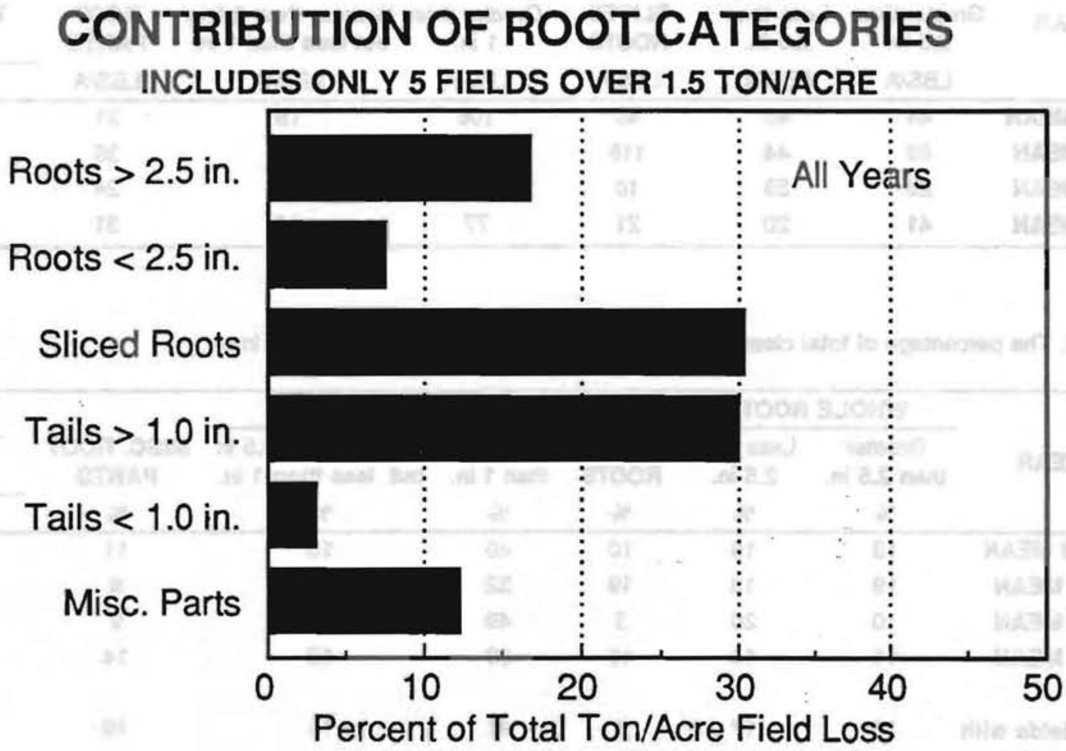

Figure 4. The contribution of each category of roots or root parts to the total field loss, averaged over only the five fields which had in excess of 1.5 ton/A loss during the three year study.

Table 2. Number of root parts left in each growers field after harvest, by type of root part found per acre.

YEAR	WHOLE ROOTS Greater than 2.5 in.	WHOLE ROOTS Less than 2.5 in.	SLICED ROOTS	TAILS Greater than 1 in.	TAILS Greater than 0.5 in but less than 1 in.	MISC. ROOT PARTS	TOTAL ROOT LOSS
	No./A	No./A	No./A	No./A	No./A	No./A	No./A
3 YR MEAN	244	1542	451	3851	4564	2169	12822
'92 MEAN	273	1460	973	4300	4713	2247	13967
'93 MEAN	213	2267	107	4613	5120	1707	14027
'94 MEAN	247	900	273	2640	3860	2553	10473

Table 3. Percent sugar content of root parts left in field after harvest, by type of root part found.

YEAR	WHOLE ROOTS Greater than 2.5 in.	WHOLE ROOTS Less than 2.5 in.	SLICED ROOTS	TAILS Greater than 1 in.	TAILS Greater than 0.5 in but less than 1 in.	MISC. ROOT PARTS
	% Sugar	% Sugar	% Sugar	% Sugar	% Sugar	% Sugar
3 YR MEAN	17	16	15	16	13	15
92 MEAN	18	19	16	17	16	18
93 MEAN	16	15	14	15	12	15
94 MEAN	15	13	14	15	12	13

Table 4. Pounds of sugar per acre left in each field after harvest, by type of root part found. (Pounds of sugar per acre was calculated by multiplying the pounds of clean root parts per acre by the sugar content of hat root part in that field.)

YEAR	WHOLE ROOTS Greater than 2.5 in.	WHOLE ROOTS Less than 2.5 in.	SLICED ROOTS	TAILS Greater than 1 in.	TAILS Greater than 0.5 in but less than 1 in.	MISC. ROOT PARTS	TOTAL ROOT LOSS
	LBS/A	LBS/A	LBS/A	LBS/A	LBS/A	LBS/A	LBS/A
3 YR MEAN	44	40	49	106	18	31	288
'92 MEAN	68	44	116	113	19	38	395
'93 MEAN	25	56	10	127	20	24	262
'94 MEAN	41	20	21	77	16	31	206

Table 5. The percentage of total clean root loss (Tons/A) for each category of field loss.

YEAR	WHOLE ROOTS Greater than 2.5 in.	WHOLE ROOTS Less than 2.5 in.	SLICED ROOTS	TAILS Greater than 1 in.	TAILS Greater than 0.5 in but less than 1 in.	MISC. ROOT PARTS	TOTAL ROOT LOSS
	%	%	%	%	%	%	%
3 YR MEAN	13	16	10	40	10	11	100
'92 MEAN	19	13	19	32	8	9	100
'93 MEAN	10	20	3	49	10	9	100
'94 MEAN	11	14	10	39	12	14	100
Only fields with <1.5 Ton/A loss	13	17	8	41	11	10	100
Only fields with >1.5 Ton/A loss	17	8	30	30	3	12	100