Agronomy Guide
Purdue University Cooperative Extension Service

Corn AY-264-W

Estimating Yield and Dollar Returns From Corn Replanting

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- Replanting of damaged corn fields occurs somewhere in Indiana every year.
- A replanting decision should be based on evidence, not perception.
- Step-by-step procedures for replant decision-making are presented.

From the time a corn kernel is laid in the seed furrow and covered with soil until the ripened grain is ready for harvest, many stresses work against survival of the corn plant. Typical early season stresses include cold and wet soils, late spring frosts, hail, wind (sandblasting), insects, diseases, flooding, and unfavorable seedbeds.

Occasionally, one or more of these stresses cause enough field damage to warrant a decision about replanting. Such a decision, of course, should be based on strong evidence that the returns to replanting will outweigh the costs. The purpose of this publication is to help you gather and analyze that evidence.

This lengthy worksheet admittedly requires a lot of patience to complete. However, I am convinced that most potential replant situations are not economic and that the patience required by this worksheet will pay dividends in terms of avoided additional expenses.

Presented here is a step-by-step procedure for estimating the yield and dollar gain (or loss) from replanting. The procedure involves first collecting the necessary decision-making information, then calculating the damaged field's current yield potential, its replant yield potential, and finally the economic return (if any) to replanting.

Handwritten figures for an example situation accompany the explanation of each step, and a blank worksheet is provided at the end of this publication for you to enter your information and make your own calculations.

Information Needed to Make a Corn Replant Decision

The following information is needed to calculate the feasibility of replanting: (1) original target plant population, (2) after-damage plant population, (3) after-damage stand uniformity, (4) after-damage plant defoliation (leaf loss), (5) original planting date, (6) expected replanting date, (7) expected replanting

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costs, (8) expected "normal" yield, and (9) expected market price for corn. These data come from your production records, field observations and measurements, and/or your best judgments.

Step 1. Original target plant population. Target population or intended plant stand is different from seeding rate. Normally, you use a seeding rate greater than the target population since seed germination and plant survival will be less than 100%.

If you already know your target population goal, record that value in Step 1d. If not, enter values for the original seeding rate, seed germination percentage, and expected plant survival rate in #1a, #1b, and #1c, then calculate target population in #1d. Remember to convert percents to decimal numbers in #1b and #1c when multiplying (e.g., 0.90 rather than 90%).

1a. Original seeding rate (from your records): 30,000 seeds/acre

1b. Seed germination percentage (from seed tag): 95%

1c. Expected plant survival rate (use 95% if you're not sure): 95%

1d. Original target population (#1a x #1b x #1c): 27,075 plants/acre

Step 2. After-damage plant population. An accurate estimate of the surviving plant population is essential to determine the potential yield of a damaged field. The time to make this estimation is 4 to 7 days after the damage first occurs. This allows time for the whorl leaves of plants with undamaged growing points to expand and emerge (Nielsen & Christmas, 2002; Thomison, 1995). If after 4 days a damaged plant shows no new green leaf material, it is probably dead.

If the damage seems to be uniformly distributed throughout the field, estimates made at four representative sites should be adequate. However, if damage exists only in certain areas of the field, then make an estimate or two in each of those areas. (Remember that only portions of a field may have to be replanted.)

2a. Determine the length of row equal to 1/1000th acre for the row spacing of the field (from Table 1, based on a row width of 30 in.): 17 ft. 5 in.

2b. Count the number of live plants in three 1/1000th acre sample lengths of row at each of four sites within the damaged field. Calculate the average number of plants per site and multiply by 1000 to equal plants per acre. Then calculate the overall average population for the field.

Site 1:
15, 13, 14 plants= 14,000 average

Site 2:
15, 17, 13 plants= 15,000 average

Site 3:
12, 14, 13 plants= 13,000 average

Site 4:
16, 12, 14 plants= 14,000 average

Average after-damage population for field = 14,000 plants per acre

Step 3. After-damage stand uniformity. Yield loss due to stand reduction results not only from the outright loss of plants, but also from uneven distribution of the survivors. The more numerous and longer the between-plant gaps within rows, the greater the yield reduction (Johnson & Mulvaney, 1980).

In fields where 25% stand loss or greater has occurred, note the gaps between live plants in the rows you inspect, and record your observations.

3a. Prevalent gap size within rows [more] or [less] than 3 feet? More

Sometimes the problem forcing a replant decision is not a loss of population, but rather the unevenness of seedling emergence. Research from Illinois and Wisconsin points to potential yield losses due to uneven emergence. Carter et al. (1992) noted, "If 1/2 or more of the plants in the stand emerge 3 weeks late or later, then replanting may increase yields by up to 10%." This magnitude of delayed emergence is often exemplified by leaf stage differences between early and late-emerged plants of two leaves or greater.

3b. Are more than half of the plants two leaf stages behind the others? NO

Step 4. After-damage plant defoliation. Hail, frost, wind, and fertilizer burn can severely injure young corn. The effect of such injury on corn yield depends on the amount of stand loss (Step 2) and defoliation (loss of leaves) of surviving plants.

Defoliation reduces the size of the plant's photosynthetic factory, which, in turn, reduces potential yield. The extent of the yield loss depends not only on the amount of defoliation (percent leaf area lost or destroyed), but also the growth stage when it occurred (Table 3). Fortunately, young corn (knee-high or shorter) is very tolerant to defoliation in terms of eventual yield loss.

To estimate percent leaf area lost or destroyed, consider both the leaf area removed and the area still attached but no longer green. Live green tissue remaining on the plant, even though mutilated, should not be considered as leaf area destroyed.

Corn growth stage determination for the purposes of estimating yield loss to defoliation is different than the traditional leaf-collar staging method (Nielsen, 2001). To determine corn growth stage, count the number of expanded leaves, beginning with the lowermost leaf (shorter than the rest and with a rounded tip). If the lowermost leaf or others have been lost or damaged, leaf number can still be determined by splitting open the corn stalk and locating the leaf sheath that attaches to the node above the first noticeably elongated internode. This is the fifth leaf of the plant. Continue counting leaves upward to the "indicator leaf," which is the uppermost leaf that is 40-50% exposed from the whorl and whose tip points below an imaginary horizontal line (Vorst, 1993).

4a. Average plant leaf area lost or destroyed: 10%

4b. Growth stage of corn: 7 expanded leaves

Step 5. Original planting date. This is the date your records show the field was originally planted.

5. Original planting date: April 25

Step 6. Expected replanting date. This is the earliest date that, in your judgment, replanting could occur. Consider factors that might affect it, such as availability of labor and machinery, securing of production inputs, and preparation of the field for planting.

6. Date that replanting could begin: May 26

Step 7. Expected replanting costs. Even if the estimated yield from replanting is greater than that from the damaged field, the cost of replanting may still be greater than the income from the additional replant bushels. So it's important that you estimate as accurately as possible the following costs associated with replanting:

7a. Seed cost: $ 11.25 /acre.
This may vary from zero to full cost, depending on the seed corn company's replant policy. This example assumes 1/3-price seed ($30 vs. $90 per 80,000-kernel unit) replanted at a rate of 30,000 seeds/acre (see Step14a). Remember to factor in any additional seed cost premium if you elect to replant with a Bt hybrid (see Step 7d).

7b. Fuel cost: $ 3.40 /acre.
Include fuel cost for any additional field work performed before and/or after replanting, as well as for the replant operation itself. This example assumes fuel for shallow tillage prior to replanting, replanting itself, and one row cultivation.

7c. Herbicide cost: $ 0 /acre.
A preplant or preemergence herbicide may be needed if deep tillage is performed prior to replanting. Try to avoid such tillage, depending instead on postemergence herbicides or cultivation for weed control. Also consider other herbicide issues pertaining to replanting corn, including the use of herbicide tolerant hybrids and plant back time intervals for next year's soybean crop (Hager & Sprague, 2002). This example assumes that the original herbicide application plus row cultivation will give adequate control, thus no additional herbicide cost.

7d. Insecticide cost: $ 15.00 /acre.
Reapplication of a soil insecticide is usually not necessary if you replant directly into the original rows. Furthermore, the amount of any given soil insecticide that can be applied per season is usually restricted. Check your specific insecticide label for detailed information on this.

Since later-planted corn is usually more attractive to insects like European corn borers (ECB) or corn rootworm beetles, you may want to factor in the possible expense of a post-emergence insecticide application. This example assumes a postemergence aerial application of a granular material for second generation ECB control.

Obviously, an alternative to the potential insecticide cost for ECB control would be to replant with a Bt hybrid resistant to ECB infestation, especially if the seed cost premium would be less than the potential insecticide cost. This is an attractive option if the potential mixing of Bt and non-Bt grain at harvest or in storage is not an issue relative to your grain marketing strategy.

7e. Other costs: $ 8.79 /acre.
Other replant costs are (1) interest on loans for replant production inputs, (2) increased grain-drying costs due to the higher harvest-time moisture levels of replanted corn, and (3) labor. This example assumes that the original damaged crop (if not replanted) would be harvested at 20% grain moisture and cost $11.85 per acre to dry the grain to 15% grain moisture (118.5 bu/acre [Step 8 x Step 10] x 5 pts. moisture removal x $0.02 drying cost per point). This example also assumes that the replanted crop would be harvested at 23% grain moisture content and cost $20.64 per acre to dry the grain (129 bu/acre [Step 8 x Step 15] x 8 pts. moisture removal x $0.02 drying cost per point). The additional grain-drying costs associated with the replanted corn would thus equal $8.79 per acre ($20.64 minus $11.85).

7f. Total costs: $ 38.44 /acre.
Sum all the costs entered in steps #7a through #7e. This sum represents the total estimated costs for replanting the field.

Step 8. Expected "normal" yield. This is what your records or experience indicate that the field could yield under normal conditions had it not been damaged.

8. Normal yield: 150 bu./acre

Step 9. Expected market price for corn. This is the price you expect to receive when you market this grain.

9. Market price: $ 2.00 /bu.

Yield Potential If Damaged Field is Not Replanted

Estimating after-damage yield potential is difficult because many factors, individually, or in combination, affect final grain yield. The main factors considered here are plant population, stand distribution, and defoliation.

Step 10. Estimated yield of after-damage plant population. This is determined from Table 2 and is expressed as percent of optimum yield. Read down the table's far left column to the date closest to your original planting date (Step 5), then go right on that line to the column that most nearly represents your field's after-damage plant population (Step 2b).

10. For original planting date of **April 25** and a surviving plant population of **14,000** plants/acre:
79% of optimum yield

Step 11. Additional yield loss due to uneven plant stands. Referring to your answer in Step 3a, if the prevalent gap size was more than 3 feet, enter 5% here; if less than 3 feet, enter 2%; if no gaps exist, enter 0%.

11a. Additional yield loss due to gaps:
5% yield loss

Refer to your answer in Step 3b. If more than half of the plants are two leaf stages or greater behind other plants in the field, enter 10% here; otherwise enter 0%.

11b. Additional yield loss due to uneven emergence: 0% yield loss

Step 12. Additional yield loss due to defoliation. This is determined from Table 3 (enter 0% yield loss if no defoliation has occurred). Read down the table's far left column to the corn leaf stage at the time of the damage (Step 4b), then go right on that line to the column representing percent of leaf area lost or destroyed in your damaged field (Step 4a).

12. Estimated yield loss for **10%** defoliation at **7-leaf stage**:
0% yield loss

Step 13. Yield potential of damaged field. Beginning with the estimated after-damage yield from Step 10, subtract any estimated additional yield loss due to uneven stands (Step 11) or defoliation (Step 12). Remember that these values are expressed in terms of percent of optimum yield.

13. After-damage yield (79%) minus loss to uneven stands (5%) minus loss to uneven emergence (0%) minus loss to defoliation (0%)
= 74% of optimum yield

Yield Potential If Damaged Field is Replanted

Step 14. Replant target population. Determine the replant target population the same way you did the original target population in Step 1.

14a. Planned seeding rate: 30,000 seeds/acre

14b. Seed germination percentage (from seed tag): 95%

14c. Expected plant survival rate (use 95% if you're not sure): 95%

14d. Replant target population (#14a x #14b x #14c): 27,075 plants/acre

Step 15. Expected yield from replanting. Read down the far left column of Table 2 to the date closest to your expected replanting date (Step 6), then go right on that line to the column that most nearly represents your replant target population (Step 14d) to determine percent of optimum yield.

15. For a replanting date of **May 26** and a target plant population of **27,075** plants/acre: 86% of optimum yield

Feasibility of Replanting

Step 16. Yield gain or loss from replanting. This is the difference between expected yield of the replanted stand (Step 15) and that of the damaged original stand (Step 13), expressed as a percent of optimum yield. If your answer shows a yield loss (a minus percentage), replanting is definitely not feasible. If, on the other hand, there is a yield gain, go on to Steps 17 and 18 to determine if that gain is an economical one.

16. Expected yield from replant (86%) minus expected yield of damaged original stand (74%) =
12% of optimum yield

Step 17. Gross income from a replant yield gain. First multiply the percent of yield gain (Step 16) by the field's expected "normal" yield (Step 8) to determine the amount of yield gain in

bushels per acre. Then multiply that figure by the expected corn market price (Step 9) to determine the dollar value of the replant yield gain.

17a. Yield gain from replanting (12%) x expected "normal" yield (150 bu./acre) = 18 bu./acre

17b. (#17a) 18 bu./acre x expected corn market price ($2.00/bu.) = $36/acre

Step 18. Dollar gain or loss from replanting. This is the difference between the potential gross income from the replant yield gain (Step 17b) and the expected cost of replanting (Step 7f). A monetary gain indicates that replanting may be a viable option for this damaged field. However, you still should weigh these dollar returns against both the alternative uses of your time and money, and the added risks associated with delayed planting before making a final decision.

18. Gross income from replanting ($36/acre) minus estimated replanting costs ($38.44/acre) = -$2.44/acre

Note that in this example, even though a significant net bushel gain was estimated for replanting the damaged field (Step 16), the additional costs of replanting resulted in an estimated dollar LOSS from replanting of -$2.44 per acre!

This example demonstrates the importance of "pushing the pencil" to determine the yield **AND** dollar returns from replanting. An estimated yield gain from replanting is not automatically a profitable gain.

Other Replant Considerations

"Patching In" versus Full Replant. Farmers are often tempted to simply replant alongside the damaged rows of the original planting rather than take the time, energy, and resources to destroy any survivors from the original planting. Resist this temptation if the survivors are at the two-leaf collar stage or larger because the competition from even a very small proportion of surviving original plants can be great enough to negate the economic benefits of replanting. The use of a burndown translocative herbicide is one of the better choices to eliminate the survivors prior to replanting.

Hybrid Maturities. Switching to earlier hybrid maturities may be advisable when replanting damaged corn fields at the end of May or later, especially in northern areas of Indiana. For help in making such a hybrid maturity decision, see Purdue Extension publication AY-312-W, "Delayed Planting & Hybrid Maturity Decisions" (Nielsen & Thomison, 2002).

Recognize that growers who contract grain for sale to specific end users are often paid premiums for high quality grain. Earlier hybrid maturities may not be available that fulfill the grain quality requirements of the contract. The potential loss of the premium in these situations should be considered another potential cost of replanting (see Step 7e).

Seeding Rates. Target the same final plant population for replanting a damaged stand of corn as that used for the original planting. Remember, though, that seeding rates are determined by dividing your targeted final stand by the product of the estimated germination percent and

seedling survival percent (e.g., 28,000 final stand divided by [95% germination times 95% survival] equals a seeding rate of about 31,000). You may choose to lower the seeding rate for replanting because warmer seedbed temperatures will encourage higher germination and survival rates than that of the original planting of the crop.

Stresses on Late Planted Corn. Recognize that the success of replanted corn is not assured. Later planted corn will be more susceptible to typical late July and early August heat because it will more likely be flowering then as opposed to flowering earlier. Later planted corn will be more attractive to corn rootworm beetles during pollination, especially if other corn in the neighborhood has already flowered. Also, later planted corn will be more attractive to second-generation ECB moths and subsequent ECB larval damage. Later planted corn will be more susceptible to yield loss due to infestation by gray leaf spot disease from the perspective that the corn will be at a relatively younger stage when the fungus begins to sporulate than would earlier planted corn.

Cited References:

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This publication is available online at:

http://www.agry.purdue.edu/ext/pubs/AY-264-W.pdf

For more information about corn, visit the **Corn Growers Guidebook** (KingCorn.org) at: http://www.kingcorn.org

The reference tables and a blank worksheet for your use in calculating the yield and dollar returns to replanting for your specific field situation follow this page. If you have downloaded this publication from the Web, you can reprint just the blank worksheet pages for use in making replant determinations for other fields.

Reference Tables

Table 1. Length of row equal to 1/1000th acre for different row widths.

Row width	Length of row equal to 1/1000th acre
15 inches	34 ft, 10 in
20 inches	26 ft, 2 in
30 inches	17 ft, 5 in
36 inches	14 ft, 6 in
38 inches	13 ft, 9 in
40 inches	13 ft, 1 in

Table 2. Central Corn Belt grain yields for various planting dates and population rates, expressed as a percent of optimum yield (uniformly spaced within row).

Planting	Plant population (final) per acre													
date	10,000	12,000	14,000	16,000	18,000	20,000	22,000	24,000	26,000	28,000	30,000	32,000	34,000	36,000
	Percent of optimum yield													
10-Apr	62	68	73	78	82	85	88	91	92	93	94	94	93	91
15-Apr	65	71	76	81	85	88	91	94	95	96	97	96	96	94
20-Apr	67	73	78	83	87	90	93	96	97	98	99	98	98	96
25-Apr	68	74	79	84	88	92	94	97	98	99	100	100	99	97
30-Apr	68	74	79	84	88	92	95	97	99	100	100	100	99	97
5-May	67	73	79	83	87	91	94	96	98	99	99	99	98	97
10-May	65	71	77	82	86	89	92	94	96	97	97	97	96	95
15-May	63	69	74	79	83	87	89	92	93	94	95	95	94	92
20-May	59	65	71	75	80	83	86	88	90	91	91	91	90	89
25-May	55	61	66	71	75	79	81	84	85	86	87	87	86	84
30-May	49	55	61	65	70	73	76	78	80	81	81	81	80	79
4-Jun	43	49	54	59	63	67	70	72	74	75	75	75	74	73
9-Jun	36	42	47	52	56	60	62	65	66	67	68	68	67	65

Adapted from Nafziger. 1994. J. Prod. Ag 7:59-62. Yield response to planting date extrapolated beyond May 25 with concurrence of author.

Table 3. Estimated percent corn grain yield loss due to defoliation at selected growth stages.[1]

Leaf	% Leaf defoliation																		
stage[2]	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	% Yield loss																		
(Less than 7 leaf stage: No yield loss likely from defoliation.)																			
7 leaf	0	0	0	0	0	0	1	1	2	3	4	4	5	5	6	7	8	9	9
8 leaf	0	0	0	0	0	1	1	2	3	4	5	5	6	6	7	8	9	10	11
9 leaf	0	0	0	1	1	2	2	3	4	5	6	6	7	7	9	10	11	12	13
10 leaf	0	0	0	1	2	3	4	5	6	7	8	8	9	9	11	13	14	15	16

[1] Adapted with permission from the National Crop Insurance Service's "Corn Loss Instruction" Leaf Loss Chart, NCIS 6102 (Rev. 1994)

[2] As determined by counting full expanded leaves (i.e., those with 40-50% of leaf exposed from the whorl and whose tip points below the horizontal.)

Worksheet For Estimating Yield and Dollar Returns From Replanting Corn

This worksheet will assist you in making that important corn replant decision. It allows you to determine your damaged field's current yield potential, its replant yield potential, and the dollar returns (if any) from replanting.

The 18 worksheet steps are explained in detail in the accompanying publication. Review it carefully to be sure you understand exactly what information is needed and how to do the calculations.

Information Needed to Make a Replant Decision

Step 1. Original target plant population

1a. Original seeding rate (from your records): _____seeds/acre

1b. Seed germination percentage (from seed tag): _____%

1c. Expected plant survival rate (use 95% if you're not sure): _____%

1d. Original target population (#1a x #1b x #1c): _____plants/acre

Step 2. After-damage plant population

2a. Length of row equal to 1/1000th acre: _____ feet, inches
(from Table 1, based on the row width of the field)

2b. Count the number of live plants in three 1/1000th acre sample lengths of row at each of four sites within the damaged field. Calculate the average number of plants per site and multiply by 1000 to equal plants per acre. Then calculate the overall average population for the field.

Field site	Sample 1	Sample 2	Sample 3	Site average
1	_____	_____	_____	_____
2	_____	_____	_____	_____
3	_____	_____	_____	_____
4	_____	_____	_____	_____
			Field average population:	_____

Step 3. After-damage stand uniformity.

3a. In fields where 25% stand loss or greater has occurred, indicate whether the gap size within rows is [**MORE**] or [**LESS**] than 3 feet: _____

3b. In fields where delayed emergence has occurred, indicate whether more than half of the plants are two leaf stages behind the others: _____ [**YES**] or [**NO**]

Step 4. After-damage plant defoliation

4a. Average plant leaf area lost or destroyed: _____ percent

4b. Growth stage of corn: _____ number of fully expanded leaves
(see Step 4 explanatory text for a description on how to stage corn for defoliation estimates.)

Step 5. Original planting date.

5. Month and day that field was planted (from your records): _____

Step 6. Expected replanting date.

6. Month and day that replanting could begin: _____

Step 7. Expected replanting costs

7a. Seed cost:	$ _____/acre
7b. Fuel cost:	$ _____/acre
7c. Herbicide cost:	$ _____/acre
7d. Insecticide cost:	$ _____/acre

7e. Other replant costs (e.g., interest, dryer fuel): $ _____/acre

7f. Total replant costs (sum of #7a through #7e): $ _____/acre

Step 8. Expected "normal" yield

8. The field's yield potential under normal conditions: _____ bu/acre

Step 9. Expected market price for corn

9. Price expected when the grain from this field is marketed: $_____ /bu.

Yield Potential If Damaged Field is Not Replanted

Step 10. Estimated yield of the after-damage plant population

10. Estimated yield of surviving stand: _____% of optimum yield
(From Table 2, based on the average after-damage plant population for the damaged field (Step 2b) and the original planting date (Step 5)

Step 11. Additional yield loss due to uneven plant stands

11a. Additional yield loss due to gaps: _____% yield loss
(If common gap size (Step 3a) is more than 3 feet, enter 5%; if it is less than 3 feet, enter 2%)

11b. Additional yield loss due to uneven emergence: _____% yield loss
(If half or more of the plants are two leaf stages or greater behind in development compared to earlier emerged plants (Step 3b), enter 10%; otherwise enter 0%)

11c. Sum of additional yield loss due to uneven stands: _____% yield loss
(Step 11a + Step 11b)

Step 12. Additional yield loss due to defoliation

12. Additional yield loss due to defoliation: _____% yield loss
(From Table 3, based on percent of leaf area lost or destroyed (Step 4a) and the corn's growth stage when damaged (Step 4b)

Step 13. Yield potential of the damaged field (percent of optimum)

13. Yield potential (percent of optimum) of damaged field: _____%
(Step 10 minus Step 11c minus Step 12)

Yield Potential if Damaged Field is Replanted

Step 14. Replant target population

14a. Planned seeding rate: _____ seeds/acre (your choice)

Multiplied by

14b. Seed germination percentage: _____ % (from seed tag)

Multiplied by

14c. Expected plant survival rate: _____ % (use 95% if you're not sure)

Equals

14d. Replant target population: _____ plants/acre
(Step 14a x Step 14b x Step 14c)

Step 15. Expected yield from replanting

15. Expected yield of replanted crop: _____% of optimum yield
(From Table 2, based on the field's targeted replant population (Step 14d) and the expected replanting date (Step 6)

Feasibility of Replanting

Step 16. Yield gain or loss from replanting

16. Yield gain or loss from replanting: _____%
(Step 15 minus Step 13)

NOTE: If the result for Step 16 is a yield loss, replanting is not warranted and should not be done. If there is a net yield gain, then proceed to Steps 17 and 18.

Step 17. Gross income from a replant yield gain

17a. Estimated bushel yield gain from replanting: _____ bu/acre
(Step 8 multiplied by Step 16)

17b. Estimated gross income from replanting: $_____ per acre
(Step 17a multiplied by Step 9)

Step 18. Dollar gain or loss from replanting

18. Dollar gain or loss from replanting: $_____ per acre
(Step 17b minus Step 7f)

Bottom Line: If there is a monetary loss, replanting is not justified and should not be done. If there is a monetary gain, replanting may be a viable option for this field.

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