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MAKING CONSERVATION COMPLIANCE WORK WITH YEARLY FLUCTUATIONS IN RESIDUE

by

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Summary

Conservation plans and conservation compliance rules have not adequately addressed the problems caused by the normal yearly variations in residue produced by a conservation tillage system. This paper argues that plans should not specify residue levels that must be met each year. Rather, plans should require that a 5-year average of residue on each field be maintained above a specified minimum. The appendix illustrates some of the ideas in the paper by applying them to data from the author's farm.

The paper argues that once a farmer selects a conservation tillage system, he has limited ability to change tillage operations to offset fluctuations in initial residue. Hence, variations in residue from the previous crop will cause yearly variations in measured residue at seeding time (when compliance checks are performed). These variations mean that a farmer will sometimes not meet the requirements of his plan even though he is using a conservation tillage system that, on average, produces residue that substantially exceeds the requirements in the plan. The SCS has used variances to account for low residue years. However, using variances causes several difficulties. A better solution is to use a 5-year residue average.

One of the most important decisions that a farmer makes is determining what tillage system to use. In the dryland areas of Northeast Oregon, there are several choices, e.g., bottom-plowing, stubble-mulch, and (although no one currently uses it) no-till. Each system has its advantages and disadvantages. Bottom-plowing gives better control of weeds and many diseases, but produces more erosion and often causes a dry seed-bed in the

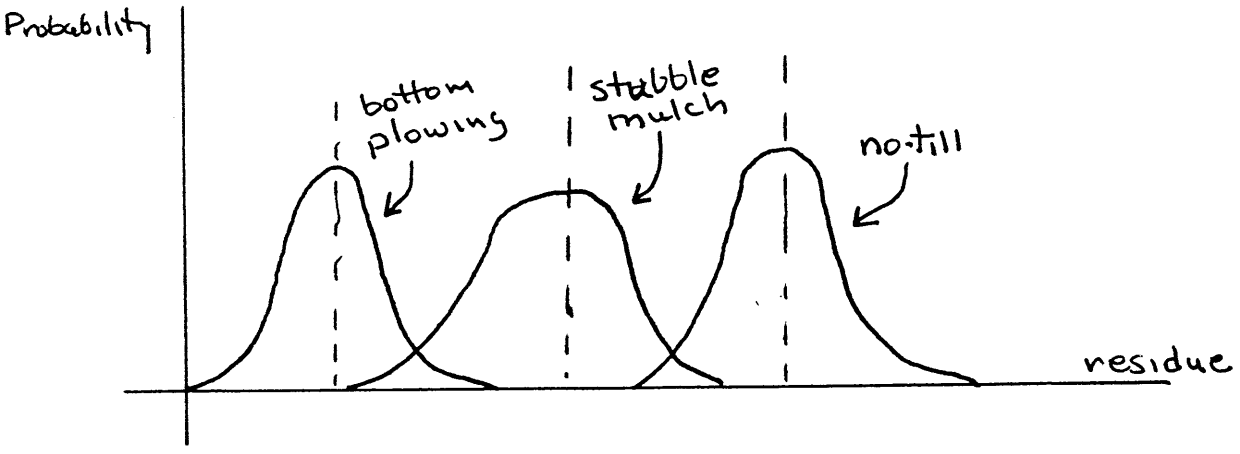
fall which delays seeding and reduces yield. Stubble-mulch farming results in more disease and weeds than bottom plowing, but usually produces good seed-bed moisture and earlier seeding. Stubble-mulch's better seed-bed moisture is a big reason why it was the predominant tillage system in Sherman County well before conservation compliance. No-till would greatly reduce erosion, but its main disadvantage in a summerfallow area with no reliable summer rains (like the Pacific Northwest) is that there would be no seed-bed moisture. Farmers must then delay seeding until the first big rains in the fall and these may not arrive until December. The yield of late seeded wheat is much reduced.

The goal of conservation compliance is to influence the choice of the tillage system by making soil conservation an important factor in the choice. A farmer must find a tillage system that meets the requirements of his conservation plan while still producing enough grain year after year to keep him in business. Once he selects a tillage system, he must accumulate the necessary specialized equipment (and knowledge) to make it work. Each tillage system requires different equipment. The high cost of this equipment means that a farmer can not easily switch tillage systems. Once he selects a tillage system, he is committed to a yearly set of field operations, -- e.g., spray roundup, disk, chisel plow, cultivate, fertilize, rodweed (two times), and seed. Weather during the year will influence the timing and number of these operations (e.g., summer rain will cause more rodweeding). The amount of residue from the previous

crop will also influence tillage. Abnormally high levels of residue will cause additional disking or chopping to reduce the amount of residue so that tillage equipment does not plug with straw. Disking might be eliminated if residue from the previous crop is very low (such as after a spring crop). However, since the goal of tillage is to make a good seed bed, most of the operations in the system must be done each year. Once a farmer selects a tillage system, he has limited control over the amount of residue that it produces. Most of the variation in residue from year to year will be caused by variations in the amount of residue from the previous crop.

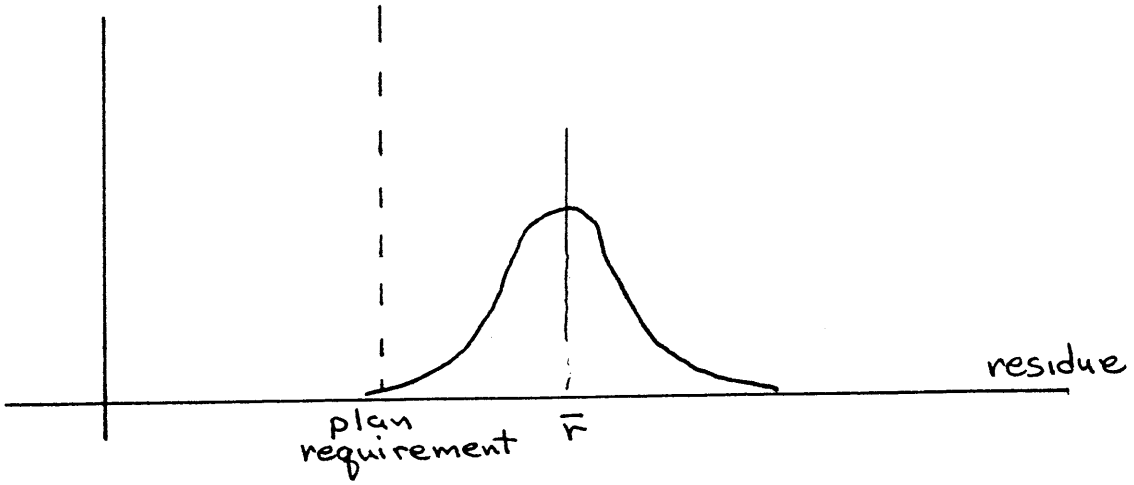
Each tillage system will reduce the residue from the previous crop in a predictable way and result in a different average residue at seeding time (when conservation compliance measurements are taken). Stubble-mulch will on average produce more residue than bottom-plowing and no-till will produce a higher level of residue than stubble-mulch. However, because initial residue will vary widely from year to year, the amount of residue produced by any tillage system will vary from year to year.

YEARLY VARIATION IN RESIDUE FOR TILLAGE SYSTEMS



What tillage system should a farmer select to comply with the conservation requirements of the Food Security Act? Our conservation plans currently require us to maintain the residue on each field above a specified minimum. This requirement must be met every year that the field is in crop. Several tillage systems could meet the requirement in some years. However, if compliance checks were based strictly on the requirements in the conservation plan and a farmer wanted to maintain his farm program benefits, he would have to select a tillage system that almost always will produce residue above the minimum. Since the residue from the previous crop varies widely from year to year, this will require a farmer to select a tillage system that on average will produce residue **much** higher than is required by his plan. In fact, for our area the only tillage system that will almost always meet the requirements of our plans is no-till.

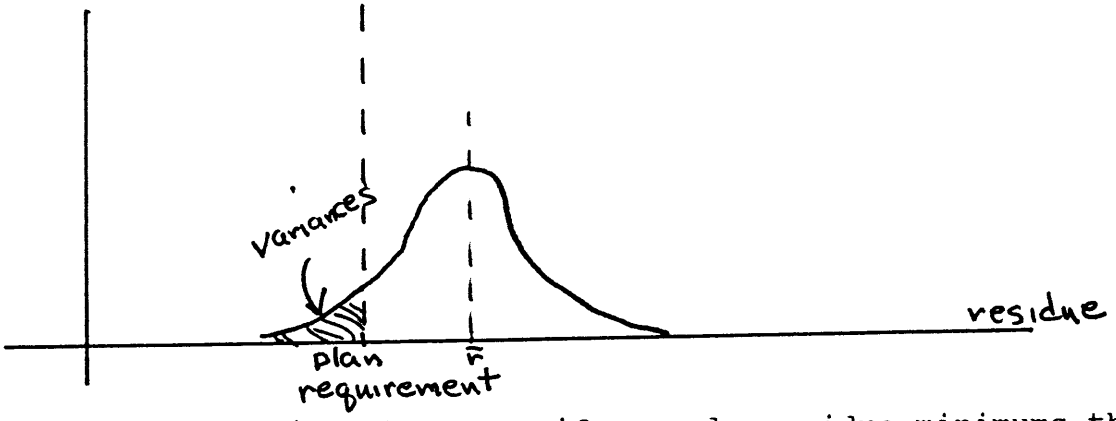
MEETING PLAN REQUIREMENTS REQUIRES A TILLAGE SYSTEM THAT PRODUCES MUCH MORE RESIDUE THAN THE REQUIREMENT



The SCS has implicitly recognized that requiring a farmer to use a tillage system that produces residue that always meets the

yearly residue minimums in his plan is unreasonable. No-till would force many farmers out of business. In years that the residue from the previous crop is low, the SCS has a procedure for granting a variance from the requirements of the plan. Hence, a farmer can use a tillage system that on average produces residue above his plan's requirements but sometimes produces residue below these requirements. The variance will allow the farmer to be in compliance when conditions are adverse.

VARIANCES CAN BE USED TO ELIMINATE LOW RESIDUE YEARS



When conservation plans specify yearly residue minimums that must be met, variances are necessary to make "reasonable" conservation tillage systems compatible with conservation compliance. However, using variances as an important part of conservation compliance has several difficulties. First, when should a variance be granted? Suppose that our plans call for 25% residue cover at seeding time and we use a conservation tillage system that on average produces residue cover of 40%. If yearly residue is normally distributed and has a standard deviation of 9%, we would have a 4% chance of being out of compliance in any year and a 33% chance of being out of

compliance at least once in 10 years. Is our conservation tillage system good enough? Should a variance be granted when low residue from the previous crop causes us to have residue at seeding time below our plan requirement? Suppose we used a tillage system that on average produces residue cover of 30%. We could then expect to meet our plan requirement 70% of the time. Would the 30% of the years that residue falls below the plan be covered by a variance? Which conservation tillage systems will be made workable with variances?

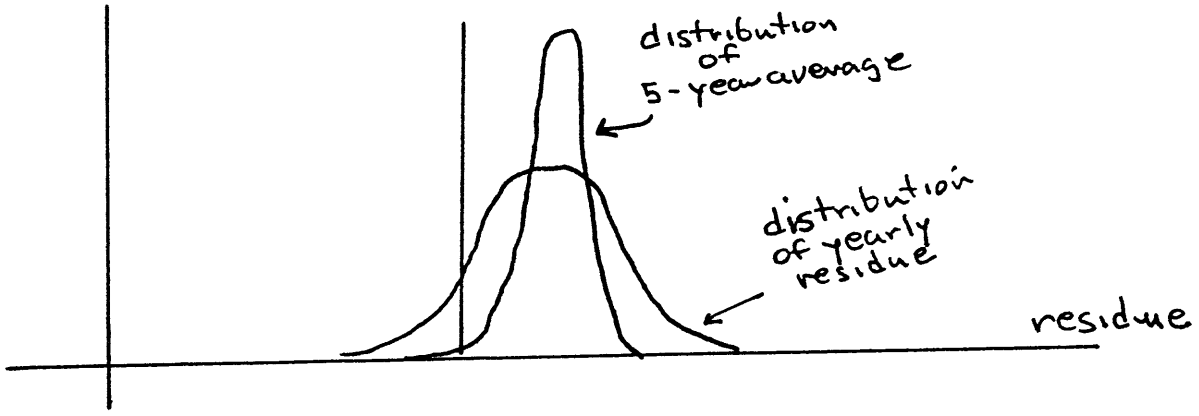
Second, variances have been granted for area-wide problems such as a drought or freeze out. Suppose that I am following my conservation tillage system in good faith but I have a problem that is not area wide. For example, suppose one of my fields has a severe infestation of Cephlasporium Stripe disease that drastically reduces the yield. Or suppose I plant a wheat variety that is less winter hardy than the wheat that is grown by most of the farmers in the area and it freezes out. Can I get an individual variance for the next crop? My argument for a variance may be just as good as the arguments for an area-wide variance.

Finally, with the diseases, drought, and freeze-outs that often affect farming, there is often a good argument that farmers should not be responsible for meeting the yearly residue minimums in their plans. We have already had several variances granted in the short time that conservation compliance has been in effect. The basic reason is the way our plans are currently written. It

is not reasonable to hold farmers responsible for complying with their plans in all years. The message is "comply with your plans in the normal years. When conditions are adverse, SCS will document the case and you will not be responsible." This message leads to uncertainty among farmers about the rules and bureaucratic paperwork in documenting the case for a variance. It seems much better to write plans that farmers can be held responsible for complying with in all years.

Can this be done? I believe it can if a simple change is made in the way plans are written. Instead of requiring a yearly minimum residue level, plans should require that farmers maintain a 5-year average of residue in each field above a specified minimum. A 5-year average of residue would vary much less than yearly residue.

YEARLY VARIATIONS OF A 5-YEAR AVERAGE COMPARED TO VARIATION IN YEARLY RESIDUE



Consider the example discussed above of a conservation tillage system that on average produced 40% residue with a yearly standard deviation of 9%. If the plan requirement was 25%, the system would produced residue below compliance levels about 4% of

the time. However, a five-year average of residue would almost never be below the plan requirement due to normal variations in residue. Even over a 10 year period, the chances of being out of compliance one year would be less than one in a thousand.

An additional advantage of basing compliance determinations on average residue over several years is that both farmers and the SCS would have advanced warning that a residue average was getting low and could do something about it. When compliance determinations are done there would be fewer surprises. A farmer would be judged based on how his conservation tillage system was performing over several years rather than being subject to the uncertainty that yearly fluctuations in residue cause. The ASCS has a long tradition of using a 5-year average of a farm's yield in determining program payments. They recognize that yearly fluctuations in yield should be averaged out.

The SCS is currently using a kind of averaging in our conservation plans by allowing us to clean till in one out of three years. Writing a plan in terms of a 5-year residue average should eliminate the need for this provision. Most important, by using this approach a farmer could be held responsible for meeting the requirements of his plan **every year** without the need for variances. Allowing the use of residue averages would be a step toward making conservation compliance work better.

Appendix

The purpose of this appendix is to show how the ideas discussed above might work using data from my farm.

The basic argument is that our plans do not adequately account for variations in residue when the same conservation tillage system is applied to a field over time. The key question is how much does residue vary from year to year? It would be very helpful to have residue measurements from the same field over at least 10 years. Unfortunately, I don't have that data for any of my fields and, as far as I can determine, there are no historical time-series data on residue for any field in the Pacific Northwest, especially where a conservation tillage system has been consistently applied. There are abundant data on yields. Hence, I will use yield variation in the previous crop to try to estimate variation in residue.

The procedure that I will use is to first estimate the relationship between residue and yield of the last crop. Then from the variation in yield, I will estimate the variation in residue from year to year. Next, I will calculate how often this variation is likely to cause me to be out of compliance with my plan. Finally, the effects of using a 5-year residue average can be determined.

I have only two residue measurements done by SCS personnel that use the strict interpretation of the the line-transect method.

field	year	residue	yield of previous crop
Robinson	1993	38%	48.7 bush/acre
Pinkerton*	1992	37%	41.2 bush/acre

* The Pinkerton field is not split out in the attached yield sheets. The Pinkerton field is a part of the Ridge field and I happened to have actual yield data for the part of the field where the residue measurement was make in 1992.

I have several other residue measurements that were done by SCS personnel before 1992 but they are all much higher and I believe that the current guidelines on measurement procedure were not followed.

Assume that residue is linearly related to yield from the last crop, so

(1) $R_t = bY_{t-1} + e_t$

where

R_t = percent residue cover in year t

b = contant

Y_{t-1} = wheat yield in year t-1

e_t = other factors affecting residue in year t.

The constant b could be estimated by dividing the average residue by the average yield for the two measurements that I have (since this is a key relationship, it would be very helpful to have much more data -- enough at least to do a simple regression),

$b = 37.5/45 = .833$.

From (1), if $E(e_t) = 0$

(2) $\bar{R} = b\,\bar{Y}$

where

$\bar{R}$ = mean of R_t

$\bar{Y}$ = mean of Y_t

E( ) = expectation operator .

Also, if Y_{t-1} and e_t are uncorrelated, i.e., $E(Y_{t-1}e_t)=0$,

(3) Variance (R) = $b^2 \cdot$ Variance (Y) + Variance (e) .

Since I have so little data on residue, I can not estimate Variance (e). Assume Variance (e) =0. Then from (3),

(4) stds (R) = b · stds (Y)

where

stds ( ) = standard deviation .

I have six fields on which I keep yield data (see attached sheets). I have approximately 17 years of yield data on each field that I can use to compute the mean yield and the sample standard deviation of the yield.

field	mean of yield	standard deviation of yield
HOME	54.023	11.423
RIDGE	53.491	8.356
EAST	46.889	11.574
ROBINSON	45.304	9.876
NORTH	48.93	8.833
HARMONY	41.235	9.189
Average of fields	48.3	9.875

Using (2) and (4), the mean and standard deviation of yield can be used to estimate the mean and standard deviation of residue.

(5) $\bar{R} = (.833) \cdot (48.3) = 40.2\%$

(6) $\text{Stds}(R) = (.833) \cdot (9.875) = 8.22\ \%$

My conservation plan calls for a minimum residue level of 25% cover. Using (5) and (6) and the assumption that yearly variations in residue are normally distributed, I can calculate my chance of being out of compliance in any given year.

(7) $\text{Prob}(R_t < 25\%) = \text{Prob}\left\{\left(\frac{R_t - \bar{R}}{\text{stds}(R)}\right) < \frac{(25 - 40.2)}{8.23}\right\} = .0324$

So, my chance of being out of compliance on any one compliance check is 3.24%.

However, my chance of being out of compliance one out of ten years is much higher.

Prob(out of compliance atleast once in 10 years) =

$\{1 - P(\text{passing in all 10 years})\} = 1 - .9676^{10} = 1 - .72$

$= .28$

Although my chances of being out of compliance in any compliance check are low, my chance of being out of compliance at least once in ten years is almost 30%. This is unacceptably high especially

since I am using a conservation tillage system that on average produces residue that is 161% of my plan requirement.

What if a 5-year average of residue is used rather than basing compliance checks on residue measurements for a single year?

Let

(8) $$A_t = (1/5) \cdot (R_t + R_{t-1} + R_{t-2} + R_{t-3} + R_{t-4})$$

$$= \text{a five year average of residue on a field}$$

then

$$\bar{A} = \bar{R} = 40.2\%$$

$$\text{stds}\ (A_t) = \frac{\text{stds}\ (R_t)}{\sqrt{5}} = \frac{8.23\%}{2.236} = 3.68\%$$

and

$$\text{Prob}(A_t < 25\%) = \text{Prob}\left(\frac{A_t - \bar{A}}{\text{stds}(A_t)} < \frac{25\% - 40.2\%}{3.68\%} \right)$$

$$= \text{almost zero}$$

Therefore, unless the yearly weather patterns show a lot of serial correlation, the use of a 5-year average would greatly reduce the risk that a farmer who is using an acceptable conservation tillage system would be out of compliance because of random fluctuations in residue.