Annual Report
Comprehensive Research on Rice
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Project title: Development of procedures for evaluating the effectiveness of rice straw incorporation methods in achieving residue incorporation and decomposition

Project Leader and Principal Investigator:
Henry Studer, Biological and Agricultural Engineering, UC Davis

Cooperators:
Steven C. Scardaci, Cooperative Extension, Colusa County
John F. Williams, Cooperative Extension, Sutter-Yuba Counties

Level of Funding: $19,000

Objectives:

1. to develop a sampling and test procedure by which the effectiveness of various rice straw incorporation methods can be determined and compared.

2. to develop physical methods to quantify the extent of straw decomposition achieved with various straw incorporation procedures.

Experimental Procedures:

Studies were conducted at three locations. The study at Maxwell CA was conducted in a set of plots designed by Steve Scardaci as a demonstration of several rice straw management practices. Soil samples were collected on April 7, 1993 from each of four plots, 50 samples from each plot. The plot treatments, all applied in the fall after harvest, were as follows: plot 1- flooded, plot 2- burned, plot 7- straw shredded with a Dandl flail shredder, and plot 8- straw chopped with a New Holland forage harvester. The soil samples were collected using a gardener's type bulb planter modified by careful sharpening of the serrated cutting edge and by welding a two inch extension onto the top of the planter body, using a piece of 2 7/8 inch diameter x1/16 inch wall steel tubing. The eight teeth ground into the end of the planter had an overall height of 5/16 inches. The modified bulb planter had an overall length of 6 inches. Two samplers were constructed, one of which was designed to be inserted into the soil by hand. A long vertical handle was attached to the other sampler, which the operator drove into the ground using his foot. The effective diameter of the cutting edge was 2.28 inches, giving an effective cross sectional area of 4.09 in^2. The samplers were driven into the ground approximately 5.5 inches. The sample of soil and residue was divided approximately equally into an UPPER and a BOTTOM fraction, and each fraction was placed into a sealed and labeled polyethylene bag. The samples were collected along ten transverse, approximately equally spaced, transects for each of the four plots, five samples per transect. The soil samples were numbered sequentially 1-50, back and forth across the plot, beginning with the southwest corner (sample 1) and ending at the northwest corner (sample 50). They were brought to Davis, where each was weighed, then oven dried and weighed again in order to determine the soil moisture content. The samples were then held in a blast freezer at -5 Celsius until analyzed. The residue was then separated from the soil mass by washing the samples through a 30 mesh screen (US. Standard sieve size no 30-0.024 in / 600 micron opening). The residue retained on the screen was oven dried and weighed, and the % residue on a dry basis was then calculated for each sample.

The straw and stubble residue in a rice field near Pleasant Grove, CA was incorporated after harvest using a stubble disk in fall 1992. Soil samples using the modified bulb planter described above were collected from this field on April 12, 1993. The 25 samples were evaluated in the same fashion to determine % soil moisture and % residue.

A second field at Pleasant Grove was deep plowed with a moldboard in fall 1992. Soil samples were collected from this field on March 29, 1993 using an 18 inch long Oakley soil probe with a probe diameter of 0.719 inches. Each of the 43 samples, collected on six transverse transects, was divided into three sub samples, namely: BOTTOM-the lowest 6 inches of the sample, MIDDLE-the next highest 6 inches of the sample, and UPPER- the remainder of the sample which varied in length from 0-5 inches. The residue in the subsamples was segregated by screening using the procedures described above.

Results:

The summary statistics for the samples collected from the four plots at Maxwell are shown in Table 1. The flooded plot was visibly wetter at the time of sampling than any of the other plots. The mean % moisture in the UPPER section of the soil for the flooded plot is shown to be significantly higher than any of the others. The burned plot had the lowest % moisture, and seemed, visibly, to be the driest of the four. In the BOTTOM section of the soil profile, the soil moisture was significantly lower for the burned plot, although the moisture differences between the plots was much smaller in the BOTTOM than in the UPPER sections.

The mean % residue in the UPPER and BOTTOM sections of the soil profile is shown in Table 2 for each of the four Maxwell plots. The burned plot had the least residue, both in the UPPER section and in the BOTTOM section. The % residue in the UPPER section for the burned plot was significantly less (at the 1% level) than that of the shredded and flooded plots. The flooded plot gave the highest % residue, approximately double that for the burned treatment, and about the same as for the shredded treatment. In each of the four plots, the majority of the residue was located in the UPPER section of the soil profile.

The summary statistics for the stubble disked field at Pleasant Grove are shown in Table 3. The average amount of residue in the UPPER section was double that in the BOTTOM section. The % residue was about the same order of magnitude as for the incorporated plots at Maxwell.

The soil samples from the deep plowed field at Pleasant Grove showed a much deeper distribution of the residue. More than half of the residue was collected from the MIDDLE section. While approximately the same residue mass was found in the UPPER and BOTTOM sections, the % residue in the UPPER section was much greater, since the length of the soil sample for the UPPER section was only about 40% of that for the BOTTOM section. The UPPER and MIDDLE sections contained, on a percentage basis, about the same amount of residue.

The calculated amount of residue remaining in the plots, lbs/acre, based on the average residue content of the samples, is shown in Table 4 for the Maxwell plots and in Tables 2 and 3 for the stubble disked and deep plowed plots, respectively. The computations indicate that the amount of residue remaining in the fields after 6 months, even after overwintering, is quite substantial. The computations yield values which appear to be in the "ball park" for the plots which were sampled with the modified bulb planter. For the deep plowed plot, sampled with the Oakley soil probe, the amount of residue remaining appears to be excessively high. This plot was deep plowed in fall 1991, and substantial amounts of 1991 residue, still undecomposed, was brought to the surface during the deep plowing operation in 1992. Thus, the amount of residue in the soil was probably higher at the beginning of the experiment, and this could account in part for the very high computed residue mass remaining in that field. However, the results may be more a function of the soil probe

design than anything else. Hairpinning of residue over the cutting edges was a problem for both the modified bulb planter probe and the Oakley probe. Hairpinning can lead to both overestimation of residue as well as to undersetimation. Overestimation can occur as a result of including in the sample residue which is not completely severed. Underestimation can occur when the residue is pushed ahead of and does not enter the probe. Both of these conditions are a function of the sharpness of the cutting edge, as well as the diameter of the probe. The effect of the cutting edge is reduced by the use of a large probe diameter, since the ratio of cutting edge length to probe area decreases with probe diameter. Thus the modified probe appears to have been more suitable than the Oakley probe for these measurements. However, the modified probe was not designed to sample to the depths required in the deep plowed plot.

Summary of results:

The study showed that residue content of the soil could be determined from soil samples taken with a modified bulb planter. The sampler was simple to construct and easy to operate. The results showed that the amount of residue remaining in the spring was dependent on the residue management practice used. The burned plots showed the least amount of residue, followed by the plot which was field chopped before stubble disking. The collection of the samples was relatively easy and proceeded quickly, compared to the amount of time required to evaluate the samples and separate the residue from the soil mass. A truly simple and inexpensive method of measuring residue content remains to be found.

Table 1. Summary statistics for the Maxwell plots. Mean pairs which do not share like numbers are significantly different at the 1% level.

% moisture	UPPER		BOTTOM	
plot no	mean	std. error	mean	std. error
2 (burned)	20.3 a	0.297	24.5 a	0.811
7 (shredded)	22.4 a,c	0.567	25.8 b	0.198
8 (chopped)	23.2 d,c	0.605	25.1 b	0.224
1 (flooded)	26.3 b	0.405	24.6 a,b	0.295

% residue	UPPER		BOTTOM	
plot no	mean	std. error	mean	std. error
2 (burned)	0.54 a	0.039	0.19	0.014
8 (chopped)	0.82 a,b	0.069	0.24	0.024
7 (shredded)	1.07 b	0.099	0.25	0.026
1 (flooded)	1.10 b	0.095	0.23	0.024

Table 2. Summary statistics for Pleasant Grove plot - stubble disked.
Values are averages based on 25 samples.

sample location	UPPER	BOTTOM
sample wet weight, g	331.7	275
sample dry weight, g	288.6	230.2
% moisture	13	16.3
residue weight, g	2.1	1.1
% residue weight, db	0.74	0.48
calculated residue weight, lbs/acre	7,100	3720

Table 3. Summary statistics for Pleasant Grove plot - deep plowed with moldboard. Values are averages based on 43 samples.

sample location	UPPER	MIDDLE	BOTTOM
sample length, inches	2.3	5.9	6.0
sample weight, g	22.1	64.0	78.2
residue weight, g	0.15	0.41	0.13
% residue, db	0.71	0.65	0.17
calculated residue, lbs/acre	5,214	13,999	4,401

Table 4. Calculated residue weights for the Maxwell plots. Values are averages based on 50 samples.

	lbs/acre		
sample location	UPPER	BOTTOM	TOTAL
plot no.			
2 (burned)	3685	1251	4937
8 (chopped)	5025	1731	6756
7 (shredded)	6837	1738	8575
1 (flooded)	7283	1515	8798