COMPARISON OF EROSION REDUCTION BETWEEN WOOD STRANDS AND AGRICULTURAL STRAW

R. B. Foltz, J. H. Dooley

ABSTRACT. *Agricultural straw is widely used as an erosion mitigation measure on disturbed soils. It has several drawbacks, however, which include increasing intrinsic value, increasing transportation costs, weed source, pesticide residues, and dust. An alternative is wood strands manufactured from small diameter timber or low–value veneer. A study to determine the efficacy of wood strands as an alternative to straw showed that straw and two types of wood strands were equally effective in reducing erosion by over 98%. The authors believe that there are opportunities to exceed the erosion control performance of agricultural straw through the disciplined design of a wood analog. Work is continuing to improve the wood strand properties for further field testing.*

Keywords. *Erosion, Erosion control, Mitigation, Mulch, Overland flow, Residue, Sediment control, Straw mulch.*

Agricultural straw is widely used for erosion control. Over 12,500 Mg of agricultural straw mulch was applied to forests and wildlands in FY2002 by the U.S. Forest Service, Bureau of Land Management, Bureau of Indian Affairs, and other agencies. Agricultural straw is typically presumed to be inexpensive, readily available, and easy to spread by hand or machine. Agricultural straw is used in forested areas of the U.S. for erosion control on burned areas, harvest landings, decommissioned road prisms, hillslope cuts and fills, and other areas of disturbed soil (Robichaud et al., 2000). Straw is among the preferred erosion control materials for grading and highway construction projects (Washington State Department of Transportation, 1999). When first applied, straw provides a high degree of ground cover to absorb the impact of raindrops and prevent soil particle mobilization. The long stems of straw create miniature check dams and surface roughness that reduce overland water velocity while capturing sediment already in motion. Long strands are believed to be important to hold the straw matrix together. Straw decomposes over a relatively short time, thus reducing its effectiveness in subsequent events and through seasons (Wishowski et al., 1998).

McGregor et al. (1988) reported that surface straw cover resulted in exponential decreases in soil loss from a silt loam soil using simulated rainfall at 64 mm/h and a 2.5% slope. For their study of raindrop splash erosion, a 71% ground cover resulted in a 23% reduction in soil loss. For a 95% cover, the reduction was 71%. Brown et al. (1989) tested the effectiveness of cornstalk residue to reduce rill erosion caused by both simulated rainfall and added inflow on a silt loam soil. For a rainfall rate of 56 mm/h and an added inflow of 9 L/min, the sediment reduction was 75% compared to a similar untreated bare soil. The effectiveness of straw mulch to reduce erosion from forest road fill and cut slopes was estimated by Burroughs and King (1989) to require a 96% ground cover for a reduction of 80%. These higher ground cover requirements were due to a combination of the steeper slopes and coarser soil found on forest roads.

Recent events and new knowledge have challenged the perceived advantages of agricultural straw, particularly when used in highway, wildland, and forest applications:

- Agricultural straw is recognized as having agronomic and ecological value when left on the field or plowed under, thus reducing the availability of straw as a crop residue (Kline, 2000).
- Agricultural straw is considered a raw material for energy production, fiber panels, and other potentially higher value uses, thus increasing its base cost (Gorzell, 2001; Fife and Miller, 1999; Bower and Stockman, 2001).
- Agricultural straw has been implicated as a weed source in forested watersheds (Robichaud et al., 2000; Associated General Contractors of Washington, 2003).
- Chemical residues from agricultural pesticides and herbicides have been carried to otherwise pristine watersheds in straw used for erosion control (Seattle Public Utilities, personal communication).
- Fine dust from shattered agricultural straw is a respiratory irritant and source of allergens to workers who are involved in spreading straw by hand or machine (Kullman et al., 2002).

Forest Concepts, LLC, explored the potential benefits of a wood–based straw analog. They concluded that a wood–based alternative to straw is likely to offer the following benefits to users and to forest–dependent communities:

- Because they are manufactured from low–value, small–diameter timber from silvicultural, forest health, or fuel–reduction thinnings, wood strands can utilize smaller–diameter poles and species not suitable for other

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The authors are **Randy Bruce Foltz, ASAE Member Engineer,** Research Engineer, USDA Forest Service, Rocky Mountain Research Station, Moscow, Idaho; and **James Henry Dooley, ASAE Fellow Engineer,** President, Forest Concepts, LLC, Federal Way, Washington. **Corresponding author:** Randy B. Foltz, USDA Forest Service, Rocky Mountain Research Station, 1221 S. Main Street, Moscow, ID 83843; phone: 208–883–2312; fax: 208 883–2318; e–mail: rfoltz@fs.fed.us.

products. Revenues from products made from wood can be used to offset the cost of forest management activities.

- Wood strands provide a more profitable use of small–diameter timber than some alternatives due to the low capital cost for manufacturing equipment and local markets for the product.
- Wood strands require lower transportation costs than agricultural straw for most areas of the Pacific Northwest, North Central states, New England states, and the Southeast due to the high density of forest lands and relative distance to sources of wheat, rice, and/or barley straw.
- Woods strands are inherently free of noxious weed seeds and are likely to be free of pesticide residues.
- Woods strands have high structural integrity and are not likely to produce dust or allergens during application.
- Production of wood strands provides a new source of income and jobs for timber–dependent communities and private non–industrial forest landowners.

A wood–based product with performance equal or superior to that of straw mulch could replace straw mulch in most applications. Substitution of wood–based mulch would support up to five community–scale production plants, providing jobs in rural and timber–dependent communities, as well as value–added uses for wood from thinning projects conducted under the National Fire Plan. Production of wood–strand erosion control products "completes the watershed cycle" by using materials from the watershed, converted with jobs in the community, to create functional environmental products to go back on the landscape.

Forest Concepts, LLC, estimates that more than 250,000 Mg of straw is used for erosion control purposes in the U.S., with an installed cost of over $75 million. Although much of the national erosion control straw market is served by commodity agricultural straw, Forest Concepts' estimates that approximately 25% requires certified weed–free straw. Certified straw sells in the Pacific Northwest for $75 to $200 per Mg, with an estimated weighted average of $120 per Mg. Waste veneer from mills is readily available at approximately $35 per Mg. Production costs are anticipated to be sufficiently modest that a wood–strand erosion control material could be profitably manufactured and sold at a price that is directly competitive with certified weed–free agricultural straw.

To investigate the erosion control aspect of wood fibers as an alternative to agricultural straw, Forest Concepts and the U.S. Forest Service performed a study to: (1) compare the erosion mitigation of wood strands to that of straw, (2) gain experience in handling characteristics of the wood strands, and (3) provide a starting point for the optimization of strand dimensions.

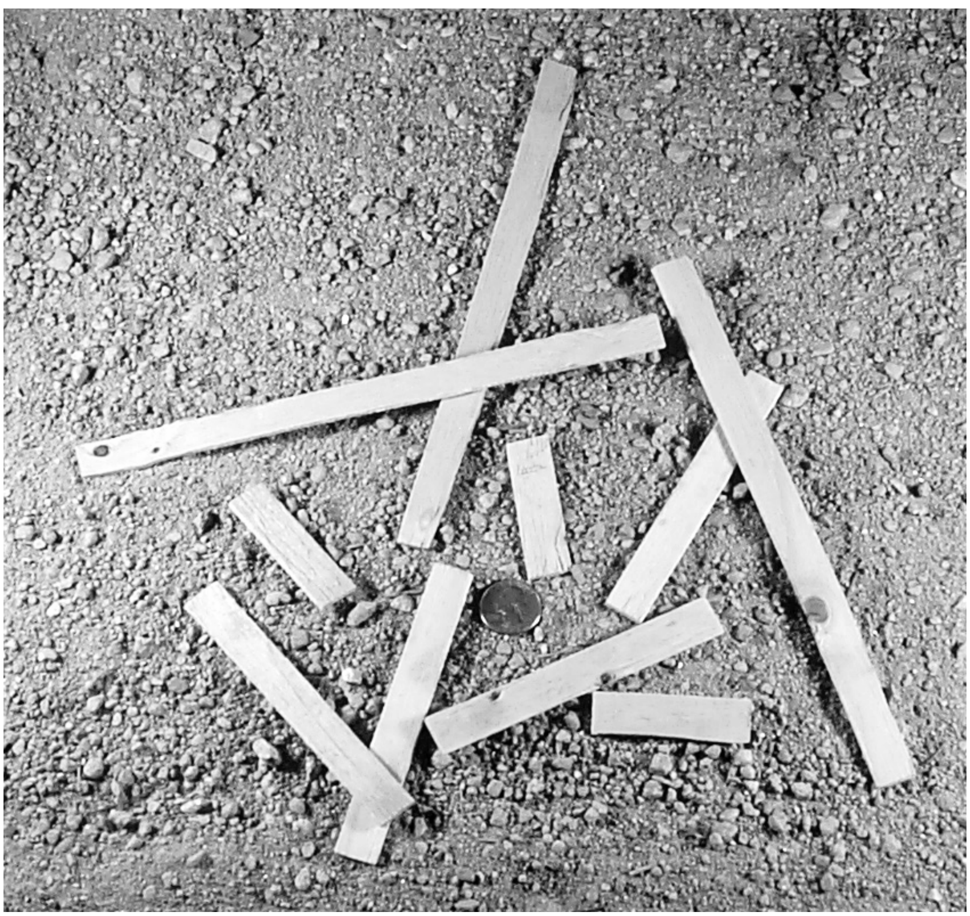

Figure 1. Wide strands on soil used in this study. Longest strands are 240 mm, intermediate strands are 120 mm, and shortest strands are 60 mm. All are 16 mm wide and 3 to 4 mm thick. Note the quarter for scale.

Methods

As a starting point for design, we created two widths of strands. The wide group (fig. 1) had a width of 16 mm, while the narrow group (fig. 2) was 4 mm wide, a four–fold difference in width. Within both groups, we had lengths of 60, 120, and 240 mm, again a four–fold range of short to long strands. All strands were cut from Douglas fir veneer "fish tails" (waste veneer) that were 3 to 4 mm in thickness.

To compare the erosion mitigation of wood strands to that of straw, we chose a replicated experimental design consisting of four soil treatments with three repetitions. The four soil treatments were bare, straw, wide wood strands, and narrow wood strands. A rain and added inflow sequence was produced by a constant rainfall rate of 50 mm/h, followed by rainfall plus added inflow sufficient to generate the estimated critical shear, and ended with rainfall plus added inflow sufficient to generate two times the estimated critical shear. We used a single soil, a single slope of 30%, a single cover of 70% for both the straw and the wood strands, and a single 4.96 m^2 plot. This set of treatment conditions was chosen to provide a first assessment of the potential efficacy for the wood strand mulch materials, and to provide a baseline for future experiments. We also wanted to be able to compare results to those of Burroughs and King (1989). For these reasons, we chose the steep slope and 70% cover. The rainfall and added inflow regime was adapted from McGregor et al. (1988).

The soil texture was a gravelly sand. After being screened to remove sizes larger than 6 mm, it had a mean diameter of 1.04 mm, a d_{16} of 0.33 mm, and a d_{84} of 3.50 mm. The soil was collected adjacent to the South Fork Salmon River near McCall, Idaho, and had no organic matter. The geologic parent material of the soil was decomposed granite. The backgrounds of figures 1 and 2 are this soil.

Steel frames were constructed to hold the soil during rainfall and inflow application. The frames were 1.24 m wide, 4.0 m long, and 0.20 m deep. The bottom of the steel frames consisted of 50 mm box members across the short dimension of the plot. There were 12 mm gaps between each box member. Expanded metal with openings of 12 mm and a geotextile fabric (Phillips 6–WS) were placed on top of the expanded metal. The gaps, the expanded metal, and the fabric allowed water to pass out the bottom of the frames, simulating infiltration into deeper soil horizons.

The soil was placed in the steel frame and allowed to settle to a bulk density of approximately 1500 kg/m^3. Following overnight settling, the bulk density and soil moisture were measured at three locations within the plot using a nuclear density device. The surface was screed in the shape of a trapezoid with a center width of 80 mm and side slopes of 5%. The frame was placed on a stand that provided a 30% slope for rainfall and inflow application (fig. 3).

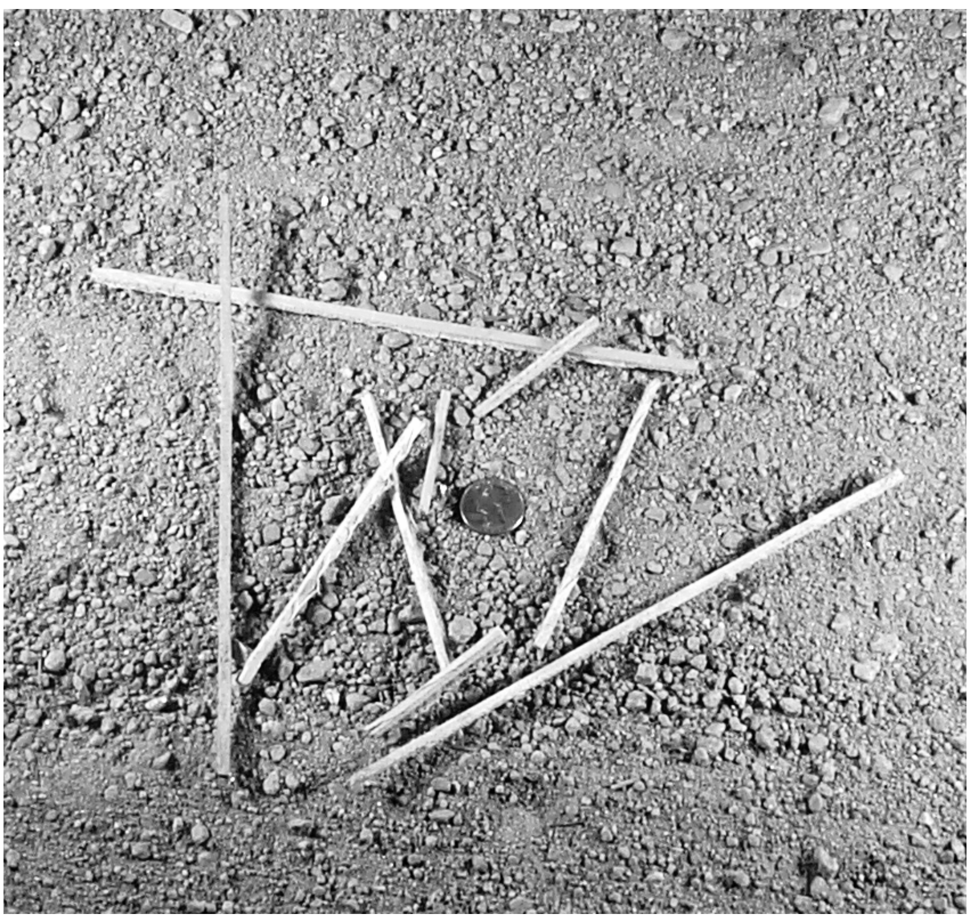

Figure 2. Narrow strands on soil used in this study. Longest strands are 240 mm long, intermediate strands are 120 mm, and shortest strands are 60 mm. All are 4 mm wide and 3 to 4 mm thick. Note the quarter for scale.

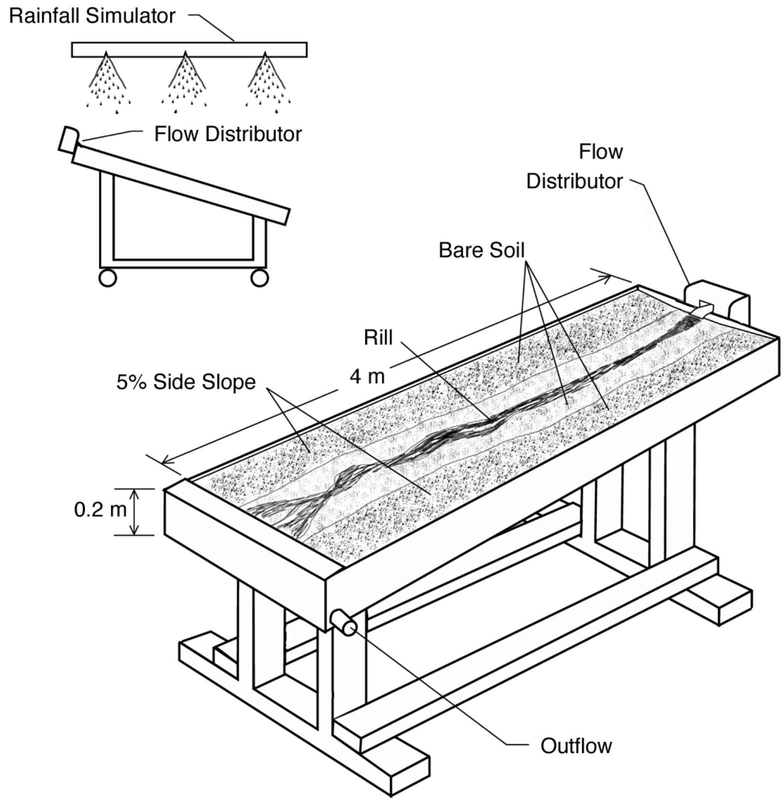

Figure 3. Sketch of plot layout.

The ground cover (straw, wide wood strands, or narrow wood strands) was spread by hand on the plot after it had been placed on the stand. After the plot appeared to have 70% cover, actual cover was measured by using a point count. A 910 × 910 mm Plexiglas sheet with points placed on 25 mm spacing was divided into nine blocks (3 vertical × 3 horizontal). Each of these blocks had 121 points. The Plexiglas sheet was placed on the plot in the upper third, the middle third, and the lower third, and counts in each of the nine blocks were taken.

Rainfall simulation was provided by a Purdue type simulator (Foster et al., 1982b) delivering a 50 mm/h storm for 15 min. The simulator at the Moscow Lab of the Rocky Mountain Research Station used VeeJet 80150 nozzles to deliver a raindrop size distribution approximating natural rainfall (Meyer and Harmon, 1979).

Based on cropland soil erodibility experiments (Elliot et al., 1989), the critical shear for the gravelly sand soil was 2 Pa. The added inflow corresponding to this critical shear was 0.97 L/min in the trapezoidal channel formed by the scree. Using this inflow rate, we ensured that soil particles below the mean diameter would be transported. The discharge of a 1.2 mm diameter orifice flowed into a settling box that was 300 mm long, 150 mm wide, and 230 mm deep to reduce the flow velocity and energy. A flow distributor, made of sheet metal and 80 mm wide, allowed the low–velocity overflow from the settling box to flow onto the soil (fig. 3). This added inflow rate was begun 15 min after the start of the rainfall and continued for 5 min.

The added inflow corresponding to two times the assumed critical shear was 4.1 L/min. It was supplied by adding the flow from a 1.8 mm diameter orifice to the 1.2 mm diameter orifice and increasing the pressure. The same settling box and flow distributor was used for this inflow rate. It began 20 min after the start of rainfall (i.e., at the end of the first added inflow period) and continued for 5 min. At the end of this added inflow, the rainfall and inflow were halted.

Runoff rates from the soil plots were determined by timed grab samples at the outlet of the plot. They were taken every minute during the rainfall and inflow periods and continued until flow from the plot ceased.

The sediment concentration of each of the grab samples was determined by oven drying overnight at 105°C. A portion of the transported sediment remained on the outlet of the plot and was collected at the end of runoff. The sediment production was determined from the sediment concentration samples and the deposited sediment.

Following the rainfall and inflow applications, the cover was again measured, and the cover, if any, was then removed. The dimensions of rills were taken, and general observations of the surface were made.

The desired initial conditions for each plot were the same bulk density, same soil moisture, and 70% cover for the three cover treatments. To test if this was achieved, three bulk density values for each plot were combined for a plot level average. A general linear model was used to test if there was a difference in bulk density between the four treatments. Tukey's multiple comparison procedure was selected for one–step pairwise multiple comparisons because it maintains Type I error protection. Identical statistical procedures were used to test the soil moisture differences. To test if the 70% cover was achieved, the 81 individual measurements of cover were combined into a single plot–level average. The same general linear model and Tukey's multiple comparison procedures were applied to the difference between actual and 70% cover.

To test if there were differences among the treatments for runoff and for sediment production, a general linear model and Tukey's multiple comparison procedure were again used. Runoff and sediment production were analyzed separately. A plot was again considered the basic sampling and analysis unit.

To test whether the rain plus inflow sequences caused a change in cover, a paired t–test for each cover treatment was used to investigate the differences between cover before and after the inflow sequence. The final cover was subtracted from the initial cover so that a negative value represented a reduction in cover.

Results and Discussion

Plot Characteristics

The characteristics of bulk density, soil moisture, and cover are shown in table 1. Taking repetitions as the basic sampling unit, the overall analysis of variance F–test for differences in bulk density was $F_{3,8}$ of 3.21 (p–value of 0.083) and for differences in soil moisture was $F_{3,8}$ of 3.05 (p–value of 0.092). Tukey's honestly significant difference (HSD) test indicated that there was no statistical difference between treatments at the 95% significance level for either bulk density or soil moisture.

Table 1 shows that there were differences in both pre– and post–treatment cover. A plot–level analysis of initial cover was an $F_{2,6}$ of 0.33 (p–value of 0.73). A Tukey HSD showed no differences among the treatments for the initial cover. Therefore, we conclude that there was no statistically significant difference in initial cover among the straw and wood strand treatments. A similar plot–level analysis of post–treatment cover was an $F_{2,6}$ of 1.65 (p–value of 0.27). Again, Tukey's HSD indicated no differences among treatments after the rain and inflow events. We conclude that there was no statistically significant difference in post–treatment cover among the straw and wood strand plots.

Table 1 also indicates that the average initial cover was below the target value of 70% for the straw and wood strand treatments. The p–values from a t–test of the difference between the measured initial cover and 70% for the straw, wide strands, and narrow strands were 0.700, 0.061, and 0.054, respectively. These results indicate that there was no statistically significant difference between the measured cover and the target value of 70% for any of the treatments with cover.

Runoff from Rainfall and Added Inflow Events

The average runoff rates for each of the four treatments are shown in figure 4. Runoff began in 3 min on the bare plot and was approaching a steady–state runoff of 18 mm/h at the end of the 15 min rain–only period. This rate was 36% of the rainfall rate. Conversely, the straw and narrow wood strands were just beginning to have runoff at the end of the rain–only period. The wide wood strands allowed no runoff during the same period.

Table 1. Soil bulk density, soil moisture, and cover.

Treatment	Average Bulk Density (kg/m^3)	Average Soil Moisture (%)	Average Cover Initial (%)	Average Cover Post (%)
Bare	1505	2.06	0	0
Straw	1521	1.91	68.1	63.0
Wide	1523	1.21	68.0	70.5
Narrow	1525	0.96	65.4	64.8

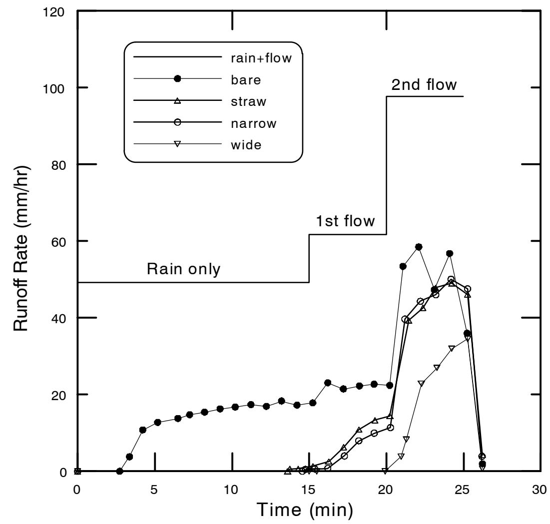

Figure 4. Average runoff hydrographs for each treatment.

Flows on the bare plot increased to 44% of the rainfall plus inflow in the first 2 min of the first inflow period, while on the straw and narrow strands the inflow increased linearly to 20%. These slower rising and lower runoff rates indicated that the straw and narrow strands were effective in increasing infiltration. There was no runoff from the plots with the wide strand cover during the first inflow period.

The second inflow period (rainfall plus 4.1 L/min) resulted in large increases in runoff for all treatments. The bare treatment had variations in flow rate from 45 to 60 mm/h due to sediment dams forming and breaking, causing concordant changes in the runoff rate. Sediment dams did not form on any of the cover treatments. Runoff rates for both the straw and narrow wood strands were similar at a peak of 50 mm/h, while the wide wood strands allowed a peak of 35 mm/h.

Our rain–only period was 15 min compared to a 60 min rain–only period by McGregor et al. (1988), who studied interrill runoff and erosion on a silt loam soil. Their plots took 10 min to begin runoff, while ours took only 3 min. At the end of their 60 min period, the runoff rate appeared to be beginning to reach a steady–state value. Our runoff rate showed little change after 10 min, indicating a steady–state condition. Therefore, we conclude that our rain–only period was sufficiently long.

Table 2 shows the runoff as a percent of rainfall plus added inflow for each treatment. Each of the cover treatments (straw, wide wood strands, and narrow wood strands) enhanced infiltration during all three of the rain and inflow events. The general linear model results comparing the rainfall plus second inflow for the four treatments were $F_{3,8}$ of 30.0 (p–value of 0.0001). Tukey's HSD test using a significance level of 95% grouped the final runoff from all three of the covers into a single class that was statistically different from the bare treatment. This result means that the three cover materials caused a statistically significant increase in infiltration over that of the bare plot. Further, there were no statistical differences in infiltration among the straw, wide strands, and narrow strands.

Table 2. Runoff from rainfall, rainfall plus first inflow, and rainfall plus second inflow.

Treatment	Average Runoff (% of rain plus inflow) Rainfall Only (%)	Rainfall Plus First Inflow (%)	Rainfall Plus Second Inflow (%)
Bare	41.1	47.8	61.3
Straw	1	4.0	17.4
Wide	0	0	6.8
Narrow	0	2.7	16.4

Sediment from Rainfall and Added Inflow Events

The average sediment rates for each treatment are shown in figure 5. The sediment rate of 2 to 3 kg/h during the rain–only period on the bare treatment represents sediment from both raindrop splash and rill erosion. The increase to 9 kg/h at the end of the rain–only period was due to rill expansion and headcut migration. The straw and narrow wood strands produced sediment rates that were 2 to 3 orders of magnitude less than the bare treatment during the last 2 min of the rain–only period. Since there was no runoff from the wide wood strands cover, there was no sediment.

During the first inflow period (rain plus 0.97 L/min), the sediment rate on the bare plot increased to 15 kg/h, an increase in sediment rate of 67% for an increase in inflow of 25%. All of the additional inflow was concentrated flow and caused an increase in rill length and depth. By the end of the first inflow period, the sediment rate on both the straw and narrow wood strand plots had increased to 0.3 kg/h, a four–fold increase. This sediment rate was an order of magnitude less than the bare treatment. Sediment rate from the wide wood strand treatment remained at zero because of no runoff.

The second inflow period triggered a sediment rate of 200 kg/h from the bare treatment, an order of magnitude increase over the previous inflow period. Observed deepening and a slight widening of the rill due to the increased runoff explained this increase in sediment rate. The straw and wide wood strands allowed sediment rates of 7 kg/h, while the narrow wood strands allowed a slightly higher final rate of 10 kg/h. As occurred during the first inflow period, the sediment rate from the cover treatments was an order of magnitude less than from the bare treatment.

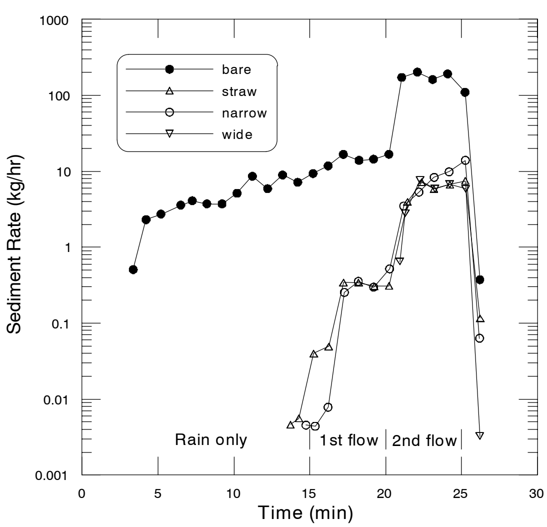

Figure 5. Average sediment rate for each treatment. Note the logarithmic scale of the sediment rate.

The total sediment for each treatment is shown in table 3. For the cover treatments where there was no runoff, there was also no sediment. As occurred for the runoff, the cover treatments reduced the sediment production. General linear model results comparing the final sediment production for all four treatments were an $F_{3,8}$ of 19.4 (p–value of 0.005). A Tukey HSD test again grouped the cover treatments into a group consisting of the bare and a group comprised of the straw, wide wood strands, and the narrow wood strands. This indicated that there was no statistically significant difference in sediment production between any of the cover types.

Erosion Mitigation

The primary purpose of placing cover on bare soil is to achieve sediment mitigation. The average sediment production values for each cover treatment are presented in table 4. Mitigation is defined as:

$$M = \frac{\left(\overline{bare} - \overline{treatment}\right)}{\overline{bare}} \times 100 \tag{1}$$

where

M = percent mitigation

$\overline{bare}$ = average bare treatment sediment production (kg)

$\overline{treatment}$ = average sediment production (kg) for that treatment.

The wide wood strands and narrow wood strands had sediment mitigation values comparable to that of straw. Since all three cover treatments had 98% to 100% sediment mitigation, it is not possible to state that one was better than the rest. It is possible, however, to state that all three greatly reduced sediment production.

Each of the three cover treatments achieved high mitigation values (i.e., in excess of 98% reduction in sediment production). These values compare well to those of Burroughs and King (1989), where values for sediment reduction due to straw were nearly 100% for a comparable combination of soil and slope. Burroughs and King (1989) also reported a reduction of 75% for a cover of wood chips, rock, and gravel.

Table 3. Sediment production from rainfall, rainfall plus first inflow, and rainfall plus second inflow.

Treatment	Average Sediment Rainfall Only (kg)	Rainfall Plus First Inflow (kg)	Rainfall Plus Second Inflow (kg)
Bare	2.0	4.2	29.4
Straw	0	0.03	0.53
Wide	0	0	0.39
Narrow	0	0.02	0.61

Table 4. Sediment mitigation for each treatment.

Treatment	Sediment Mitigation (%) Rain Only	Rain Plus First Inflow	Rain Plus Second Inflow
Straw	100	100	98
Wide	100	100	99
Narrow	100	100	98

Since the values in our study are similar, we have confidence that our testing method was appropriate. The agreement also provides confidence that the two new materials tested, wide wood strands and narrow wood strands, would perform well outside of a laboratory setting. A field test of similar strands performed by the Rocky Mountain Research Station is ongoing.

Changes in Cover Due to Flow Sequence

A plot–level cover analysis of initial and post rainfall and inflow sequence is shown in table 5. A paired t–test analysis showed that only the straw had a statistically significant change (p–value of 0.023), which was a decrease in cover following the rain and inflow sequence. Mechanisms for a change include movement of the cover downslope and burial of individual strands by sediment.

Following each run, we removed the cover to observe the soil condition and burial of the cover material. Our observation was that the straw was buried deeper than either of the wood strands. Individual strands of the straw were often buried 10 mm deep. Burial of the wide wood strands appeared the least deep and least often. The narrow wood strands had both intermediate burial depths and intermediate burial occurrences. Foster et al. (1982a) observed that buried residue and roots would be effective in reducing rill erosion. Laflen et al. (1985) developed an equation relating the effect of incorporated residue on total soil loss that included the amount of residue buried 10 to 100 mm below the soil surface. Their equation predicted reduced erosion from the buried residue. Our tests did not include events after burial, so we cannot comment on the effectiveness of the wood strands. Further research will include this topic.

Rill Formation

Rills formed in each of the bare plots, while no rills were formed on the cover treatment plots. Typically, rills on the bare plots were initiated at a distance of 3 m from the top of the plot in 5 min and expanded to a length of 2.5 to 4.0 m during the 15 min rainfall. In 2 min after initiation of the first inflow period, the rills had grown to a length of 4.0 m, equal to the entire length of the plot. At the end of the first inflow period, the rills were 10 to 15 mm deep and 80 to 100 mm wide. In 2 min after the start of the second inflow period, the rill deepened to about 100 mm near the added flow inlet and 50 to 60 mm deep at a distance of 2.5 m from the top. These rills were the source of much of the sediment produced during the added inflow periods on the bare plots.

In contrast, the treatment covers allowed no rills to form. Sediment slugs were observed to travel only a short distance, 100 to 150 mm, before being stopped by the material matrix. This was an important difference that reduced erosion greatly. Our impression was that the wide wood strands were most effective in keeping the slug travel distance to a minimum. We have no measurements of this, however.

Table 5. Plot level cover analysis of initial and post flow sequence.

Treatment	Cover Post–Initial (%)	t–statistic	p–value
Straw	–5.04	–6.53	0.023
Wide	+2.53	3.15	0.087
Narrow	–0.62	–2.05	0.177

Observations

The following sections discuss subjective observations. No measurements were made of these phenomena, but we believe them to be sufficiently important for discussion.

Handling Characteristics

Because we spread each of the three covers three times, we were able to make some subjective observations on the handling characteristics. All materials required care in spreading to keep them from forming isolated mats of high cover surrounded by bare soil. The straw was the most prone to this. We did not observe any tendency for the materials, whether straw or the wood strands, to orient in any particular direction.

The longer (240 mm) wood strands presented some difficulty during spreading, such as aligning when handled and not having a random orientation during placement on the plot. They also segregated in the shipping containers, resulting in clusters of longer strands on the plot. Due to these reasons, we suggest the longest wood strands be 2 to 2.5 times as long as the shortest strands, rather than the four times as long that we tested. The long wood strands also tended to bridge over the soil rather than lie in contact with the soil. Good contact with the soil appears to promote mini–dams for increased infiltration opportunities and sediment trap formation.

Opportunities for Further Research

From a technical and engineering perspective, there are substantial opportunities to exceed the erosion control performance of agricultural straw through disciplined design of a straw analog. For example, the functionalities and trade–offs associated with the cross–sectional dimensions of the strands include:

- Increasing strand height increases the volume of water ponded and sediment trapped upslope of the strand for a cross–slope strand. However, increasing height also dams water and concentrates flow, with potentially increased erosion effects when a strand is not cross–slope.
- Increased width increases soil contact and stability of a strand, thus resisting downslope movement of the strand. However, increased width beyond some point may interfere with seed germination and establishment of vegetation (Robichaud et al., 2000).
- Increased cross–sectional area increases decay life of a strand. Increased cross–sectional area also increases unit mass of a strand, improving its resistance to flotation and downslope movement. Decreased cross–sectional area speeds decay and contribution of organic matter to the soil surface, which may accelerate vegetation establishment and early growth.

While agricultural straw has an oval or nearly flat cross–sectional shape, the rectangular shape of the wood product may have improved its functionality. In particular, a rectangular shape might become anchored by accumulated sediment on its upslope face. If so, then the question becomes one of specifying the optimal width and thickness to achieve sediment accumulation while also maximizing strength of the strand.

Similar functionalities and trade–offs are associated with strand length, kinks, and surface characteristics. Further research should develop response surfaces for efficacy of multiple properties and mixtures of lengths. A mixture of strands with varying properties could create an optimal solution that provides both high initial surface cover to protect against rain drop erosion and long–term protection against downslope movement of sediments.

We were somewhat surprised at the high level of sediment mitigation for all three materials, and the lack of significant differences in the results. Further research should include lower materials application rates (cover) and finer texture soil to see if the materials continue to perform as equals.

Conclusions

This study, comparing the erosion control potential of wood fibers to agricultural straw, achieved the stated objectives. Two blends of wood strands were statistically equal to straw in reducing both runoff and sediment production. The experience gained in the handling characteristics of the woods strands suggested that the 240 mm strands were too long. Their tendency to segregate in the shipping containers and the difficulty in placing them uniformly indicated that this length was too long. The two wood strand widths of 4 and 16 mm with a length mix of 60, 120, and 240 mm provided a starting point for the optimization strand lengths, widths, and application rates.

Opportunities for further research into the utility of wood strands as an alternative to agricultural straw include the impact of buried strands, the optimum strand cross–sectional dimensions, the sediment reduction from lower material application rates, and the effect of strand curvature on erosion mitigation. Non–erosion related issues that need research are decay rates of the wood strands and the impact on seed germination and vegetation establishment. Finally, further work is needed to explore the economic viability of producing and using wood strands for erosion control.

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