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EVAULATION OF SHORT FIBER MEASUREMENT METHODS

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Abstract

Given the cotton industry's need for a meaningful short fiber measurement, the USDA, AMS, Cotton Program in Memphis, Tennessee and the USDA, ARS, Cotton Quality Research Station (CQRS) in Clemson, South Carolina have assembled a study to evaluate available short fiber measurements relative to each other and relative to textile processing performance. Twenty-nine U.S. grown Upland cotton bales have been selected to represent a wide range of length and short fiber contents. These bales have been tested in USDA, AMS cotton calibration value setting testing procedures to obtain HVI measurement levels referenced to established USDA benchmark reference cottons. Study participants from various cotton fiber testing labs within and outside the U.S. have been asked to test samples from the study bales on instruments including HVI, AFIS, Schaffner Isotester Li, Lintronics FiberLab and the Suter-Webb Duplex Cotton Fiber Sorter (array method). The 29 bales will be processed in a textile spinning plant to determine bale utility value. Initial results, from data being submitted by participants, are showing good correlations between methods. However, different test levels exist between instruments. Processing of the cottons is scheduled to begin in the spring of 2004. The intent of this report is to explain the study plan and to provide a preliminary look at some of the early data collected so far.

Objectives

The ultimate objective of this study is to determine the sensitivity of short fiber measurement methods relative to spinning performance. In addition, by utilizing multiple measurement methods on a common set of cottons, sensitivity and short fiber measurement characteristics between the methods can be compared. In cases where more than one instrument of the same type is evaluated, sensitivity and characteristics within an instrument type will also be evaluated. In this study, most of the measurement methods will take advantage of maximizing their sensitivity given the opportunity of performing high testing repetitions on each bale. Although this may lead to measurement sensitivities that are not realistic in lower repetition testing applications such as cotton classification, finding the potential of a measurement's sensitivity is a critical first step in developing a practical short fiber measurement.

The U.S. grown Upland cottons selected for this study represent a wide range of fiber lengths, short fiber contents and combinations of both properties. Figures 1, 2 and 3 show the distributions of properties based on AMS HVI study results. Given the wide range and varying combinations of length characteristics in the study bales, the potential for a meaningful short fiber measurement assessment is good.

Methodology

A total of eight participants are involved in providing testing on cottons sampled from a set of 29 U.S. Upland cottons. The participants are Cirad in Montpellier, France; Cotton Incorporated in Raleigh, NC; Gdynia Cotton Association in Gdynia, Poland; International Textile Center in Lubbock, TX; Lintronics, LTD in Arad, Israel; USDA, ARS, CQRS in Clemson, SC; USDA, ARS, SRRC in New Orleans, LA; and USDA, AMS, Cotton Program in Memphis, TN. As of this writing, sample testing and textile processing remains in progress. Therefore, this report will provide some analysis on only the data collected so far. Full presentation of results will come after all testing is completed.

A total of 10 test sets were assembled for distribution among the participating laboratories. Each participating laboratory was given one set. Each test set was made up of a total of 290 samples (29 bales x 10 samples/bale). Individual sample weights were from 150 to 250g. Bale sampling was performed by pulling 10 samples from 10 regions across the bale "fanhead". Ten samples from each of the 29 bales were previously screened by 9 HVI systems to insure that the bales had a high degree of uniformity.

In addition to short fiber measurements, all other available measurements provided by each instrument (e.g. micronaire, neps, strength, etc.) were performed on the test samples. Each instrument used in the study was calibrated prior to sample testing according to each lab's normal operating procedures. Calibration cottons (based on AMS established values) were provided, but were not required for calibration.

A total of three test repetitions were requested on each test sample. Given that a test set contained 290 samples, the total number of requested tests per instrument was 870 (290 samples x 3 reps). Given that some test methods are slower than others; reduced repetitions were required in some cases. In addition, a few sample sets were assembled with only 20 of the 29 bales to further reduce the testing load for labs unable to meet the testing volume. For participants using AFIS instruments, a single test replication of 3,000 fibers was requested.

Results and Discussion

As previously stated, full data collection for this study has not been completed. Therefore, these results are preliminary. Data from all participant sources will be shared among the participants followed by a more complete analysis. Other participants will have the opportunity to perform their own analyses and to present their own results from the pool of data. For this report, the data analysis will focus on showing some of the relationships between currently submitted data versus the AMS HVI data. Only AMS data will be identified in these results. Data from other labs presented in this report will be referenced only by coded lab or instrument numbers to ensure lab anonymity.

Figures 4 and 5 show the short fiber study results from AMS testing. By utilizing HVI UHM length and HVI Uniformity Index measurements, an accurate prediction of short fiber content is possible. By utilizing such a prediction method (Knowlton, 2001), Figure 4 shows the predicted HVI short fiber content versus the HVI Short Fiber Index (SFI) measurement sorted by ascending HVI SFI. Figure 5 shows the HVI SFI versus the HVI Predicted Short Fiber Content sorted in ascending HVI length order. Figure 5 demonstrates how short fiber contents do not track (inversely) exactly with UHM length. However, given that the predicted short fiber and SFI track each other closely, the graph demonstrates how well that the Uniformity Index measurement when combined with UHM length provides a close prediction of SFI. The R^2 value of this correlation is 95.5%. All AMS HVI data is based on more testing than was dictated in the study procedure. This data is based on the AMS HVI calibration cotton value setting procedures that utilize strict testing procedures on 9 HVI systems. As a result, the differences between the SFI and predicted short fiber methods are small but significant. In more practical low repetition testing, such as classification, it is doubtful that the small differences found between the two methods would be detectable. Only through increased repetition testing or perhaps through module averaging could a difference between the methods be potentially significant in classification.

Figure 6 compares both AMS HVI methods to the HVI SFI measurements from the Lab #2 HVI. The level of Lab #2 was corrected to the AMS benchmark calibration cottons that were also tested in the study. The agreement between the AMS SFI and Lab #2 SFI was very high, supported by an R^2 value of 99.5%. Figure 7 compares AMS HVI methods to the HVI from Lab #3. As with Lab #2, data from Lab #3 was corrected to the AMS benchmark cottons. The R^2 value of this correlation is 98.3%. For Lab #4, HVI results (shown in Figure 8) had a R^2 of 97.0%.

Figures 9 and 10 show results from two AFIS instruments versus AMS HVI short fiber results. Figure 11 shows the short fiber results of one AFIS versus the other. R^2 values for AMS SFI versus AFIS #1 and AFIS #2, were 78.4% and 78.5%, respectively. The R^2 for AFIS #1 versus AFIS #2 was 93.0%. Unlike HVI results, the AFIS results shown are not corrected to the AMS benchmark calibration reference level. The AMS HVI predicted short fiber was also correlated to the AFIS short fiber measurements. The R^2 values of the predicted short fiber versus AFIS #1 and AFIS #2 were 73.5% and 72.0%, respectively. This indicates that the HVI SFI measurement does track the AFIS measurements better.

Figure 12 compares both AMS HVI methods to Suter-Webb Array results. The Suter-Webb Array results shown are more variable than the HVI results mainly because only three arrays were performed on each bale. Results do indicate a wider short fiber measurement range for the array method versus the HVI.

Conclusion

If the objectives of this study are met, the results should increase understanding of short fiber measurement behavior. The preliminary results of this study show that short fiber measurement results vary within and between methods. However, it is encouraging to see that strong correlations do exist. Ultimately, however, the true assessment of any fiber measurement is only achieved when the measurement is evaluated with respect to its utility value relative to spinning performance. Additional reporting is planned as all intended measurement and spinning performance data are collected. As the data is shared among the participants, it is hoped that the collaborative nature of this study will contribute greatly to the short fiber measurement development initiative.

References

Knowlton, James. 2001. HVI Short Fiber Measurements. Proceedings of the Beltwide Cotton Conferences. Pp. 1245-1247.

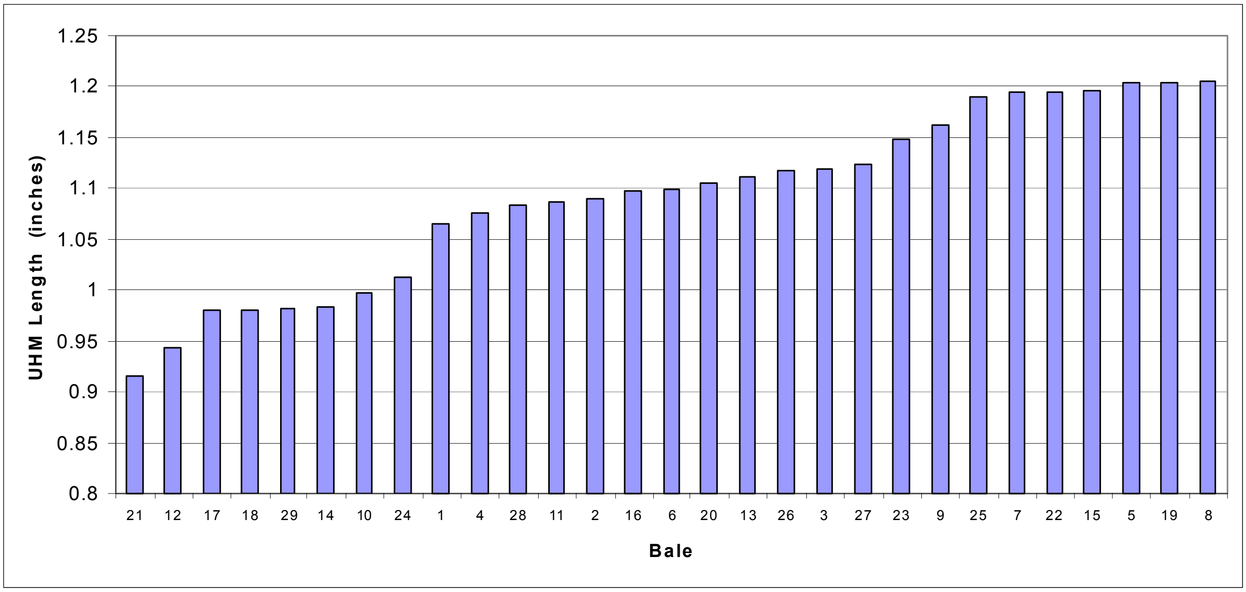

Figure 1. HVI length distribution of study bales sorted in ascending HVI UHM length order (AMS results).

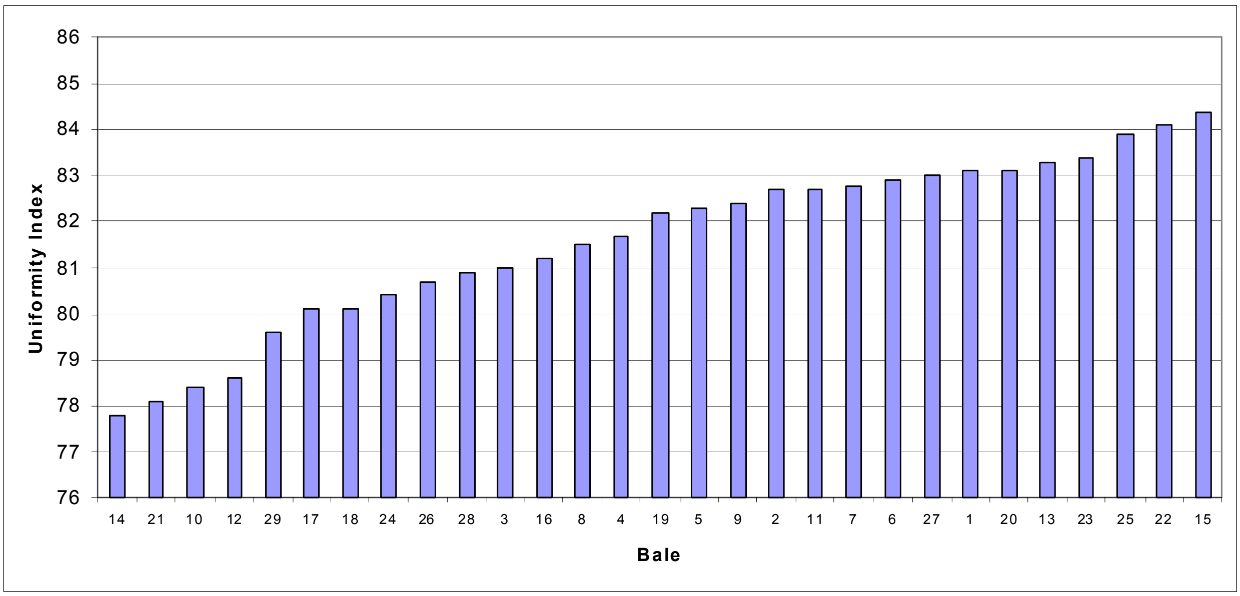

Figure 2. HVI Uniformity Index distribution of study bales sorted in ascending HVI Uniformity Index order (AMS results).

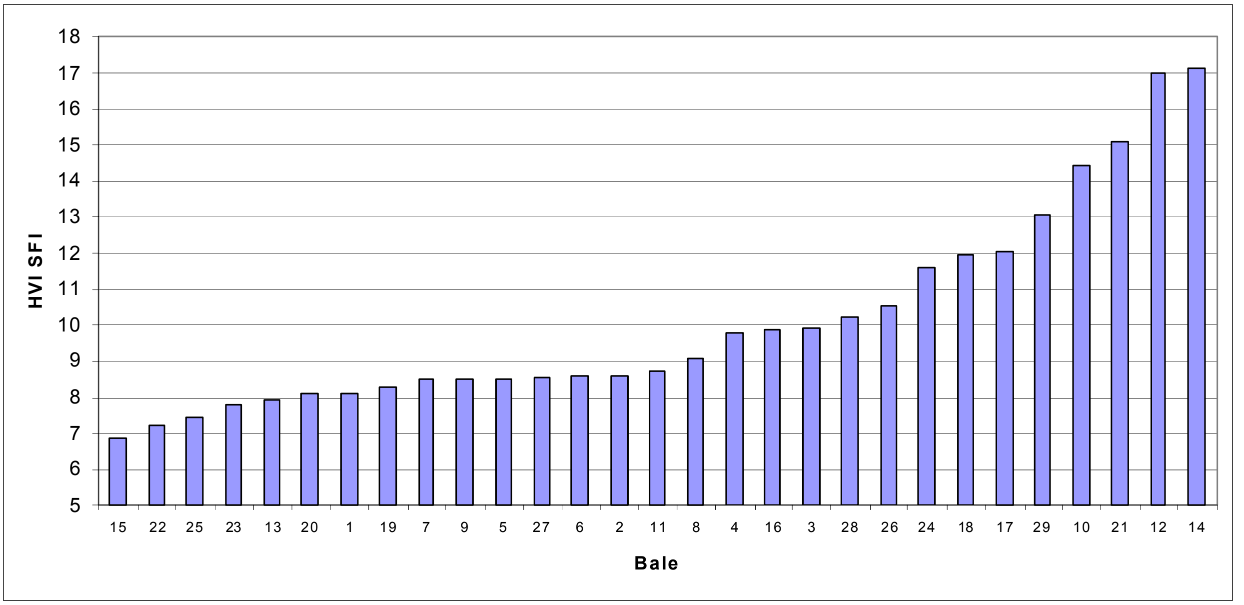

Figure 3. HVI Short Fiber Index (SFI) distribution of study bales sorted in ascending HVI SFI order (AMS results).

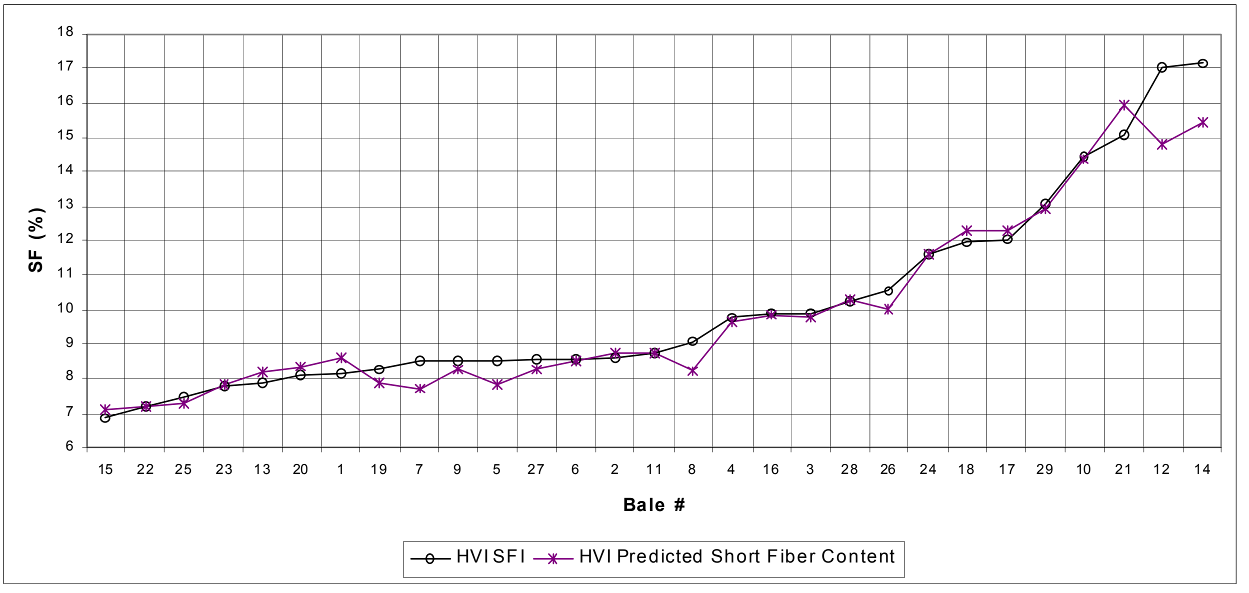

Figure 4. HVI SFI versus HVI Predicted Short Fiber Content sorted in ascending HVI SFI order (AMS results).

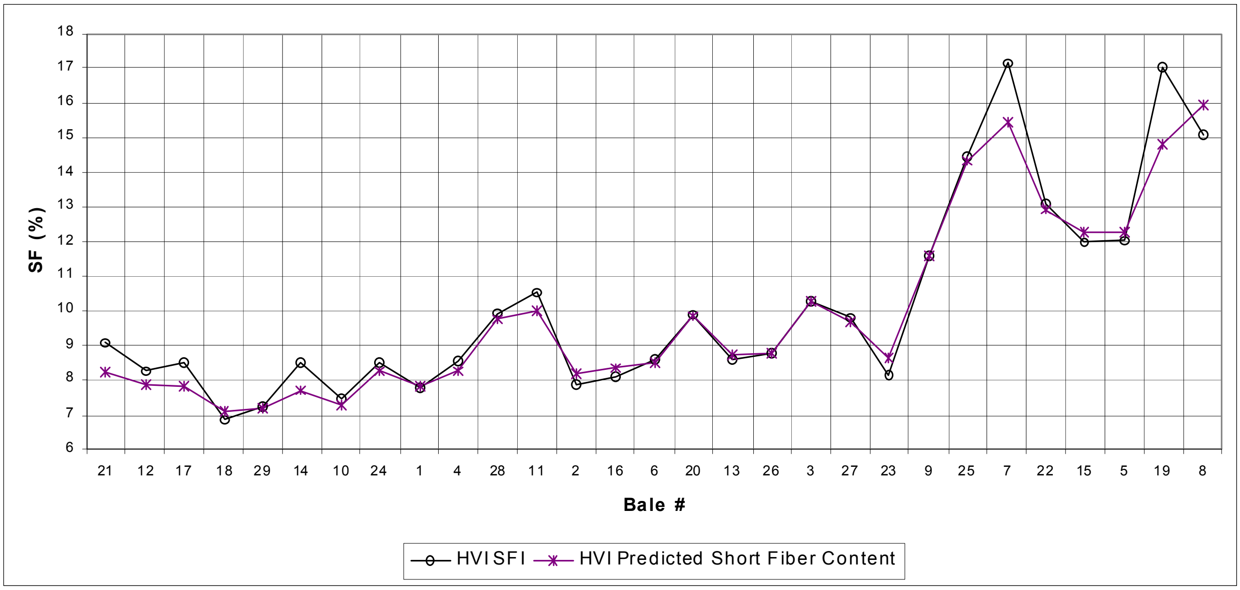

Figure 5. HVI SFI versus HVI Predicted Short Fiber Content sorted in descending HVI UHM length order (AMS results).

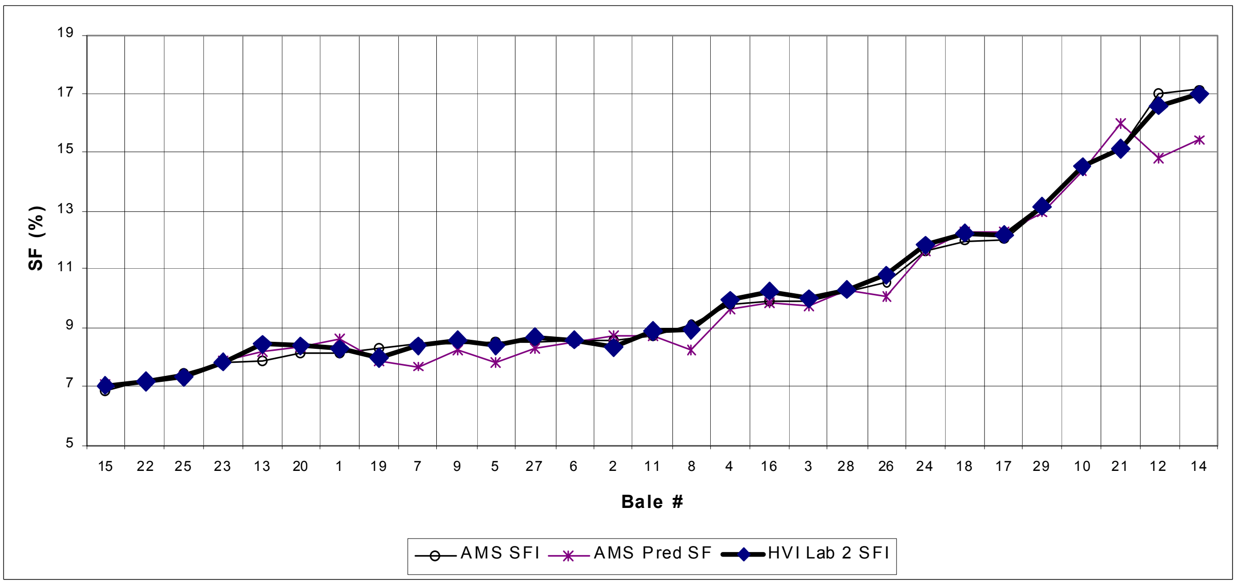

Figure 6. AMS short fiber results versus Lab 2 HVI results sorted in ascending AMS HVI SFI order.

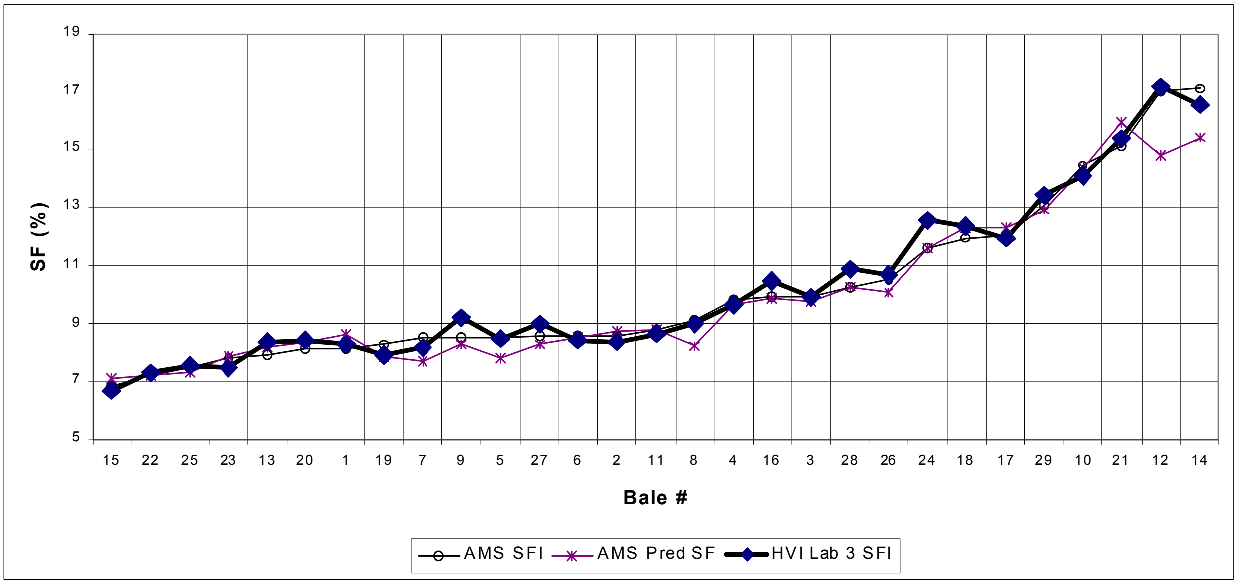

Figure 7. AMS short fiber results versus Lab 3 HVI results sorted in ascending AMS HVI SFI order.

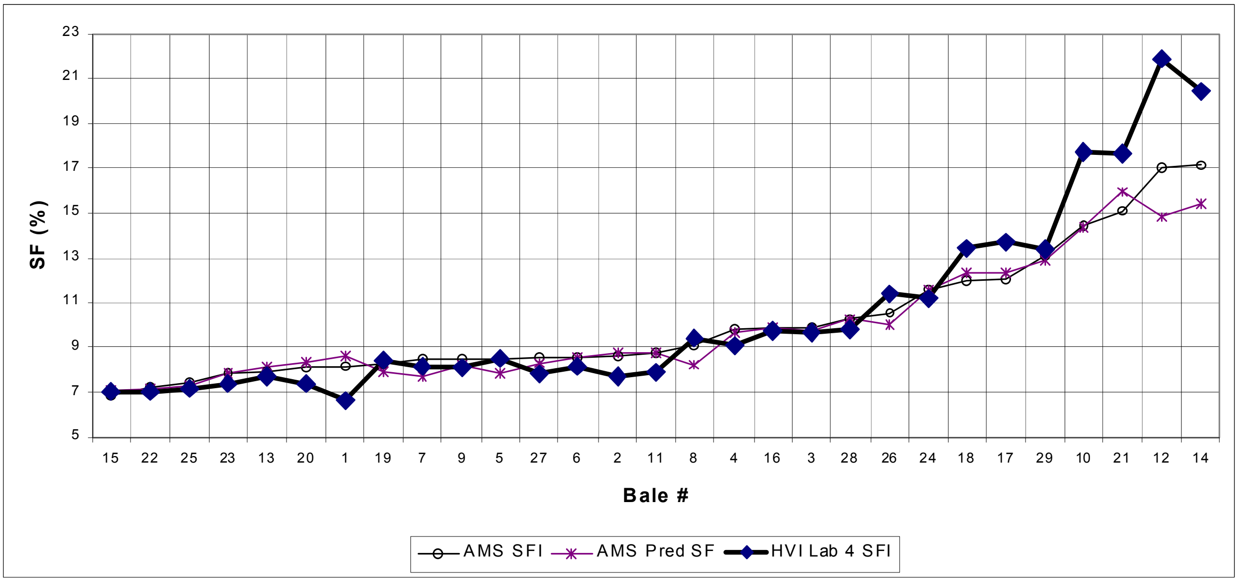

Figure 8. AMS short fiber results versus Lab 4 HVI results sorted in ascending AMS HVI SFI order.

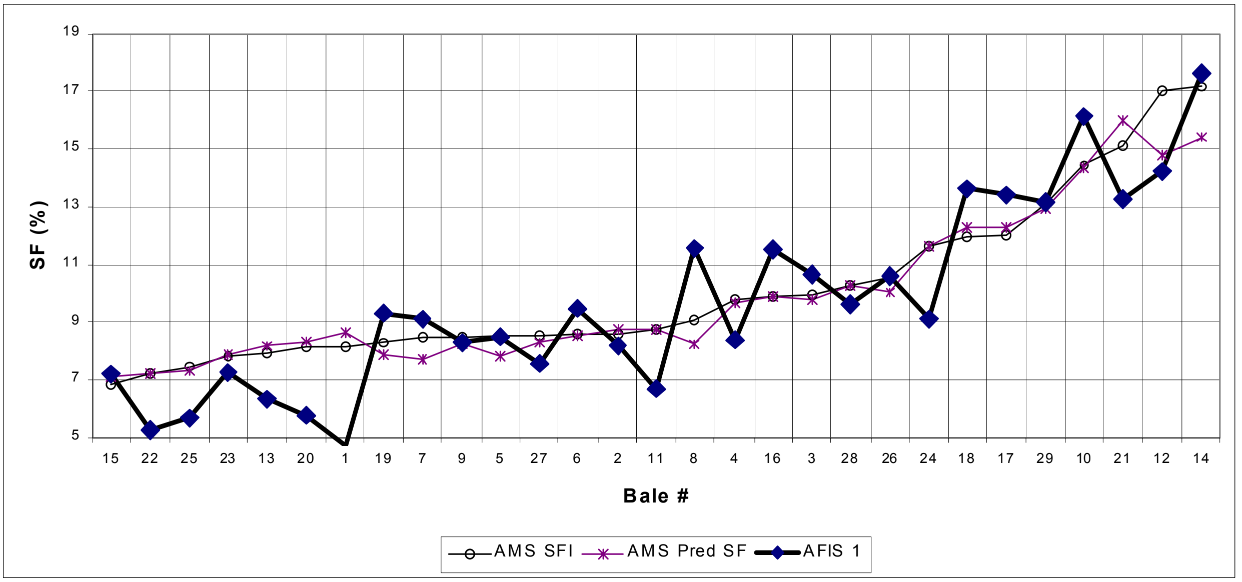

Figure 9. AMS short fiber results versus AFIS #1 results sorted in ascending AMS HVI SFI order.

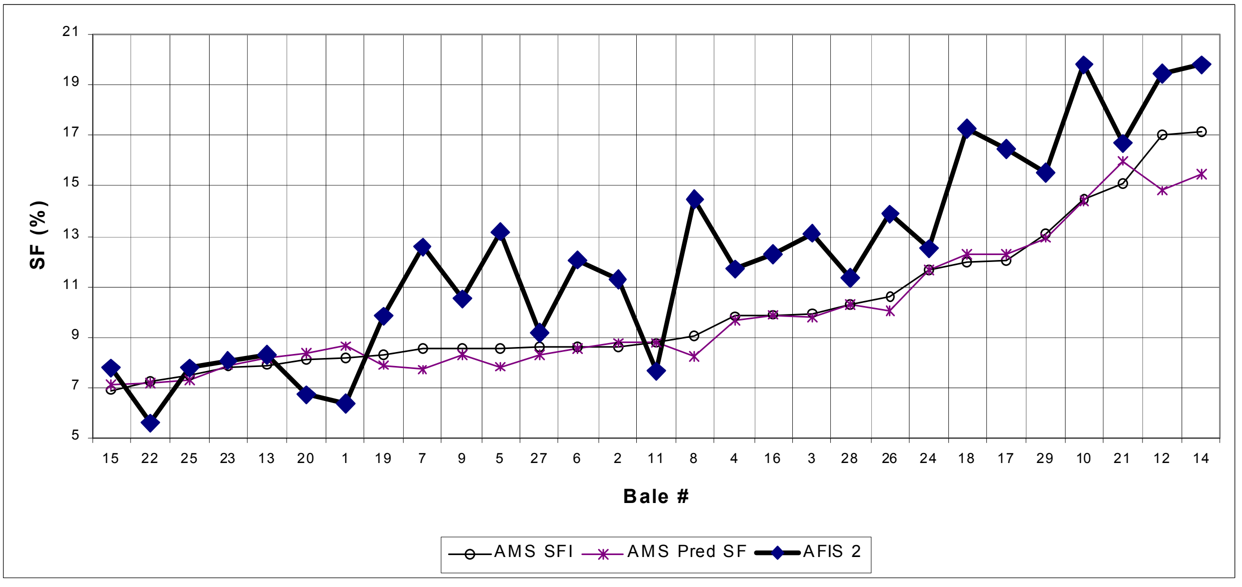

Figure 10. AMS short fiber results versus AFIS #2 results sorted in ascending AMS HVI SFI order.

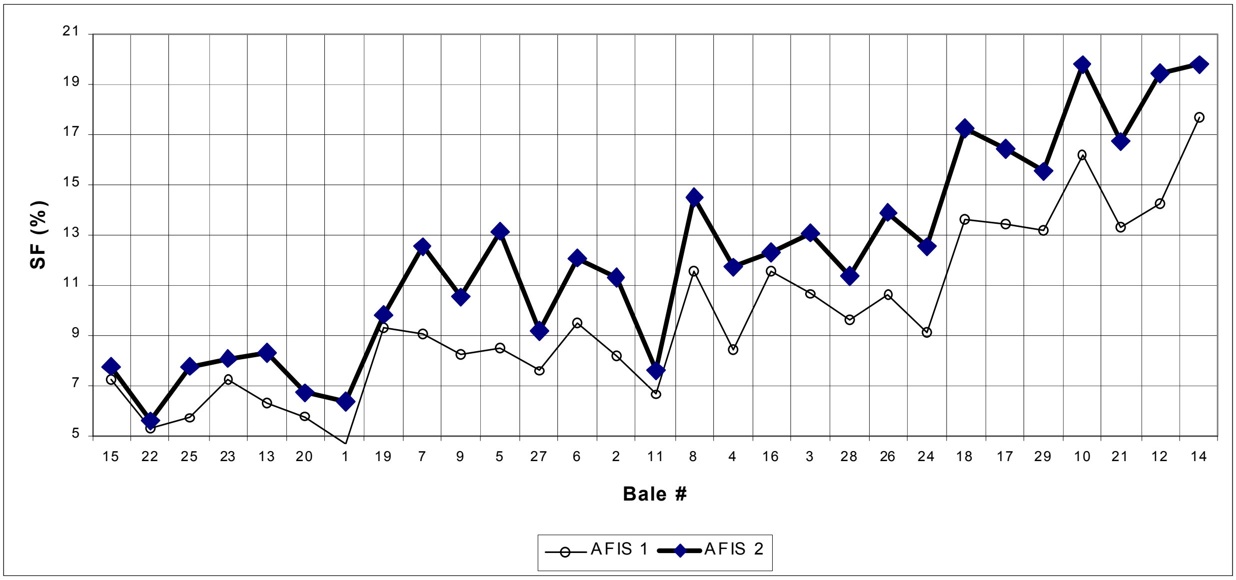

Figure 11. AFIS #1 versus AFIS #2 results sorted in ascending AMS HVI SFI order.

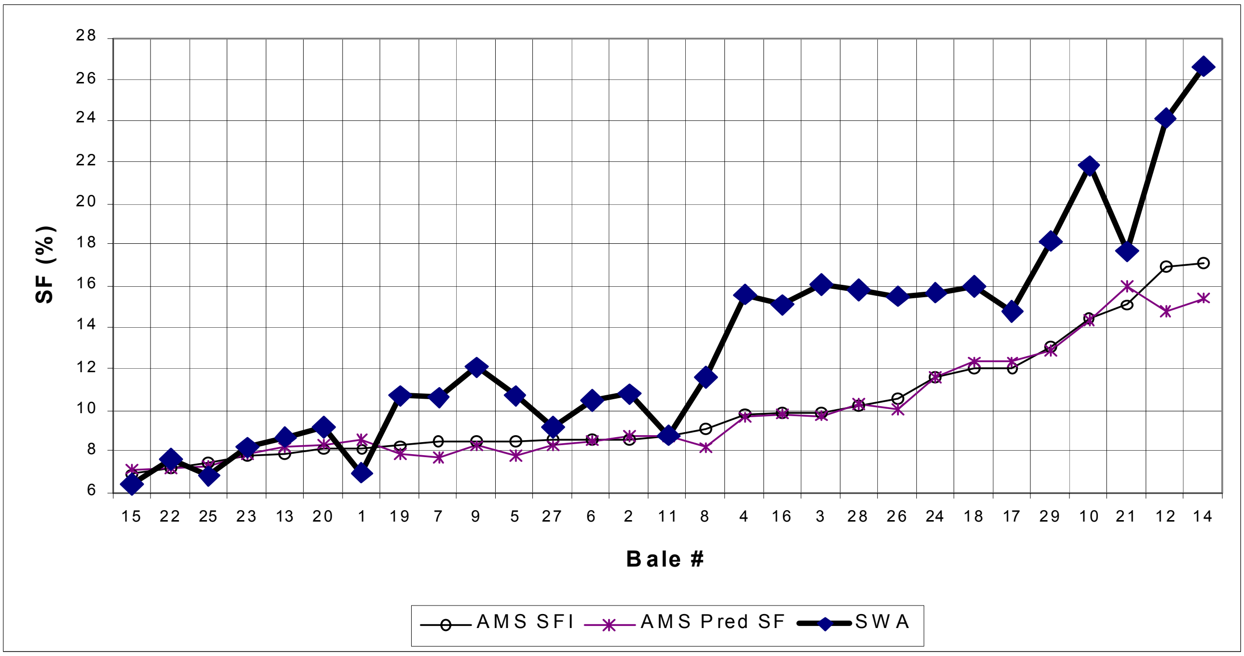

Figure 12. AMS short fiber results versus the Suter-Webb Array sorted in ascending AMS HVI SFI order.