iLUC and AEZ-EF Modeling

iLUC

National Sorghum Producers (NSP) led sorghum industry efforts to secure an advanced biofuel pathway for sorghum under the RFS2 and performed extensive analysis on several models over the past four years. These models included those that the EPA used to produce the iLUC emissions values ultimately assigned in the final rule conveying the qualification of sorghum ethanol as a renewable and potentially advanced biofuel. One such model was the FAPRI model, which we do not feel accurately described sorghum ethanol iLUC emissions because of the model's obvious difficulty in handling the inclusion of higher amounts of sorghum.

For a visualization of this difficulty, see pages 11, 12 and 13 of the attached "NSP FAPRI Analysis" document. The maps on these pages depict the differences in substitution indices of various crops between the FAPRI sorghum and FAPRI corn models. Positive values indicate the sorghum model was more aggressive than the corn model in substituting acres for the applicable crop (noted in the bottom left corner of each map), and negative values indicate that the corn model was more aggressive for that particular crop.

From the four maps on page 11, there is very little difference in the substitution indices across these crops or state lines. This fits with economic reality that large acreage shifts would not occur with a small increase in sorghum usage in ethanol production. The maps on pages 12 and 13 show significant differences in substitution indices between models across state lines for the sorghum and hay crops. For example, from page 12, Kansas is 34 percent more aggressive in substituting sorghum in the sorghum model than in the corn model while Texas is 19 percent less aggressive. Given the large amount of sorghum production in both states and similar pricing patterns, it would only be normal that they would substitute similarly, not at a difference of 53% [34% - (19%) = 53%]. Notice similar problems with the sorghum model's handling of hay on page 13.

Obviously, the FAPRI sorghum model has difficulty in handling sorghum, as its output consists of unrealistic substitution rate differences. Thus the iLUC emissions values it calculates are suspect, as incorrect domestic acreage substitutions lead to incorrect international acreage substitutions, which would—and did—significantly raise modeled iLUC emissions values.

Further demonstrating this are the model's predicted effects on feed usage when more sorghum is used to produce ethanol. In the corn model, more corn being used to produce ethanol decreases corn feed usage and predictably increases sorghum and wheat feed usage. In the sorghum model, however, more sorghum being dedicated to ethanol production causes the expected decrease in sorghum feed usage

coupled with an *unexpected* and unrealistically large increase in all other feed usage, to the tune of 184 percent of the sorghum feed usage decrease. See page 4 for further explanation. From the second paragraph: "This would imply that sorghum's feed value is considerably more than corn when in fact they are very similar."

Despite sorghum having a feed value similar to that of corn and not being used as a major feedstuff for livestock production in the U.S., the implication of the FAPRI sorghum model is that the feeding value of sorghum is such that it takes significantly more of other feed to replace it when it is diverted to ethanol production than corn. This unrealistic implication leads to increased iLUC emissions for grain sorghum in the FAPRI model as published by EPA.

AEZ-EF

One component of the AEZ-EF model that we are concerned about is the calculation of the CropCarbonExpansionFactor as detailed on page 16 of the attached "AEZ-EF Paper" document. A key component in the calculation is the RootShootRatio which is a constant per crop as detailed in Table 9, page 15.

Grain and silage sorghum have an extensive root structure and the value of the root:shoot ratio should be more than corn. Please refer to the attached "Stewart et al Root Shoot" paper regarding the root:shoot values for both corn and sorghum in the same trial. Please note in the paper that the values are given as shoot:root, so the inverse is taken from the referenced tables to compare to the root:shoot values published in Table 9. In table 1 of the Stewart paper, the mean root:shoot value for corn is 0.178 (see 90 days after emergence, mean for all corn) which is the same as the 0.18 value in Table 9 of the AEZ-EF paper. Stewart table 4 has the same data for grain sorghum. The mean root:shoot value for sorghum is 0.302 (see 90 days after emergence, mean for all sorghum) which is considerably higher than the published value of 0.08 in the AEZ-EF paper. This finding would validate the practical knowledge that grain sorghum has an extensive root structure which is one of its key physiological traits that make it much more drought tolerant than corn. This is a recent paper and NSP believes its inclusion into the dataset would make for a more robust model and better represent grain sorghum.

Conclusion

NSP strongly believes that the current iLUC values are reflective of grain sorghum and would hope that they remain the same except for the one change in the AEZ-EF model for grain sorghum that would more appropriately reflect grain sorghum's root:shoot value and affect the calculation of the CropCarbonExpansionFactor.