DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Managing Crop Residues to Reduce Particulate Matter Emissions

Progress Report

Submitted to:
Arkansas Department of Environmental Quality

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Duration of Project: January 1 2017 to June 30 2017

Objective II - Task 1

Crop Residue Management Questionnaire

Plans are underway to administer the crop residue management survey in the fall and winter of 2017–2018. Approval to administer the questionnaire will first need to be obtained from the University of Arkansas, Institutional Review Board (IRB), which must approve all proposed research involving human subjects, whether funded internally or externally. The IRB protocol form is currently in its final edits and will be sent to the IRB with required signatures of all co-researchers on the project during the latter part of June, 2017.

Once IRB approval has been granted, the questionnaire will be converted to Qualtrics format. Qualtrics is an online survey tool supported by the University of Arkansas IT Services. A former version of the questionnaire has already been converted to Qualtrics, but this version requires producers to answer questions via laptop or personal computer and is too unwieldly to be answered via iPhone. Correspondence with Arkansas Farm Bureau last fall indicated that most producers would be more willing to answer questions on an iPhone rather than a computer. The updated questionnaire will be converted to allow producers to have that option. Testing of the questionnaire tool will then be conducted during the mid to late summer months of 2017.

The questionnaire will be administered to producers from November 2017 through February 2018. These are down months for producers, as they have already completed all harvest operations prior to November and will not start back with major field work and planting until mid-March of the following year. Producers will be contacted via county producer email contact lists from the University of Arkansas Cooperative Extension Service. There will also be potential to administer the questionnaire to producers at various production meetings occurring in the fall and winter months.

Objective II - Task 2

Effect of Crop Residue Management on Plot-Size Rice Production

Rice field trials were established at the Pine Tree Research Station near Colt, AR and at the Rice Research and Extension Center near Stuttgart, AR. Treatments included: 1) conventional tillage, 2) burning of residue followed by conventional tillage, and 3) winter flooding followed by conventional tillage.

To date no significant differences in grain yield have been observed between crop residue management practices. In addition, no differences in soil test fertility values have occurred as a result of the crop management practices. Economic analysis of differences in management practices will occur at completion of the study.

Total biomass was collected at maturity from each plot by cutting the aboveground portion of the rice plants from a 1 m section of a bordered row. Samples were returned to the lab dried and separated into grain and biomass (stalks, leaves and panicles) and then weighed. These

weights were used to determine total biomass production, grain yield, harvest index and residue returned to the soil from each treatment. Plant samples were also ground and digested to determine nutrient concentrations including but not limited to N, P, K and S. To date there have been no significant statistical difference in any of the parameters of interest when compared at the $\alpha = 0.05$ level.

Composite soil samples consisting of 6- 15 cm deep soil cores were collected from each plot between rice planting and preflood N application each year. Soil samples were returned to the lab and dried at 60 ° C and ground to pass through a 2 mm sieve. A series of analysis including Mehlich-3 extractable nutrients, total N, total carbon, ammonium, nitrate and soil organic matter measured by loss on ignition were conducted on each of the replicate samples. To date there have been no significant statistical difference in any of the parameters of interest when compared at the $\alpha = 0.05$ level.

Objective II - Task 3

Quantifying Crop Residue Burning in Arkansas and their Impact on Air Quality

The objectives of Task 3 are to develop burned area estimation for the crop-residue burning emissions in the State of Arkansas using remote sensing approach, and to develop air quality dispersion model to simulate the impact of crop residue burning on PM_{10} and $PM_{2.5}$ concentrations.

To develop emission inventory from agricultural field burning, a spatial and temporal distribution of crop-specific burning information (fire activity) is needed. Emission factors and residue-to-yield ratios for the crop of interests, i.e. wheat and rice, are available in the literature. To estimate emissions from crop residue burning in Arkansas for a given year, we decided to use LandSat 7 and 8 images and compute spectral indices of Normalized Burned Ratio (NBR) using supervised classification.

Work started with spring wheat harvest with progress made so far including:

- Identify initial study area covering the combined area of six Landsat footprints, i.e. Path/row polygons: 24/35, 23/35, 24/36, 23/36, 24/37, 23/37
- Download CropScape data for of harvested wheat of 2016, clipped to new study area
- Download Landsat 7 and 8 images of 2016 between mid-May and the end of July
- Started image processing of a Landsat 8 image from 24 June 2016 covering path/row 23/36. The analysis included creating a "wheat-only" mask, a "cloud-free" mask (WOCF) to extract Landsat pixels that fall within the WOCF mask. Two spectral indices, NBR and NBR2 (using different bands) were computed (Figure 1). Using 2014 and 2015 Landsat imagery over known burned wheat fields (ground data for known burns collected by the team) as a basis for image interpretation , a threshold for burned/not-burned pixels from the NBR (pixel values below 0.03) and NBR2 (pixel values below 0.115) were created. Hence, burned pixels from the

NBR and NBR2 results were combined to create a final raster layer of burned wheat. Basic statistics were then derived for these preliminary results (Figure 1).

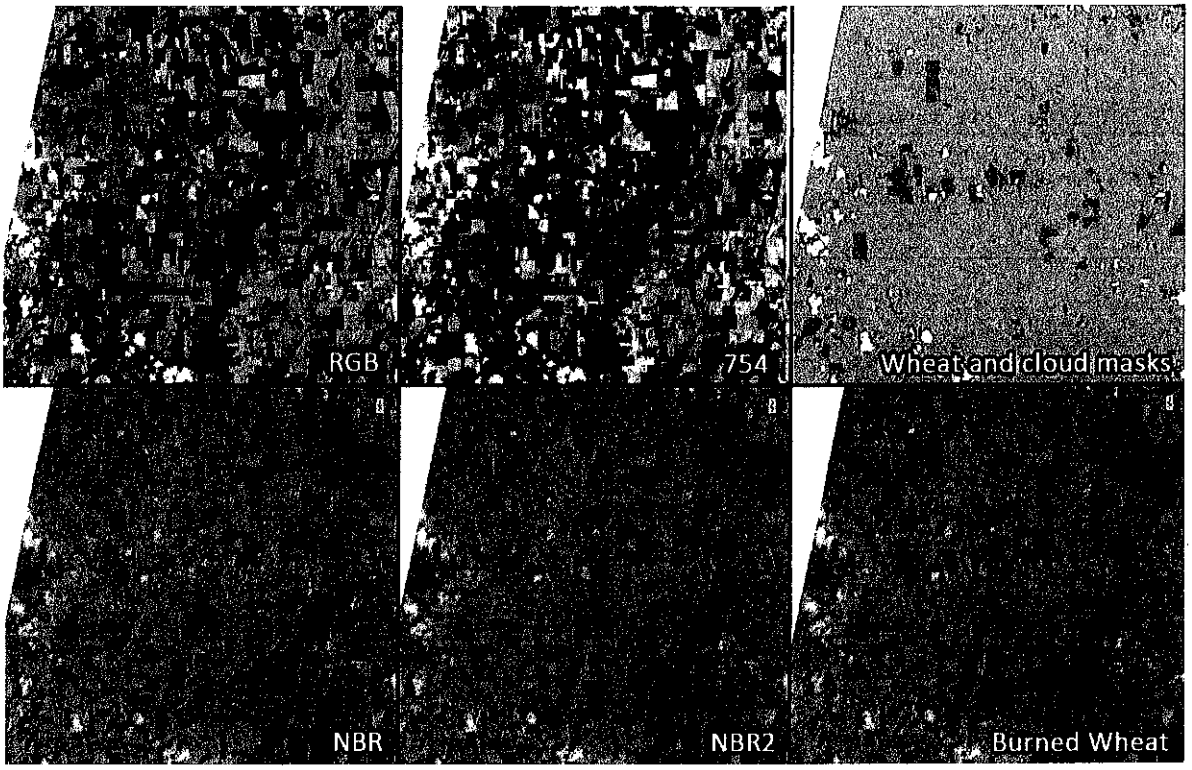

Figure 1. Example of preliminary results for a zoomed area of 23/36 image from 24 June 2016.

Preliminary results of Landsat scene: LC08_2336_20160624 showed that total CropScape wheat across entire scene: 114,058 acres; Wheat pixels that are cloud-free in image: 83,520 acres (73.2% of total); Cloud-free wheat that appears to have been burned: 24,175 acres (28.9% of cloud-free)

Future plans are 1) to run the same process on a selection of 2014 and 2015 Landsat imagery, then compare the results to the ground data we have for known burned wheat fields; 2) run the same process on a selection of 2014 and 2015 Landsat imagery of the fall rice harvest season, then compare the results to the ground data we have for known 2015 burned rice fields; 3) Emissions will be estimated and allocated. The impact of crop burning emission on atmospheric concentrations will be simulated by combining the Weather Research and Forecasting (WRF) model and the non-steady-state air quality model (CALPUFF).