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WHEAT PRODUCTIVITY ESTIMATES USING LANDSAT DATA

TYPE II PROGRESS REPORT

16 February 1976 - 15 May 1976

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WHEAT PRODUCTIVITY ESTIMATES USING LANDSAT DATA

TYPE II PROGRESS REPORT

16 February 1976 - 15 May 1976

The following report serves as the fourth Type II Progress Report for Landsat Follow-on Investigation #2062L which is entitled "Wheat Productivity Estimates Using Landsat Data."

This investigation has several objectives, including the following:

1) to develop techniques and procedures for using Landsat data to estimate characteristics of wheat canopies which are correlated with potential wheat grain yield.

2) to demonstrate the usefulness of Landsat data for estimation of wheat yield

a) for irrigated and for non-irrigated LACIE (Large Area Crop Inventory Experiment) intensive test sites.

b) for two different years with varying weather conditions.

A. PROBLEMS

We have tried to combine our field data collection efforts for the 75-76 growing season with those of Texas A&M University (TAMU) in order to most efficiently get data on field condition. However, it appears that our respective objectives are too dissimilar for us to fully integrate our separate studies. This, plus equipment and funding limitations, is probably going to make it impossible for us to make actual Leaf Area Index (LAI) measurements. To address this difficulty, we plan to estimate LAI by using previously established correlations between percent cover and LAI.

B. ACCOMPLISHMENTS AND RESULTS

We have begun to collect field data for the 1975-1976 (dryland) Finney test site. A two-person team was on site for the 18 April Landsat overpass which reportedly obtained good data.

A number of wheat fields were observed on the ground and certain ones were selected for possible subsequent field data collection. In order to efficiently sample the wheat fields it is necessary to stratify each field into homogeneous sections. This can be done most easily using aerial photos. Accordingly, 35mm color and polaroid aerial obliques of candidate fields were gathered from a light plane. The polaroid photos enabled us to pick fields to sample and to stratify them immediately so that sampling could begin on the first field trip. The 35mm photos served as a higher quality, more permanent record of the fields, and they were used to make 8x10" prints of the fields for use on subsequent trips.

On our first trip to Garden City, photographic data was collected on 4-6 plots in each of 10 fields which ranged in condition from very bad to quite good. Preliminary indications are that vegetation cover varies from less than 5 percent to more than 80 percent on the selected fields.

We had hoped to establish "permanent" quadrants by marking their locations with stakes. However, due to the uncertainty of whether all or parts of fields were going to be plowed this generally could not be done, so we recorded the position of the plots so that we could sample approximately the same area on each trip. On one field we were able to get the farmer's permission to establish permanent plots with stakes.

On our second trip to the 1976 Finney test site, we found that two of our previously sampled fields had been entirely plowed up. Other fields which were only partially plowed were retained as sample fields and four additional fields were added for a total of 12. Photographic data on percent vegetation cover were obtained on all 12 fields.

We made some reflectance measurements of wheat leaves in the field with the help of TAMU personnel and their ERTS radiometer. However, numerous difficulties were encountered, and the resulting data is of dubious quality. In an attempt to get better leaf reflectance

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data, samples of wheat leaves were harvested and returned to ERIM for measurement on a Beckman spectrophotometer. The samples included green leaves of several common varieties of wheat, irrigated and dryland wheat, and fertilized and non-fertilized wheat. A sample of yellow leaves was also obtained.

Also on our second Kansas field trip, we visited the head of the Ellis County ASCS (Virgil Quint) regarding some questions that arose as a result of processing some May 1975 Landsat data of Ellis County. Several of our questions were with regard to the reported yield for certain fields. Mr. Quint said that the farmers' figures were only rough estimates, and could be off by as much as 10 bushels/acre. Large discrepancies (>15 bu/acre) between farmers' estimates of yield and FCIC estimates of yield on particular fields also suggest some inaccuracy in the estimates. This inaccuracy will of course cause some unavoidable uncertainties in the analysis of our results.

In the new data processing and analysis we have done for the '74-'75 (irrigated) Finney test site we have compared the ASCS stand quality ratings as indicators of yield with Landsat data as indicators of yield. The stand quality ratings are ratings of the ASCS field personnel regarding the relative stand quality of the fields seen for that collection of fields for that year.

For the 11 fields for which we could obtain stand quality ratings, Landsat data, and yield for 21 May 1975, the correlation between stand quality rating and actual yield was +.63, significant at the 5 percent level. The correlation between Landsat red band digital values and yield was -.86, significant at the 1% level. This limited data set offers hope that early in the growing season (at or before heading) Landsat data may be as good an indicator of ultimate yield as are estimates of field personnel who are quite familiar with the site.

During this reporting period, we have begun to examine the temporal and spatial variation in the relationship between Landsat

data and wheat yield. Because of the good Landsat-1 and Landsat-2 coverage of the Ellis ITS during the 1974-1975 growing season, the focus of this effort will be on Ellis Landsat data. In addition, the Ellis ITS is entirely a dryland farming (non-irrigated) site, which is a contrast from the primarily irrigated Finney 1974-1975 ITS.

Field designations (polygons) for pertinent fields have been defined for four time periods (data sets) for the Ellis County site. Landsat signatures have been obtained for three of these times, namely May 3, May 11, and May 21, 1975.

For each of the three dates there are high correlations between Landsat digital data and yield. However, the relationships change as a function of time. This is partly due to the expected illumination and atmospheric changes as a function of time, and partly due to the differences between Landsat-1 and Landsat-2 satellite data. The data are not presently normalized with respect to such changes, so it is not possible at this time to make valid comparisons between dates at Ellis or between the Finney and Ellis sites.

However, Landsat data on a given date can be compared to stand quality ratings made by local ASCS personnel which we obtained on our visit to Hays. For the 12 fields for which Landsat data, stand quality ratings, and actual yield are available, Landsat Band 5 digital values from May 11 data have a correlation with actual yield of -.86, significant at the 0.1 percent level, whereas stand quality ratings of May 15 are not significantly correlated with actual yield. This result adds credence to the proposition that Landsat data may be a good early indicator of actual yield relative to traditional alternative methods.

In an attempt to reduce the differences in measurement conditions (e.g., atmospheric states) between the Ellis Landsat data sets, we examined the lowest signal value or darkest object in each of the data sets. If these objects were truly black (0% reflectance), the digital data value from such objects would be indicative of relative amounts

of radiation coming from the atmosphere (path radiance) in the various data sets and the data could be corrected for any differences. This approach proved to be unsatisfactory, because no sufficiently dark object was present in the scene. In addition, the reflectance of the darkest object in the scene may have varied from one data set to another. There are indications that there may also be differences in sensor dark level between Landsat-1 and Landsat-2 that will have to be taken into account.

C. Future Plans

We will continue our efforts toward Landsat data normalization. One approach will involve normalizing to known targets in the vicinity of the test area which have reflectivities that are expected to be rather constant during the growing season. The most likely candidate targets we can so far identify are airport runway aprons. There is an airport near both the Ellis and the Finney test sites, although the one near Finney may not be useful.

A more sophisticated (and target independent) means of removing external effects is being developed at ERIM and will be implemented. This procedure normalizes each data set to a standard data set by using a physical atmospheric model to match a measurable vector of features from a data set to a corresponding vector of features associated with the standard data set. At present, the procedure is nearly ready for the initial testing effort. We will also begin to implement Landsat data transformations which theoretically maximize differences among features of interest (such as % green vegetation cover), and minimize differences due to other causes (e.g., soil moisture, litter, standing dead vegetation).

Finally, we will continue to collect field data for the '75-'76 (dryland) Finney County site.