USDA looks for better ways to measure yields

WASHINGTON, D.C. – Back in the 1950's, USDA's first-of-the-season corn production forecasts missed the mark by an average of 6.6 per cent. During the past three years this margin narrowed to 2.9 per cent.

Part of the reason: Over the years, the Crop Reporting Board has added in-field plant counts and measurements and sophisticated sampling methods to supplement the crop information it gathers from farmers

Changes like these originate in the Statistical Research Division, which continually seeks new and improved methods of collecting and providing crop and livestock information. Better acreage estimates, improved yield forecasts before harvest, and more precise estimates of harvested yield form the basis for more reliable crop production data.

Wendell Wilson, head of the Division's Yield Assessment Section, sees his research work falling into two main categories. "First," says Wilson, "we monitor current data gathering procedures to see what works well and what doesn't so that we can fine tune our current methods for better results.

"Our second goal is to develop new techniques that can be added to our program for determining crop yields"

This type of research covers a gamut of commodities ranging from fruit and citrus crops in Florida and California, to tart cherries in Michigan, pecans in Mississippi and papayas in Hawaii. The larger projects, however, center on major field crops - corn, cotton, wheat, and soybeans.

To make timely forecasts for each of these crops, the Crop Reporting Board relies on both subjective and objective data. The first stem from farmers' judgements of crop conditions and are often subject to certain observational biases.

Objective methods refer to the actual plant counts and measurements made in sample fields throughout the growing season by trained enumerators. These first-hand observations are designed to produce factual yield indications that are not based on judgement.

"Together the two systems have served us well," Wilson relates, "but we continually strive for refinements and adjustments to improve results."

"This year, we plan to examine a new method of collecting objective data for soybeans, which we call 'destructive counting'. We anticipate running this study along with out regular objective yield work in Illinois"

In experimental plots within each sample field, enumerators will make the usual plant counts and measurements, but after they've clipped off the plants at ground level. This will help determine if removing a few plants for closer examination will give more accurate indications of plant characteristics than current methods in which the plants are left intact.

Also, during the August and September field visits, leaves from experimental plots will be mailed to Washington, D.C., to be analyzed for total dry matter and nitrogen content. "We expect to find out," says Wilson, "if leaf dry matter and nitrogen content - which we can only get by destroying the plants - are useful indicators of soybean yields, especially for the early season forecasts."

Another chief area of research focuses on developing forecasting methods that more closely reflect conditions within the current year Right now, crop forecasting "models", or formulas, are based on relationships determined in previous crop seasons.

In years when crop growth and development are unusual, these relationships may shift and forecasting accuracy is likely to suffer Since the need for reliable forecasts becomes even more acute in unusual years, Wilson's group is giving high priority to building within-year growth models to project yields based on crop growth and development within the present season

The within-year models relate the growth of grain dry matter to some measure of time after a distinct change in plant development occurs near the time of pollination and fertilization. For corn, this has been the time after silk emergence or silk drying, and for wheat, the time following head emergence or flowering.

Generally, the models reflect a slow period of initial growth, followed by a rapid increase in the growth rate, and then a gradual tapering off until all development stops at maturity. Based on observations up to a forecast date, the model can project the amount of dry matter at maturity, and expand that information to project yield per acre.

"We've worked previously with corn growth models in Iowa, Nebraska, South Dakota, Texas, and Missouri; and with wheat growth models in North Dakota and Kansas," Wilson reports.

This year the within-year growth model for wheat will be studied in 24 small test plots in each of four Kansas wheat fields. Enumerators will determine a flowering date for each of the 100 tagged stalks that do flower in each plot

Field personnel will also clip a random sample of heads each week based on flowering date and forward the clippings to a laboratory where dried head weight will be determined Shortly before harvest, they'll clip nearby heads to determine dry kernel weight This will provide a factor for converting head weight to kernel weight at 12 per cent moisture - the standard moisture content at which grain yield and production are reported Field measurements of harvest loss will be used to adjust to a harvested yield basis

"We'll check the model's accuracy after harvest," says Wilson, "by comparing the indicated yield with the actual yield as measured by delivery of the grain to local elevators.

"This year we are also conducting a Corn Yield Research Project that will involve testing a within-year growth model and seeing if combining various weather data will strengthen early and mid-season yield forecasts.

"The first part of this project will be to evaluate a yield model developed at the University of Missouri that uses only a minimum of weather and biological data, planting date, tasseling date, availabe soil moisture at planting, and total weekly rainfall and average maximum temperature for a 10-week period starting 6 weeks before the crop has fully tasseled. Enumerators will carry out this part of the project in 20 Missouri corn fields.

The project's second goal is to come up with in-field and laboratory measurements of plants and environmental factors that are closely tied to final yield and can be used to estimate yields at the field level Data will be collected to run the within-year growth model as well as forecast yields using the regular objective yield procedures. These efforts are being made in 8 of the 20 corn fields

"After the crop is harvested, we'll compare the forecasts and final yield estimates generated with field output measured at elevator delivery. This will show us how all the indications we've gotten from regular objective yield procedures, growth model projections and the University of Missouri model - stack up against the actual yield."

Another system under study is called GOSSYM (taken from the scientific name for cotton). This is one of the more detailed crop growth and development models available. It's one of the few, for example, that accounts for rooting zone and other below-ground conditions and attempts to relate them to factors above ground.

"To more fully evaluate various crop yield-weather models, we're continuing to develop weather simulation capabilities," explains Wilson. "This is essential in using weather/growth models to forecast crop yields

"The crop growth simulation models must 'grow' the plants all the way to maturity until the one thing we're interested in forecasting - the grain or fruit - has been completely produced.

"Because we don't know what the weather will be like from a forecasting date until plant maturity, it's difficult to plug weather data into a forecasting system. We could simulate plant development until maturity by using long-term average weather conditions, but this has all the 'bad' qualities of an average - it's a little bit wet and cold and a little bit hot and dry at the same time and very different from

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