Introduction
Crop simulation models can accurately predict yield with a prior knowledge of the soil properties and management practices. The models simulate plant development and growth, and soil processes to estimate yield. Knowing the demand for nutrients and water by the plants and the supply of these factors from the environment can be calculated and used to limit plant growth and yield. Without knowing all the factors or relationships and the comparisons of observed and predicted yield cannot be done accurately (Sieler et al., 2000).

Remote sensing allows continuous monitoring of the plant canopy in space and time. The plant canopy reflects the effects of plant statures and yields (Hatfield and Potter, 1993). In this study, a crop simulation model was adapted to use canopy attributes derived from remote sensing. The objective was to assess how well corn yield can be predicted at the field level with a crop simulation model in conjunction with remotely sensed data.

Material and Methods
A prototype of the generic crop simulation model SALUS (Schulthess and Ritchie, 1997; Ritchie, 2000) was adapted so that it could be forced with remotely sensed information to predict corn (Zea mays L.) yield. Remotely sensed data were collected with a RESOURCE21 airborne multispectral system in 1997 and 1998. The forced crop simulation was calibrated with research plot level data from Lubbock, TX (1997) and Holdrege, NE (1998) at the University of Nebraska-Lincoln west of Chadron, NE and at different locations in Nebraska (1998). In addition, yield data had been gathered from 22 fields (1998) twelve fields from the Holdrege, NE region and ten from the Geneseo, IL region. Wherever available, yield maps derived from a yield monitor were used to assess the spatial accuracy of the yield predictions. Elevator receipts were used to calculate the yield of some fields in the Holdrege region (1998). In addition, yield data were collected with a RESOURCE21 airborne multispectral system (Schulthess and Ritchie, 1997; Ritchie, 2000) was adapted so that it could be forced with remotely sensed data.

Results
Prediction of average yield:
The average yield of the fields ranged from 840 to 10,000 kg/ha. The forced crop simulation model predicted the yield over the entire range of data (Fig. 1). On average, it under-predicted measured yield by 6.7%. This was due to an under-prediction of yields in the Holdrege, NE region. Better results were obtained for the Geneseo, IL, region where the average error was only 0.7%.

Prediction of within field variability:
The method to assess the spatial accuracy of the predicted yields is to visually compare the yield maps (Fig. 2). The results from the validation showed that remote sensing and crop modeling complement each other. A great advantage of yield maps derived with this methodology is that they can be used for scouting, site the technique is non-destructive. The forced crop simulation model accurately predicted the within-field variability of yield indicating that it is probably capable of predicting yield for fields that have higher or lower average yield than the validation data set.

Discussion
The fields in this study were planted with a wide range of hybrids, including 89 and high oil corn. In the Geneseo region, the model accurately predicted yield for all of these hybrid types, without adjusting the genetic coefficients. Additional analysis showed that the under-prediction of the yield of some fields in the Holdrege region was probably due to different canopy architecture of some of the hybrids. Algorithms are in development that can detect and correct for such hybrid differences.

The forced crop simulation model accurately predicted the within-field variability of yield indicating that it is probably capable of predicting yield for fields that have higher or lower average yield than the validation data set.

The results from the validation showed that remote sensing and crop modeling complement each other. A great advantage of yield maps derived with this methodology is that they can be used for scouting, site the technique is non-destructive. The forced crop simulation model is currently being refined to generate in-season yield forecasts and yield maps. They can be used to improve in-season crop management, scouting, and grain marketing.

References:

For further information contact: Urs Schulthess, 355 744-2702
schulthess@resource21.com