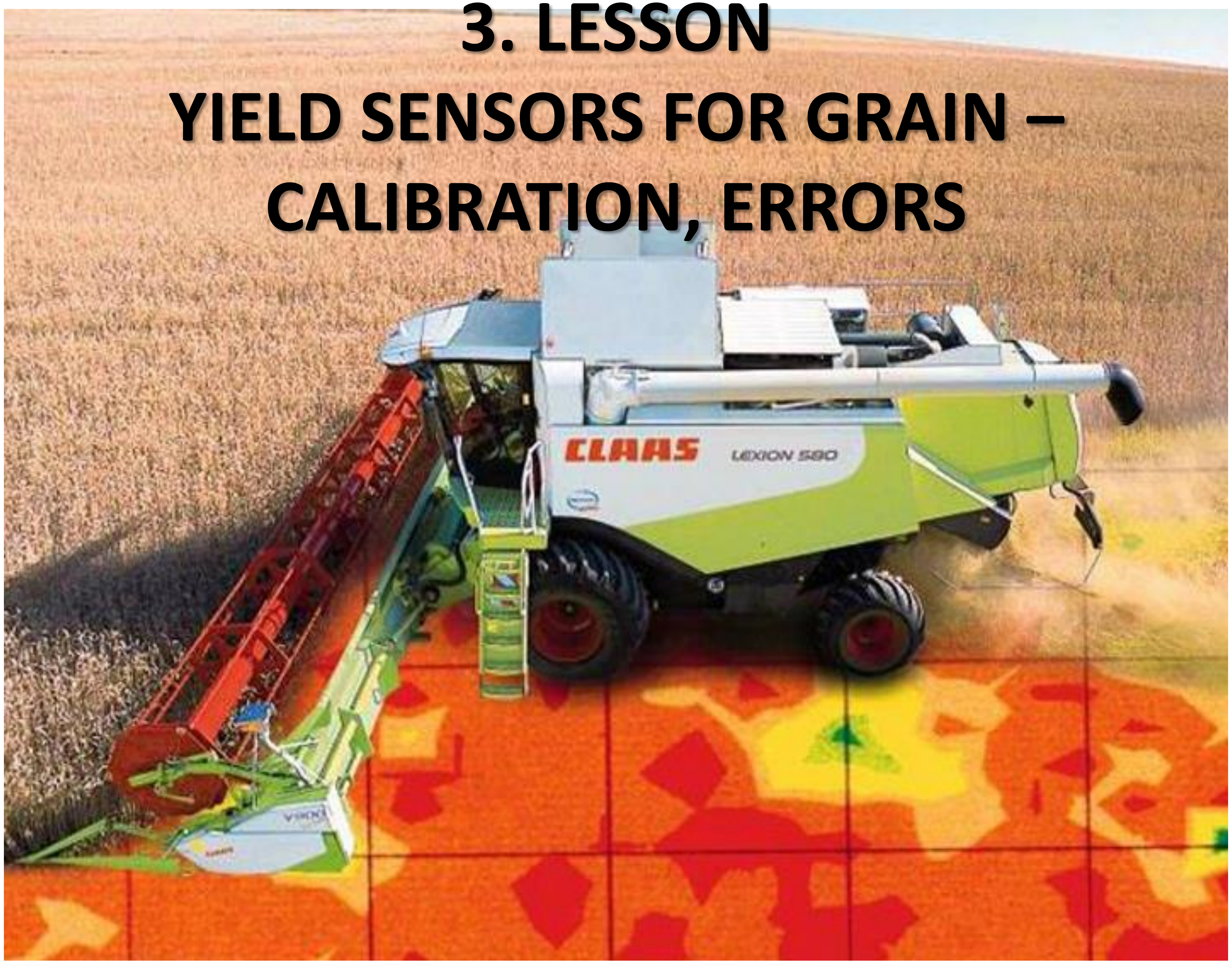
3. LESSON

YIELD SENSORS FOR GRAIN – CALIBRATION, ERRORS



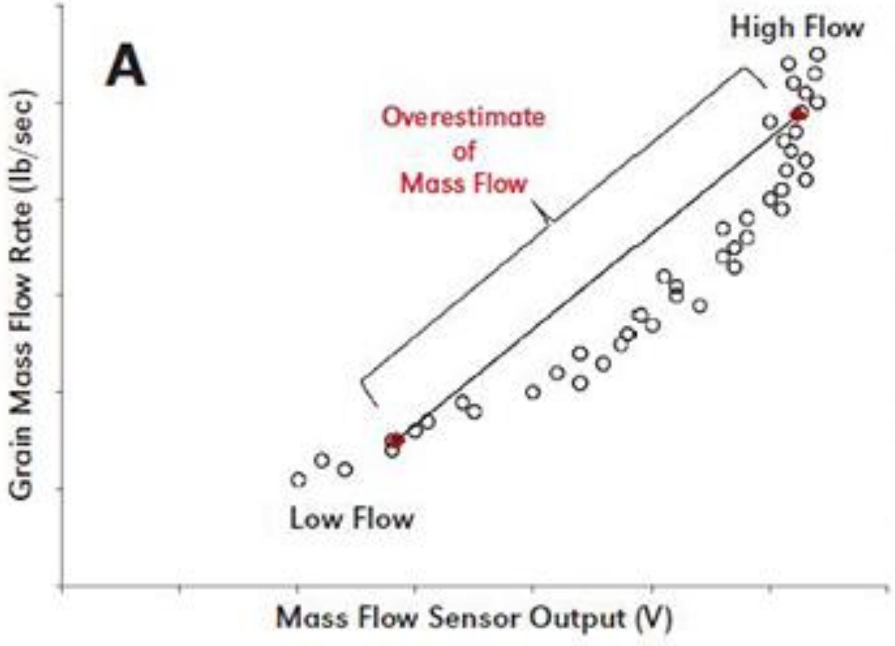
Factors affecting the accuracy of determining instantaneous grain yield

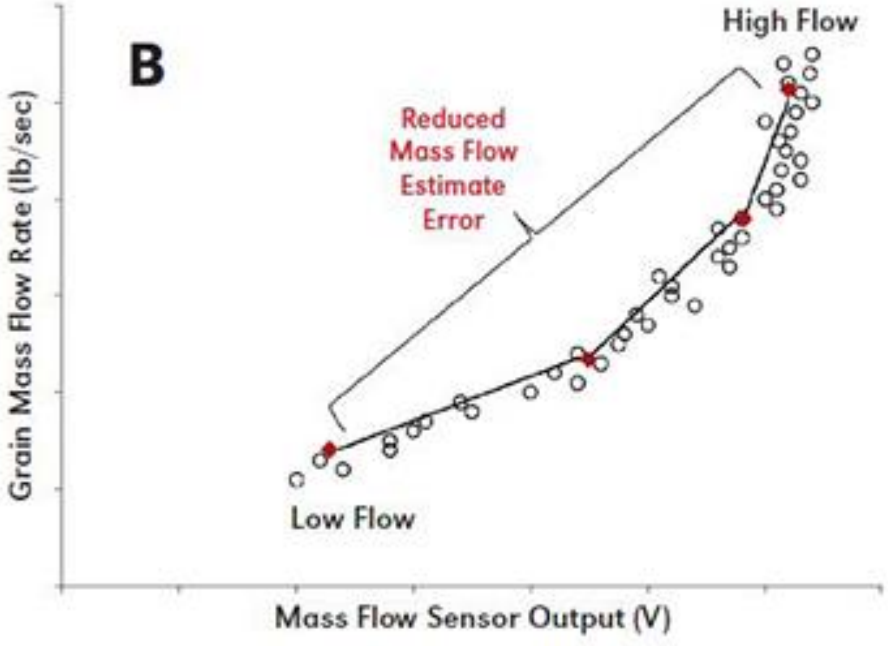
- Yield sensor used. Weight based (errors up to 5%) are more accurate than volumetric (errors up to 6%). The most accurate are the radiation sensors (errors up to 2%)
- Harvested field size up to 25%
- System calibration according to manufacturer's specifications up to 12%
- Failure to keep the same working width of the combine up to 10%
- Working on a slope (slight slope (5-10%) up to 6%, sharp slope up to 20%)
- Travel speed changes up to 5%

Grain flow sensor

As perhaps was evident from the 1st lesson, grain yield monitors not measure grain yield.

- Yield monitors **estimate** yield by converting electrical signals received from a impact or optical sensor, into estimates of grain flow (kg) per one, two, three or five seconds of travel time.
- Yield monitor calibration involves a series of steps to ensure that the estimation of yield is accurate.
- Calibrating a yield monitor **requires the harvest of individual loads** of grain that represent the range of grain flow rates. We teach the monitor what is true.
- It is not always easy under harvest conditions.





Mass flow sensor output for (A) improperly calibrated yield monitor and (B) a properly calibrated yield monitor. Source: "Best Management Practices for Collecting Accurate Yield Data and Avoiding Errors During Harvest," Luck J. and Fulton J. University of Nebraska Lincoln Extension Bulletin EC2004.

Grain flow sensor calibration

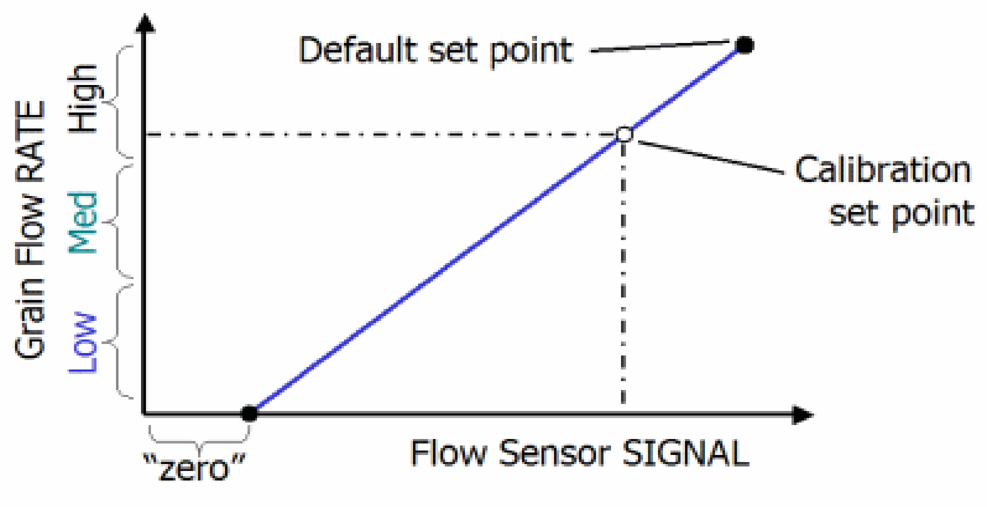
Equipment condition

- Check for wear and/or material build-up on impact plate or related components.
- Replace worn and broken paddles.
- Check clearance between paddles and top of elevator. Adjust if necessary.
- Check clean grain elevator speed sensor.

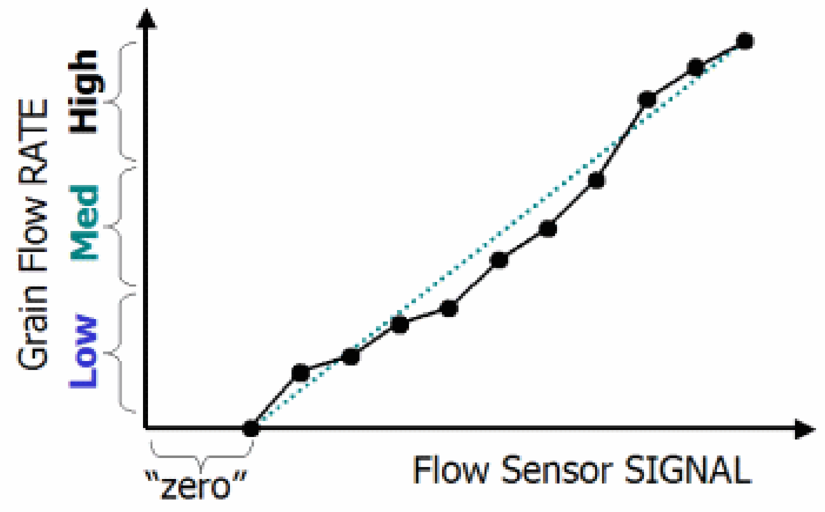
Procedure

- Empty tank
- Start calibration mode
- Harvest load (preferably in level area with uniform yield)
- Stop calibration mode
- Empty tank and weigh load
- Enter scale weight
- Repeat at multiple speeds if possible

Near-linear calibration curve



Non-linear calibration curve



- Some manufacturers suggest that only one grain load is necessary to perform an accurate calibration - calibration response curve is a straight-line or near-linear.
- Other manufacturers recommend between 3 and 6 grain loads are required to perform a satisfactory calibration. This recommendation suggests that the calibration response curve is rather non-linear.

Moisture sensor

- Should be checked for operation annually and calibrated periodically for accuracy. Proper moisture readings are essential in determining the dry yield.
- During calibration of grain flow sensor, grain samples should be collected and grain moisture content dermined.
- Use a high quality meter that has been calibrated recently. Number of handheld moisture meters are portable and convenient, but lack in accuracy.
- Use moisture data when you enter the calibration data for the grain flow sensor.

Moisture sensor

Factors that influence accuracy
- Temperature
- Density of grain
- Surface moisture on grain

Equipment condition
- Check for residue buildup
- Check for cobs, stalks, etc.

Field calibration
- Adjust offset to match reference sensor (grain elevator usually best)
- Best to take several samples

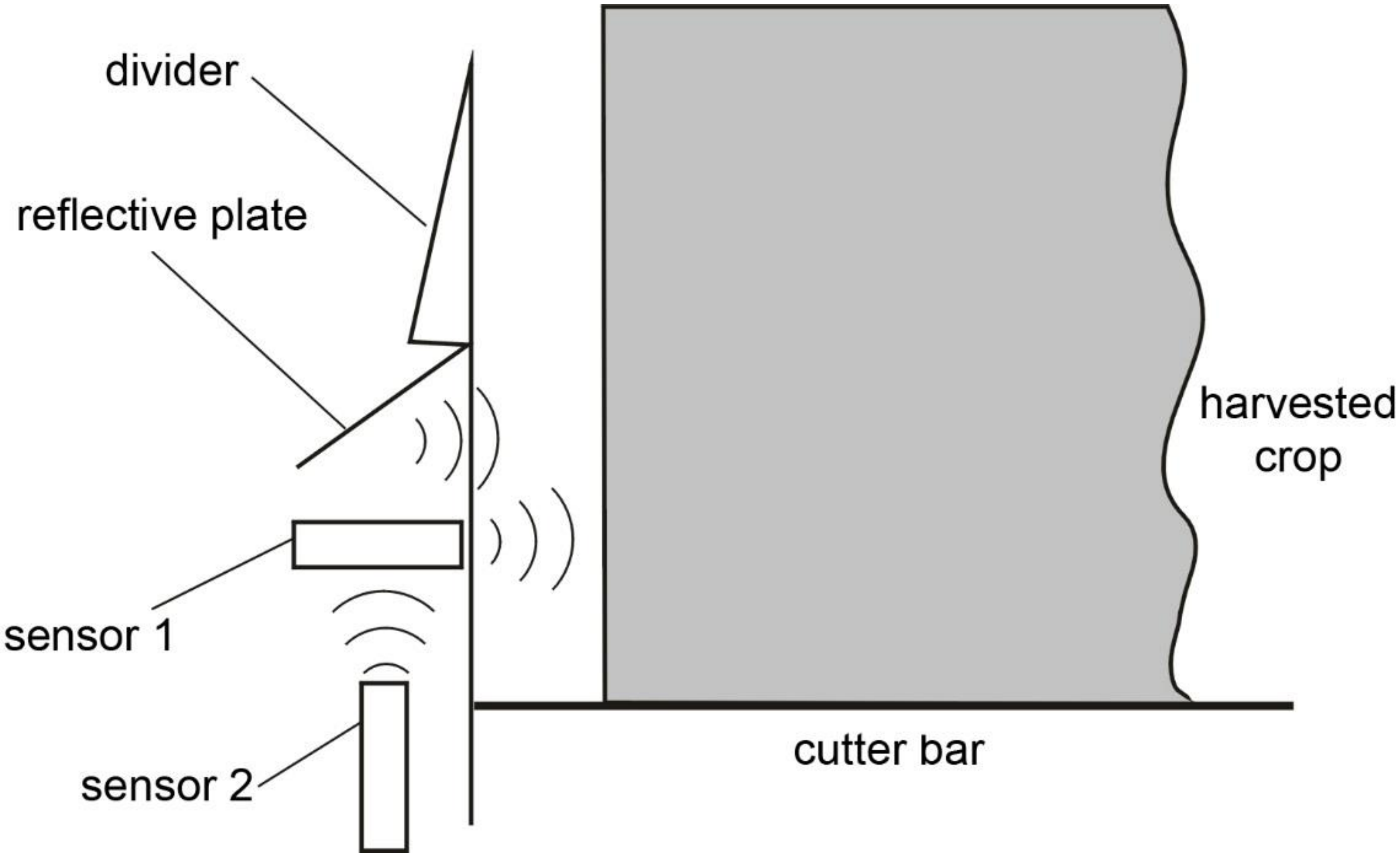
Updated calibration curves
- Software from manufacturer

Lag time setting

- Amount of time it takes grain to flow through the combine from the header, thresher and clean grain elevator before grain starts hitting the grain flow sensor.
- It is possible to count the seconds it takes from the time your header engages the crop until you start to see grain enter the grain tank on the combine (usually 12 seconds).
- Yield maps should show each pass lining up on the headland. If every other pass is longer and shorter, you probably need to adjust the lag time setting.
- This can also be corrected with post-processing of your data after harvest.

Header cut width

- Yield monitor uses the header width to calculate yield.
- Each combine must have set the proper cut width.
- Sometimes it is necessary to change headers between combines. It is necessary to take care to the correct width setting in the yield monitor.



Measuring the instantaneous cutting width of the combine harvester using ultrasonic sensors

Header position setting

- Header position setting start and stop logging data points by yield monitor.
- On the headlands, header is raised during turning around and then lowered again when re-engaging the crop.
- If operating height is set properly, the machine will automatically stop logging data points when header is raised, then start logging again when header is lowered.
- This eliminate the collection of zero yield points during turning.
- This is another setting that can be fixed with post-processing of the data after harvest, but the more accurately yield monitor is prepared in the field, the more accurate data will be achieved.

Distance traveled measurement

- Most yield monitors now use the GPS signal to determine distance travelled and it can be very accurate, especially with RTK systems.
- Older systems used to have a backup system in case the GPS signal was poor or lost. These relied on measurements of wheel revolutions and calculated distance and speed based on wheel size.
- Follow operator’s manual to properly calibrate distance measurements if you have the backup system.

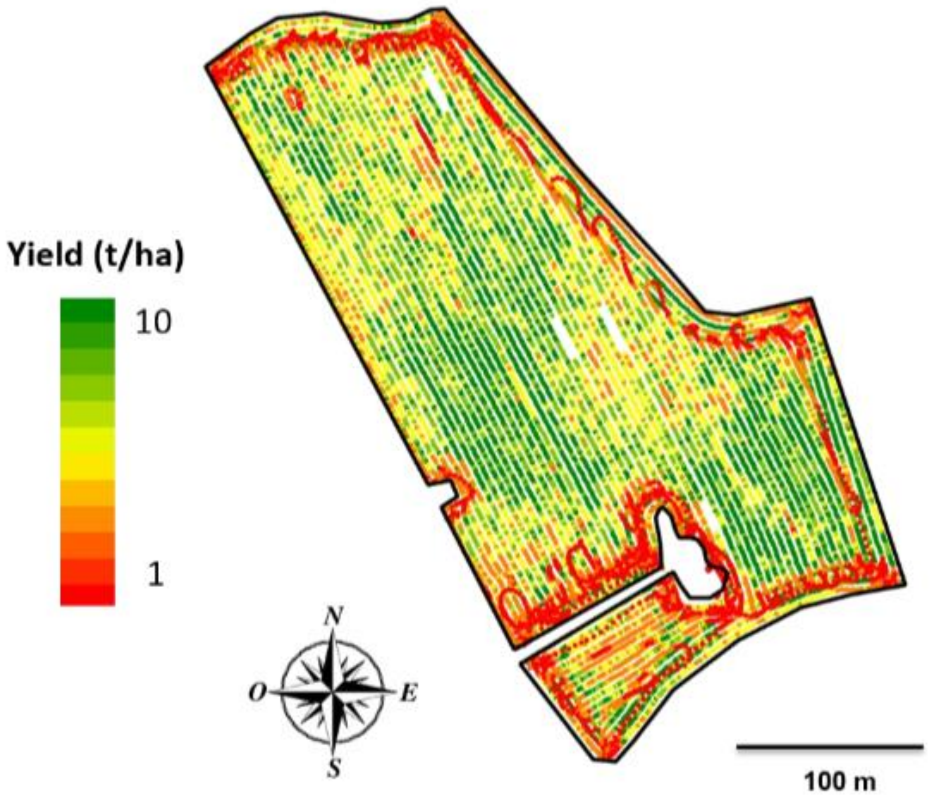
Improving the accuracy of yield sensors

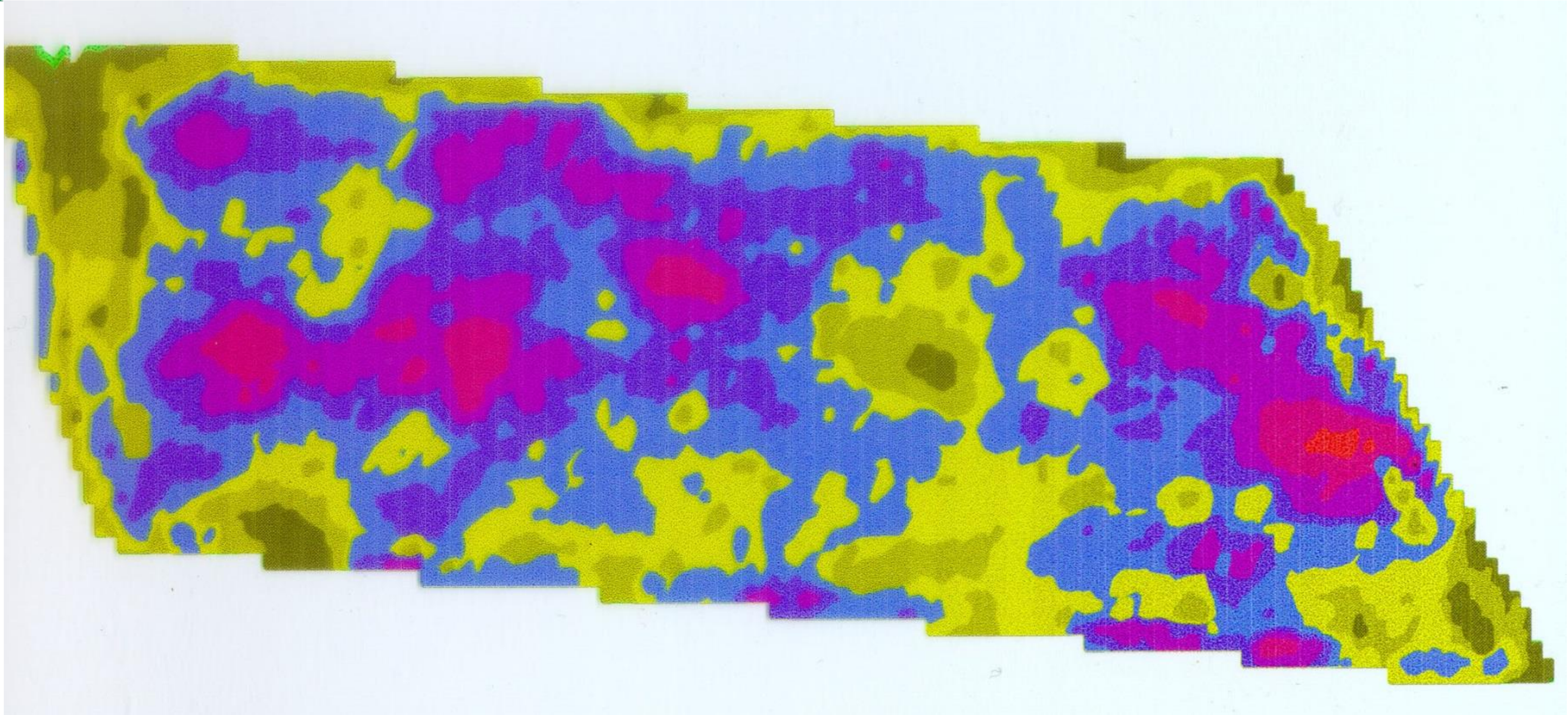
- Combine harvester manufacturers are aware of the difficulties associated with calibrating yield monitors.
- Already in the second half of the 1990s, New Holland introduced patented geometry to a force measuremenn cell to compensate varying friction force. The advantage of this system is the need for fewer calibrations when harvesting different crops.
- In 2018, John Deere reaped success with Active Yield. System provides automatic continuous calibration of grain yield sensor.

John Deere ActiveYield - provides continuous calibration of the grain flow sensor through load cells installed in the grain tank.

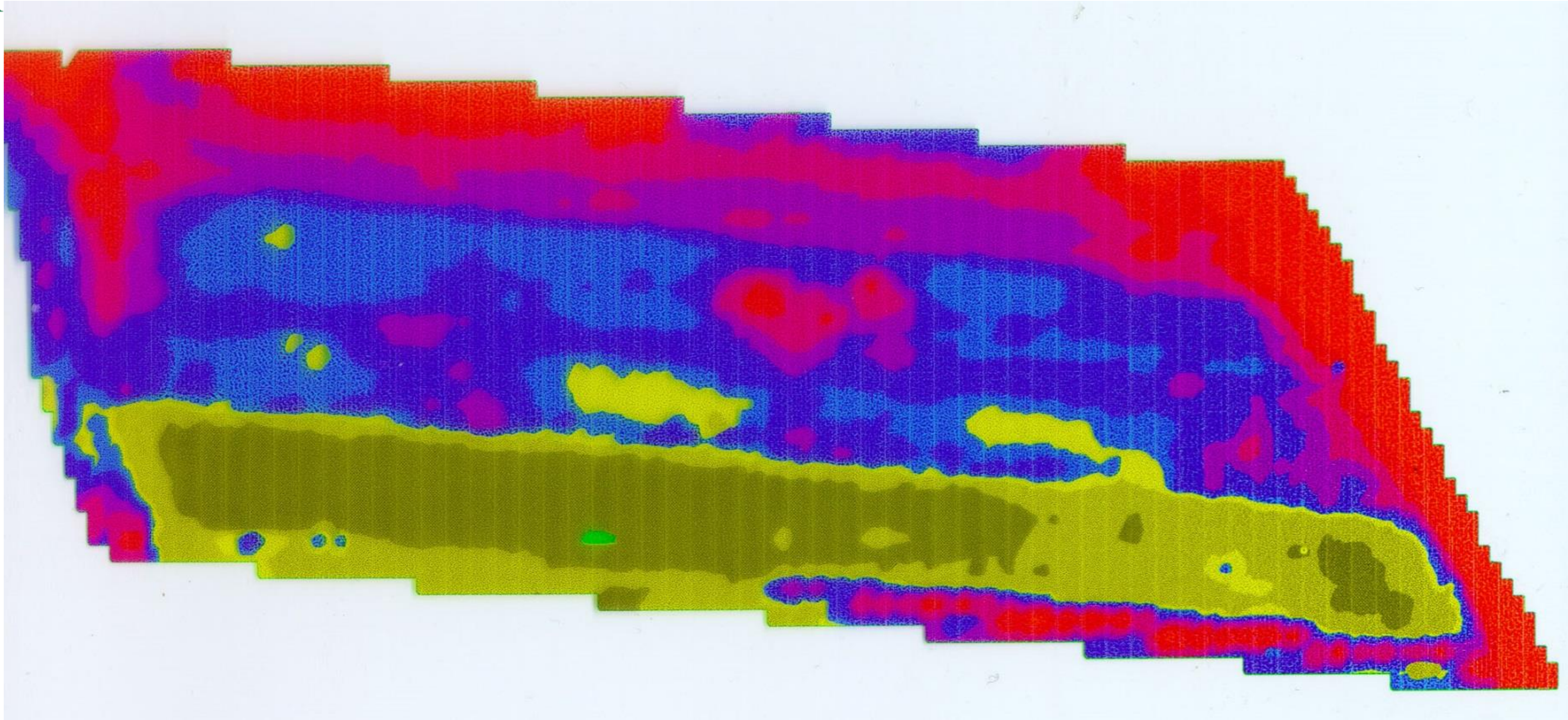
Yield map and its importance for precision agriculture

- Basis for decisions about field cultivation
- Checking the results of previous field management (differentiated fertilization, plant protection, sowing, etc.)
- Comparison of historical development of yields on field
- Possibility to create yield frequency map
- Verification of remote sensing information
- Shows economic results of cultivation of individual parts of the field

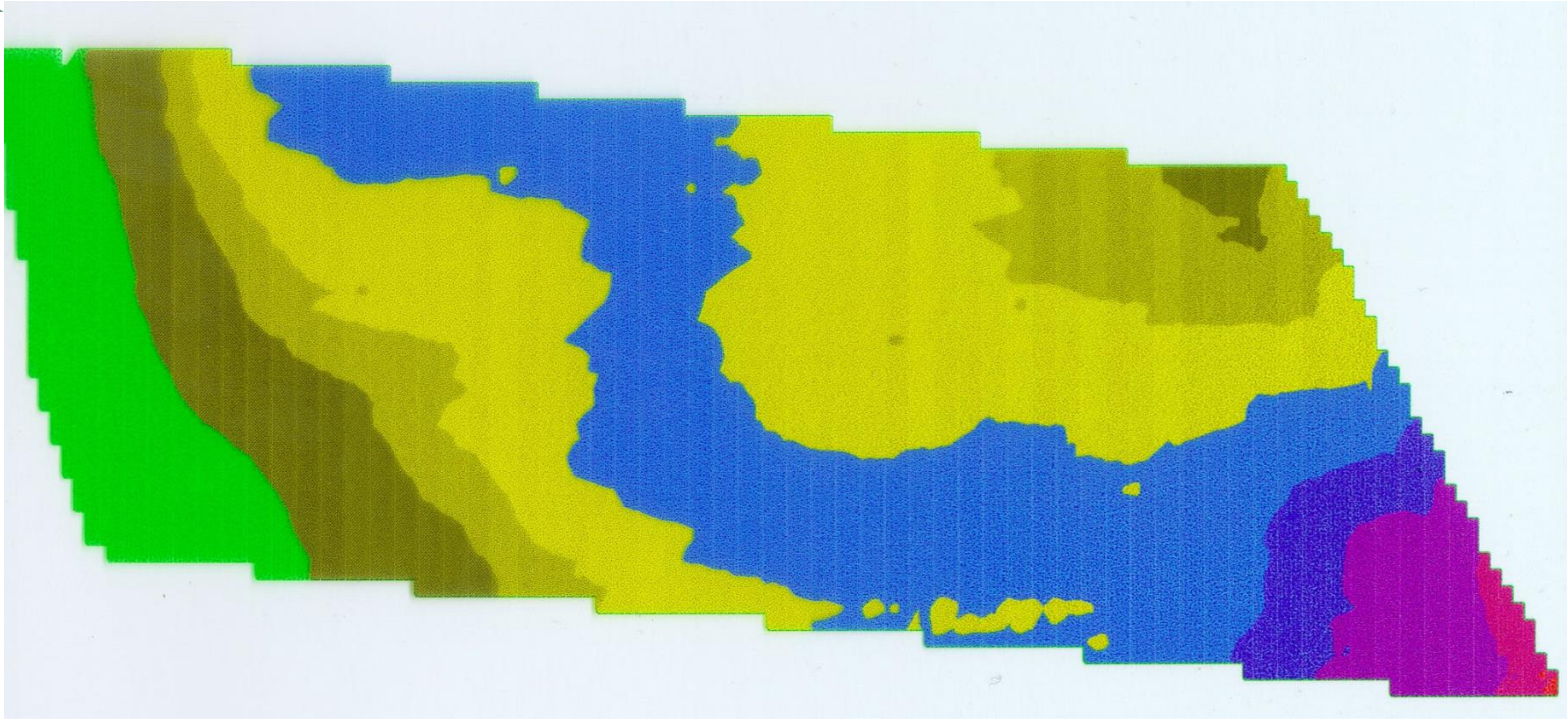




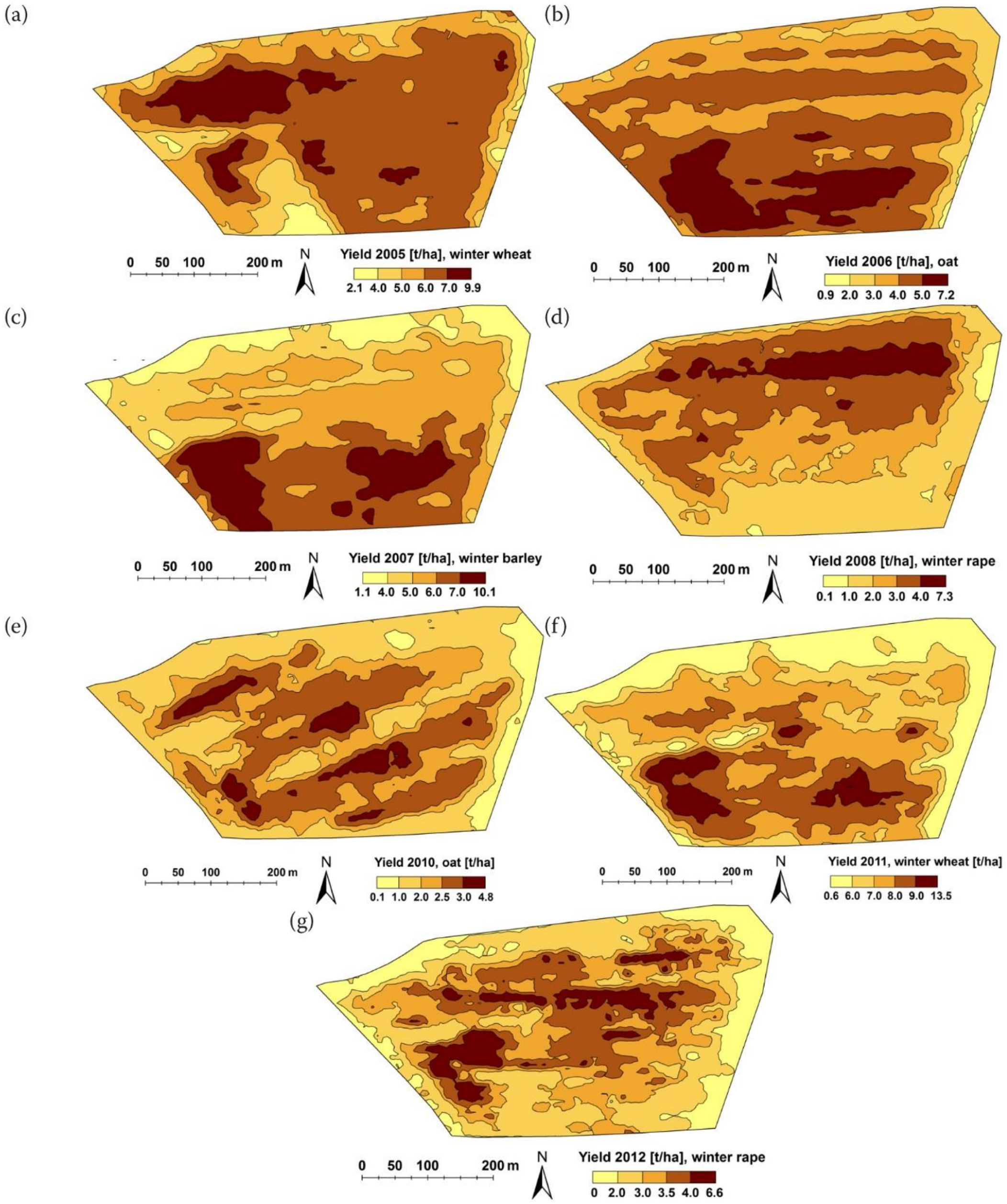
Yield map obtained during spring barley harvest. Field area 50 ha. Uniformly managed field. Differences in yield commonly 50%. Red areas – 8 t/ha, yellow areas 4 t/ha.



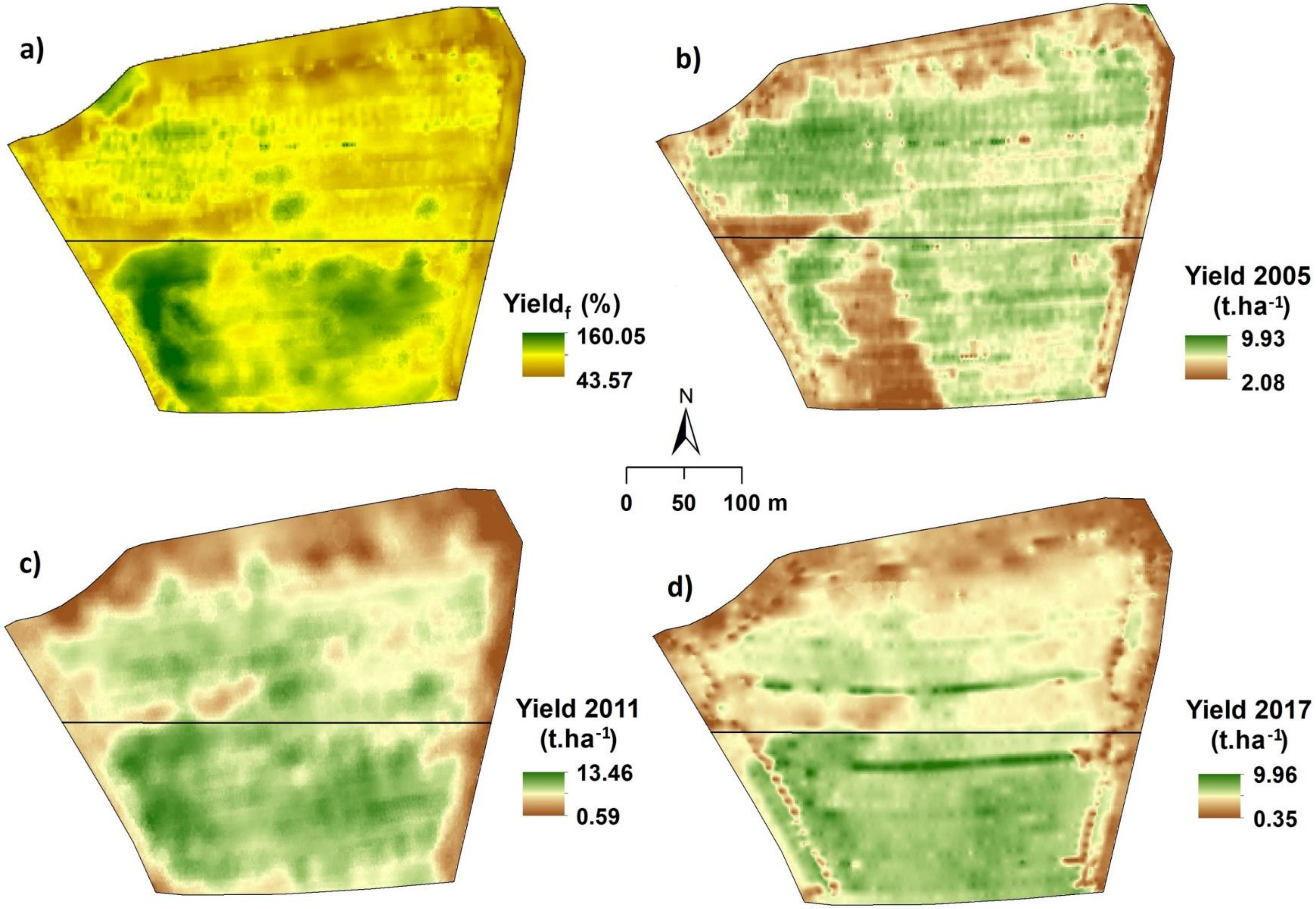
Moisture map from the same field and harvest. Red areas about 14% of grain moisture content, yellow about 12%. Field was harvested during two days and crop gradually dried up.



Field elevation map can be also obtained from yield mapping system. Geographic coordinates are measured in 3D system. Altitude measurement accuracy is worse than positioning, but sufficient for most cases.



Yield development in years on one field. Crop rotation: 2005-winter wheat, 2006-oat, 2007-winter barely, 2008-winter rape, 2010-oat, 2011-winter wheat, 2012 winter rape.



Yield frequency map and measured yields of winter wheat (2005, 2011) and spring wheat (2017).

Thank you very much for your attention!

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<u>Important note:</u> List of used literature is available in separate file.