

# Analyse of real and simulated tractrix of modern agricultural machines

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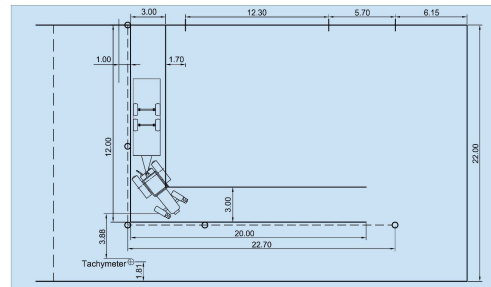
The study analyses the precision of simulated tractrix curves of modern agricultural machines and reviews the possibility of using tractrix simulations to estimate bend dimensions of agricultural paths. In order to verify that the tractrix simulation is accurate enough, real tractrixes of five modern agricultural machines are examined in an experiment and afterwards they are compared to the simulated tractrix.

## Question



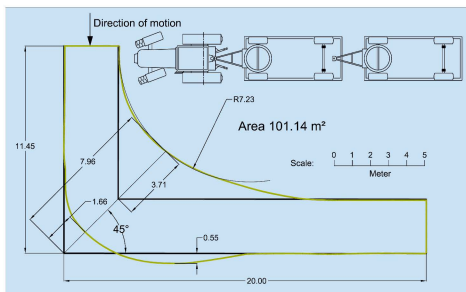
The width and the length of agricultural machines have extremely risen in the last years. Country lanes are still dimensioned on the size of the machines of 40 years ago. This can lead to problems especially in the curves.

## Material and Methods

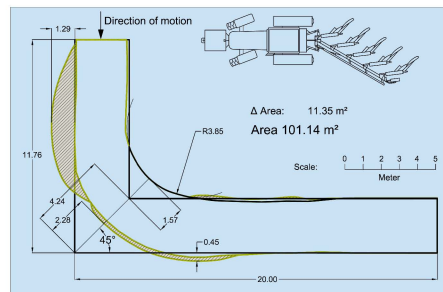


**The machines under examination are:** an four-wheel-drive tractor with a frontweight and a 5-furrow reversing plough, an all-wheel-drive tractor with a tandem-axle trailer, an all-wheel-drive tractor with two pony trailers, a sugar beet harvester and a harvester with a cutterbar-trailer. These machines had to drive a 90° curve which corresponds to the current construction standard for country lanes. Once the machines drove through the experiment, the drive lines are digitized into a CAD-software where the data are processed. The digital tractrix curves are prepared in three different variations. The first variation shows the overrun areas, the second shows the coated areas and the third compares both of them.

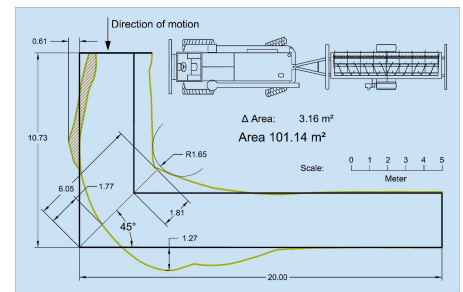
## Results



The curve intersection line was used as comparative measurement of the tractrices, being based on the length of the bisectors from the point of intersection of both outer edges of the road through to the inner tractrix line. These curve intersections measured 2.67 m for the tractor with plough, 7.72 m for tractor with tandem trailer, 8.41 m for the agricultural trailer combination, 6.69 m for the beet harvester and 7.40 m for the combine harvester.



In recording the tractrices, the track followed by the running gear, as well as the total area required for the maneuver, were represented. The difference between the roadway required and the total maneuvering area was determined and represented, e.g. for the combine harvester 3.21 %, for the tractor with plough 12.33 % and 21.25 % for the beet harvester.



The simulated vehicles had the same curve behavior as their real counterparts, covering the same running gear tracks and overhang areas in almost the same way as the vehicles in reality. However, differences were recorded. For instance the four-wheel-drive tractor with reversible plough and front-mounted weights showed a difference of 5.62 %, the largest difference recorded in the trial.

## Discussion

The comparisons of simulated and real tractrices show that simulation software can depict tractrices for agricultural machinery with sufficient accuracy. In the planning of field access roads the area requirement for maneuvering by the overhanging parts of machinery or attached implements can be simulated so that the location and size of this extra space, as well as that for the running gear tracks, can be determined. In this way provision can be made beforehand for sufficiently dimensioned load-bearing roadways and the right amount of additional free space overhangs for vehicle combination.

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