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MASTER'S THESIS Winter Wheat Harvest Prediction Using Primarily Satellite Radar Data from Sentinel-1
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Predicting Winter Wheat Harvest Using Radar Satellite Data From Sentinel-1

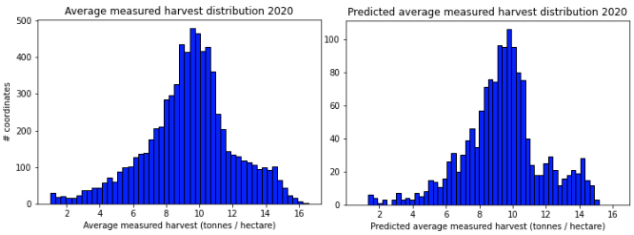
POPULAR SCIENCE ARTICLE **Oliver Persson Bogdanovski, Christoffer Svenningsson**

Agricultural farming is in the midst of a digital revolution where new technology is more frequently used to aid farmers' operations. We have investigated the possibility of using radar data to predict the harvest. Achieving successful predictions is a crucial step in optimizing the harvest.

Farmers have the difficult task of sustainably producing enough food for the world. Without new innovation, farmers would need to cultivate more and more land to produce more food, at the expense of our precious ecosystems and their wallets. Information technology may help in the farmers' pursuit, giving accurate information about their crops and aiding them in their operations and decision-making process. Precise harvest estimation (or *prediction*) can be advantageous for farmers. Suppose farmers could know how much harvest they are expecting early in the season. With this estimate, farmers can then adapt their operations, and better utilize their resources, time, and money.

Our work shows that satellite radar data contains valuable information for winter wheat harvest prediction from fields in Skåne. We used this data and data regarding weather, topology, and elevation to create models using machine learning. The best model could predict harvest within an average root mean squared error of 0.89 tonnes per hectare (an area of 100×100 m^2).

The figure shows the true harvest distribution accompanied by the distribution that our model predicts. Note how the predictions roughly capture the shape of the true distribution.



There still exist several challenges that need to be tackled before the operational use of our models. Firstly, our models work well on data from one year but have poor performance if you try to estimate the harvest of the next year. We found that this is due to the changing nature of the harvest distribution from year to year. A way of mitigating this problem, which should be investigated further, is to model the next year's harvest distribution given previous years' distributions and other auxiliary data.

Furthermore, we believe that satellite radar data from Sentinel-1 combined with satellite optical imagery from Sentinel-2 have the potential of achieving more accurate estimates than using just either of the two. The reason for this is that they are fundamentally distinct signals and potentially carry unique information valuable for harvest prediction.