Synergetic Use of Sentinel-1 and Sentinel-2 data for Wheat Crop Height Monitoring Using Machine Learning

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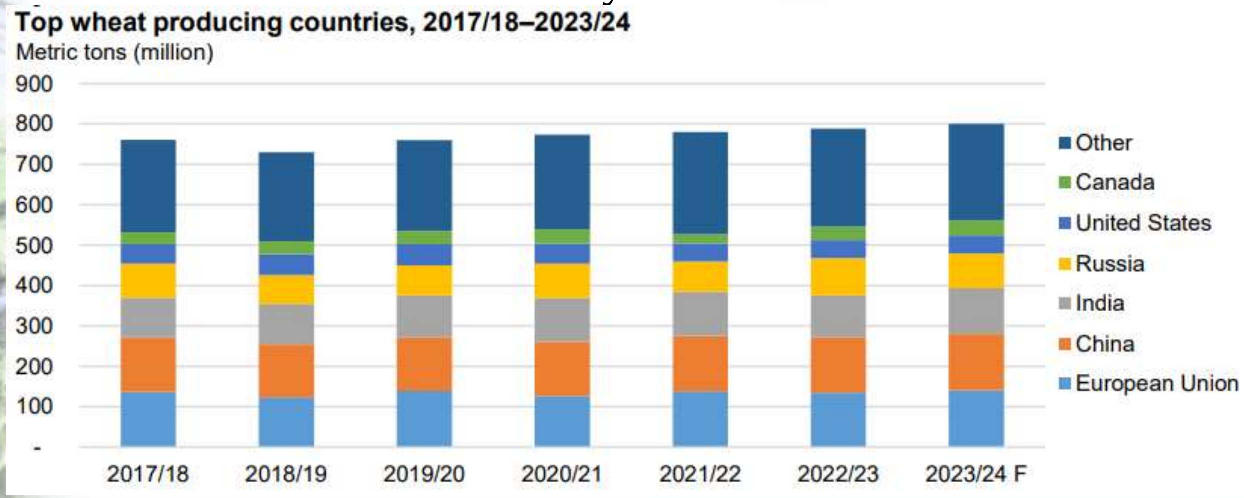
AGRICULTURAL RESEARCH COUNCIL

Outline

- Wheat Crop
- Study Area
- Methods
- Results and Discussion
- Conclusion and Future Research
- Project Information

Wheat Crop

- Millions of people depend on wheat crop
- Supply is affected by climate, global geopolitics, etc.
- Increase in basic food prices affects food security
- Sentinel-1&2 can contribute towards wheat crop management, thus towards food security



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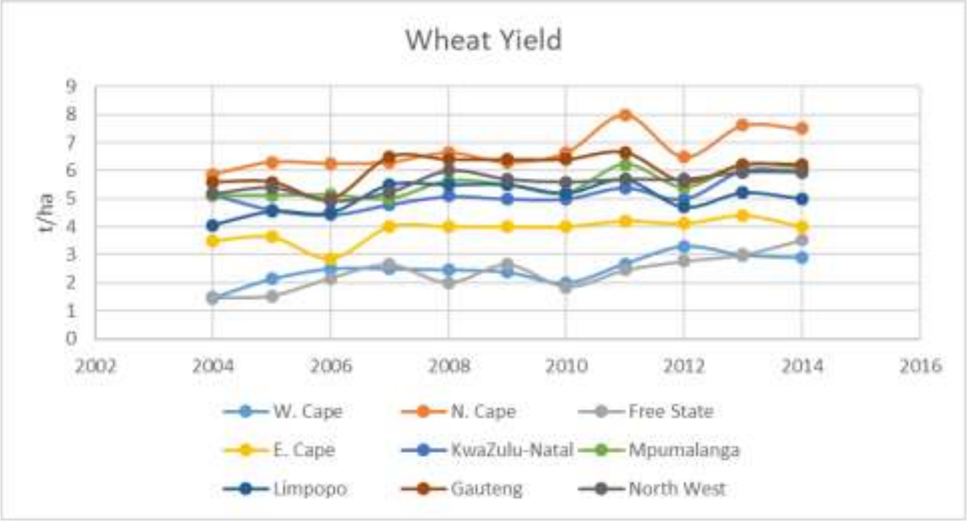
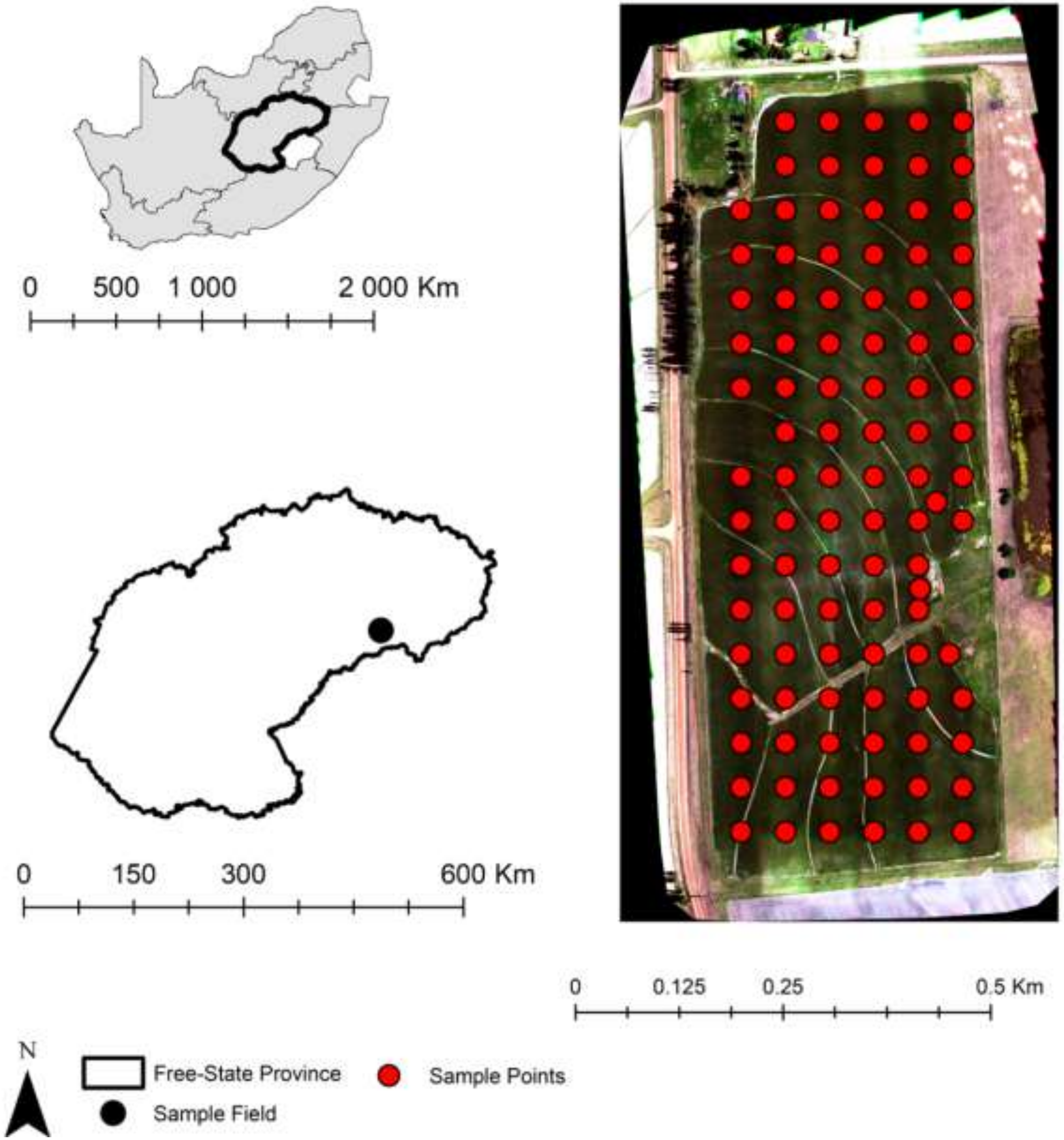


Study Area

- Site is in Clarens, within Thabo Mofutsanyane district in Free State Province
- The site receives an annual average rainfall of 688 mm
- Minimum and maximum of 7.8- and 20.7-degree Celsius average temperatures during the winter and summer seasons respectively

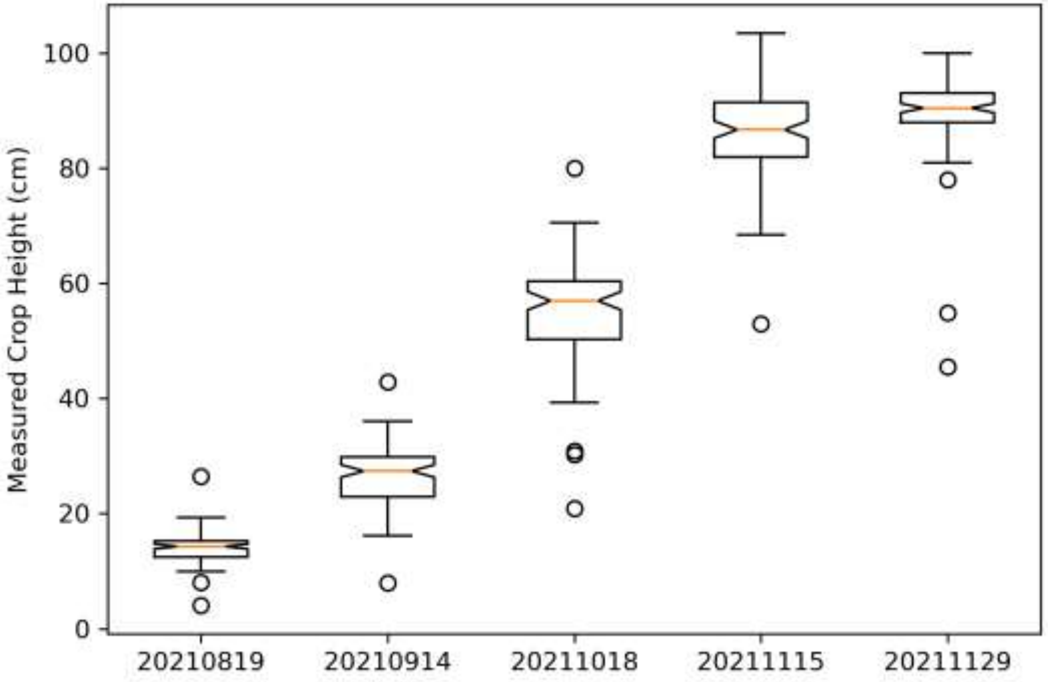
Table 1: Phenological stages of the wheat crop

Phenological Stages	Dates	Activity
Seeding	2021/07/02	Planting
Early germination	2021/08/19	Sentinel-l-&-2
Early Development	2021/09/14	Sentinel-l-&-2
Late Development	2021/10/18	Sentinel-l-&-2
Maturity Stage	2021/11/15	Sentinel-l-&-2
Senescence	2021/11/29	Sentinel-l-&-2



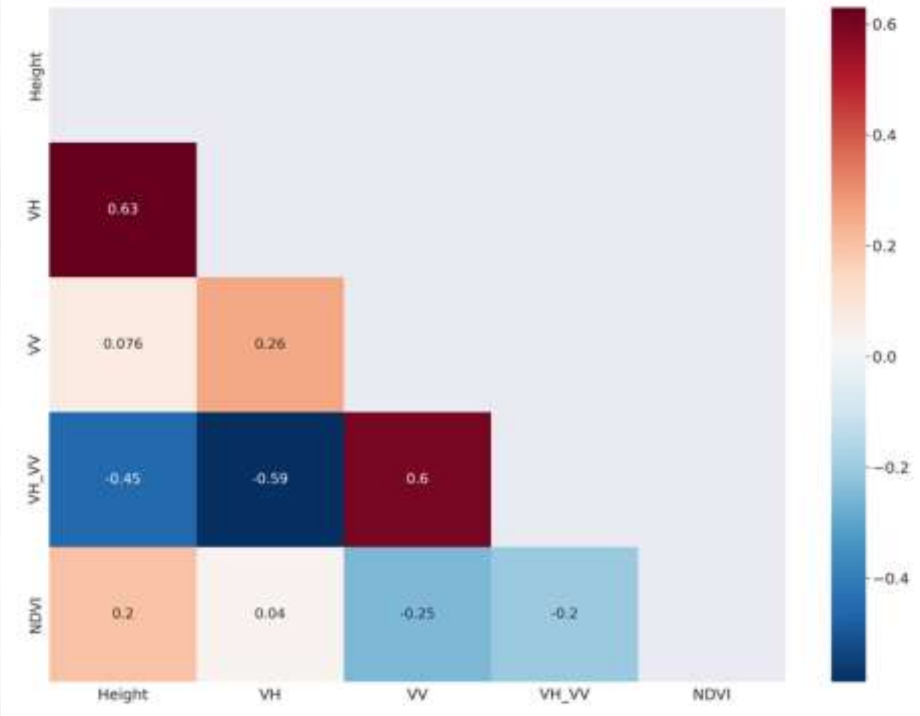
Method

- **Goal:**
  - Generate simple and usable model but accurate
- **Variables**:
  - Sentinel-2
    - NDVI
  - Sentinel-1
    - VH & VV
    - VH/VV
  - Measured height (cm)
    - N=100
- **Models**:
  - Random Forest (RF)
  - Support Vector Machine (SVM)
- **Validation:**
  - 70%-training and 30%-validation data split
  - 5-fold cross validation
  - RMSE
  - R-squared



Results and Discussion

Correlation matrix

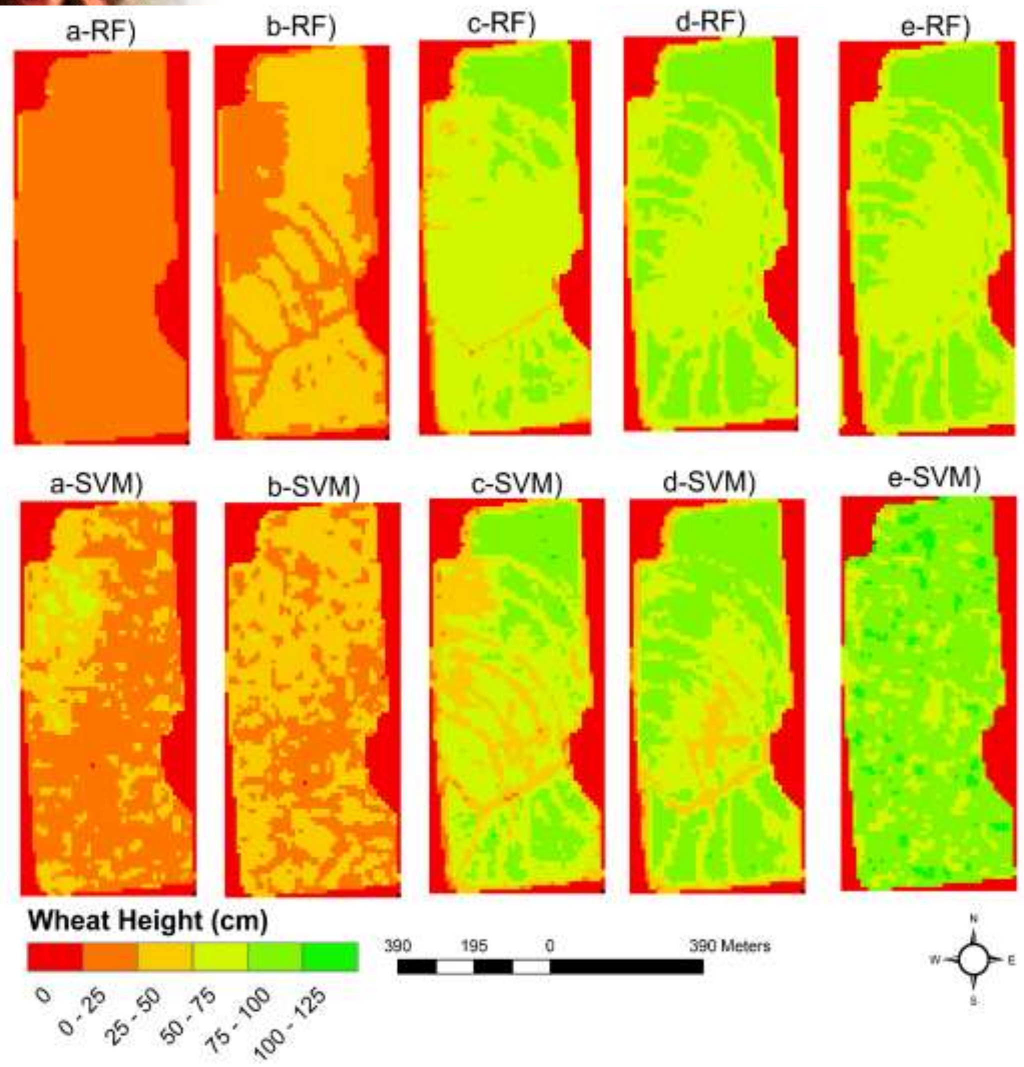


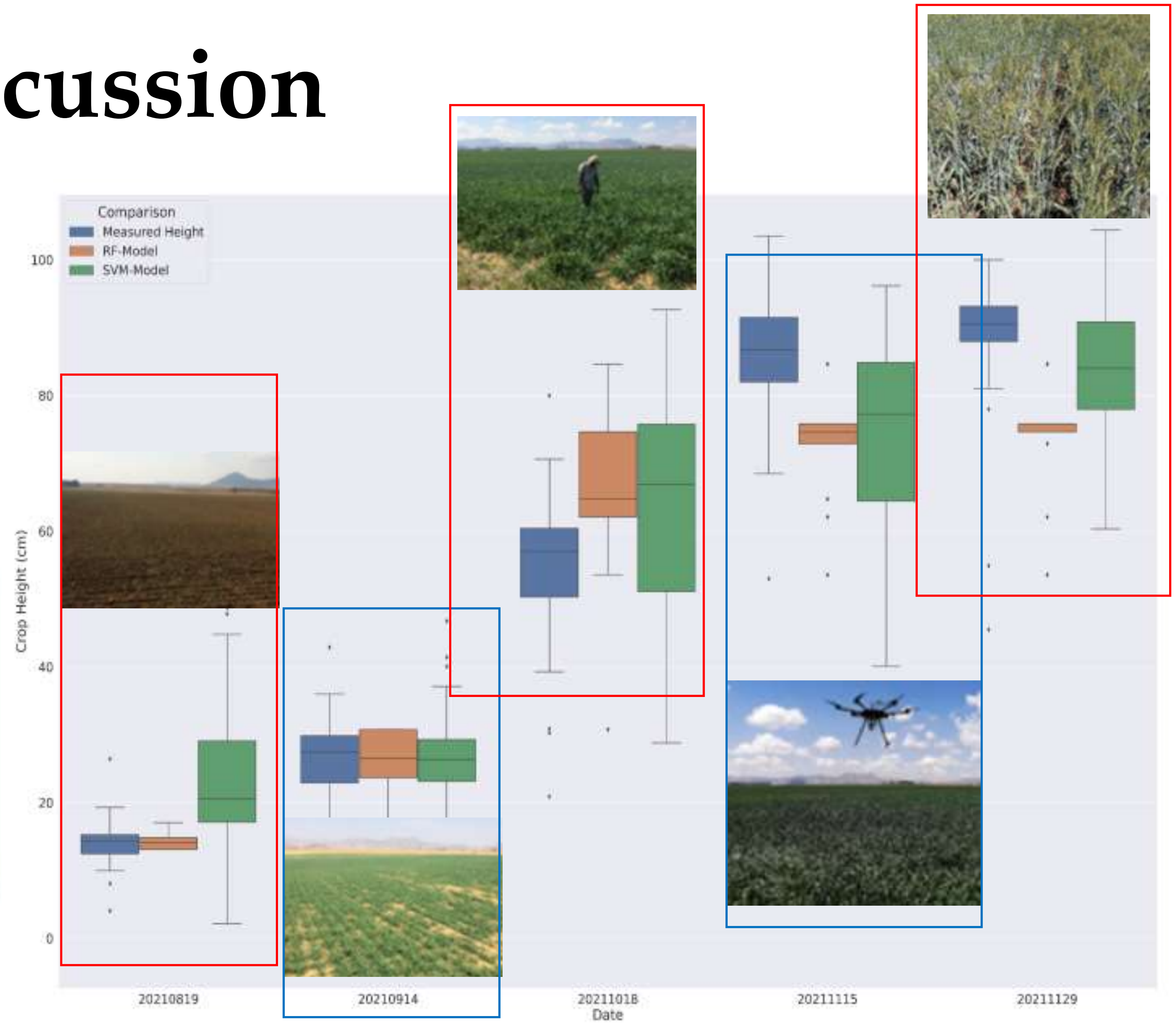
Mean values during crop stages

Model performance

	Sentinel-1		Sentinel-1+Sentinel-2 NDVI	
Methods	R2	RMSE (cm)	R2	RMSE (cm)
SVM	0.40	24.246	0.74	16.075
RF	0.35	25.334	0.84	12.58

Results and Discussion





Conclusion and Future Research

- Sentinel-1&2 datasets have proven to be very useful in modelling wheat height during different crop stages

- Farmers can benefit from such product in monitoring and managing their investments

- Models of different crops should be developed to assist more farmers





Project Information

- Collect muti-temporal UAV datasets of different crops and develop models to generate level 3 products and upscale to satellite-level
- Funded by CSIR and DSI in 2021/22/23 FY
- Different crops: maize, wheat were collected.
- More crops to be added in the future
- Two PhD students: Mrs Colette de Villiers and Mr Lwandile Nduku

Current research output