

National scale agricultural dynamics in Saudi Arabia since 1990 using machine learning

Introduction

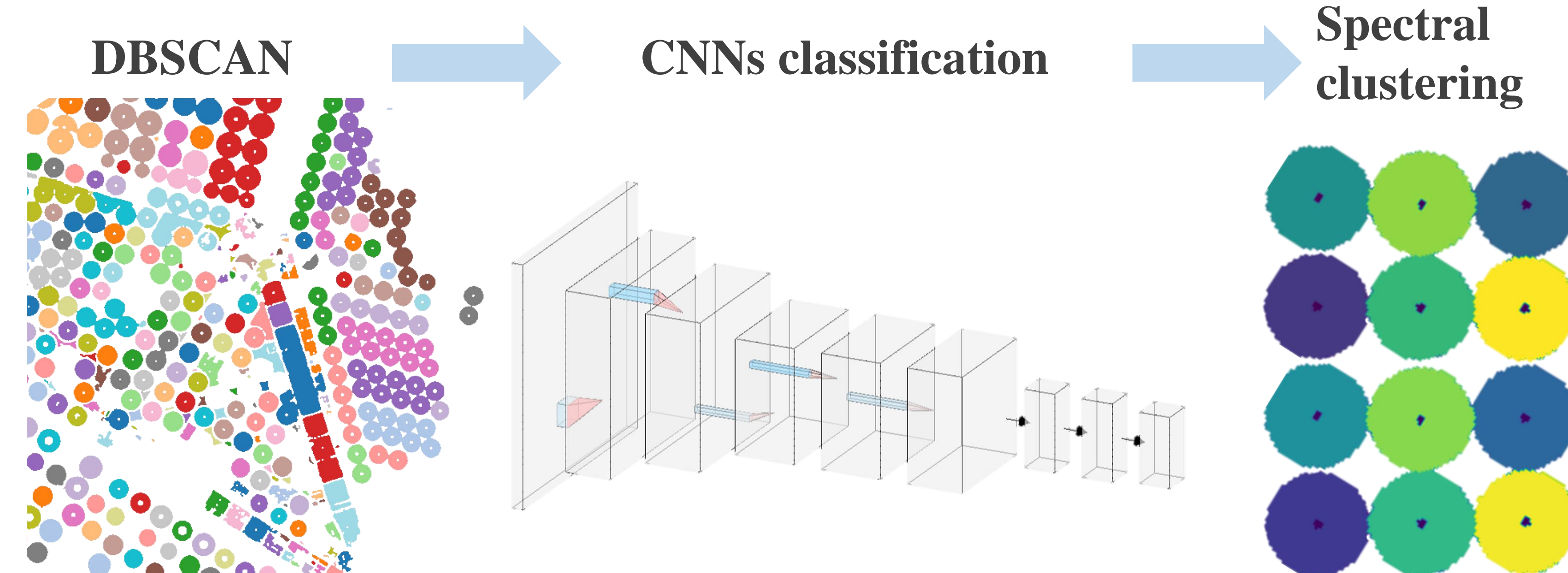
The agricultural sector in Saudi Arabia has undergone significant changes since the 1970s, largely due to policy initiatives aimed at improving food security through the construction of numerous center-pivot irrigation fields. However, the dynamics of these changes remain poorly understood. To address this knowledge gap, we employed a hybrid machine learning framework to investigate the multi-decadal evolution of agricultural development in Saudi Arabia, with a particular focus on quantifying the number, acreage, and size distribution of center-pivot fields.

Methodology

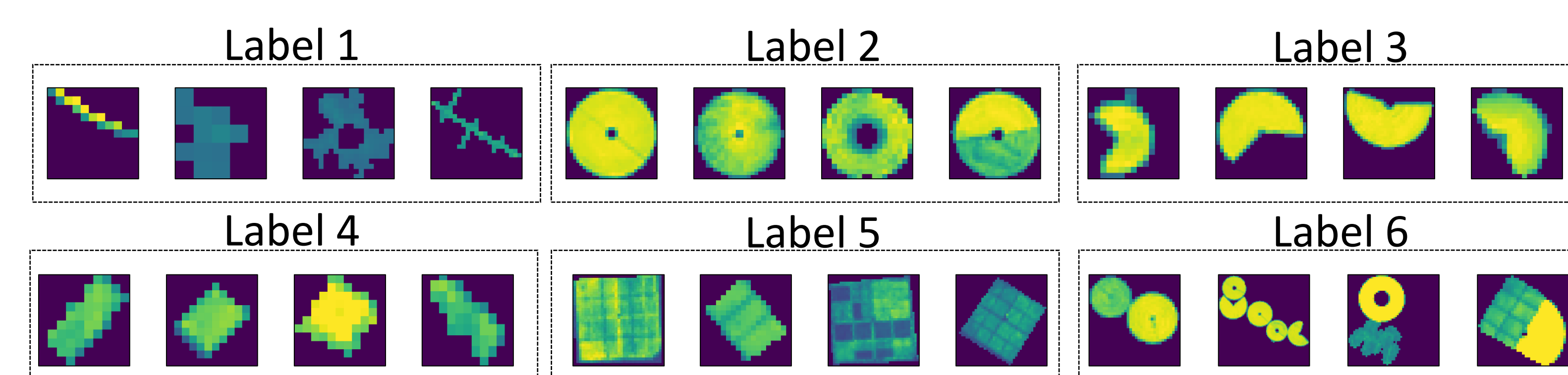
DBSCAN was implemented to cluster pixels on an annual maximum NDVI map collected from Landsat imagery into field candidates. CNN classification was then implemented to identify if a field candidate consisted of multiple fields or only a single field. Spectral clustering was lastly implemented to cluster field candidates consisting of multiple fields into individual fields.



Center-pivot fields presenting different shapes and size



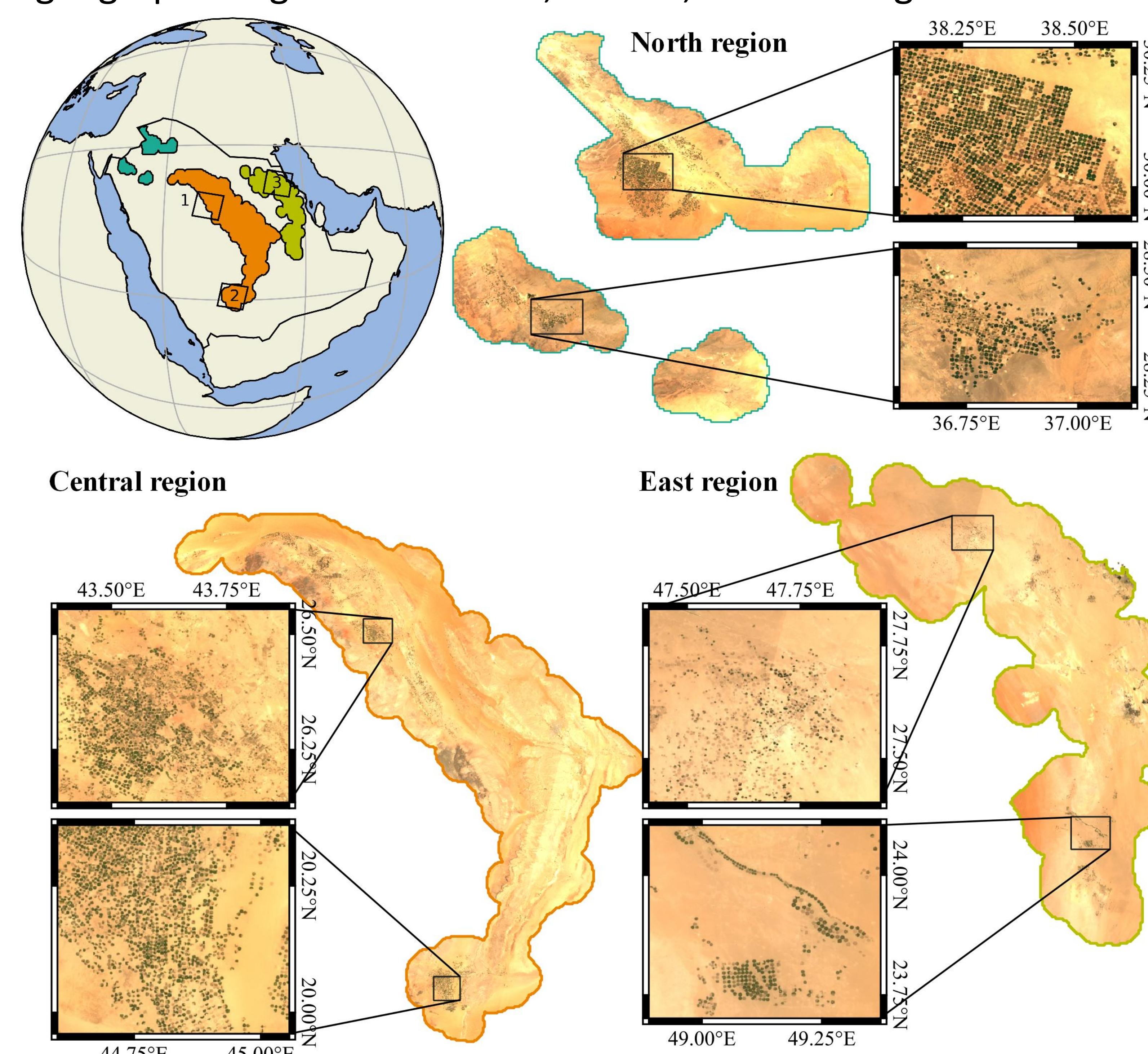
Schematic of the approach for delineating center-pivot fields with different colors in DBSCAN and spectral clustering representing different field candidates



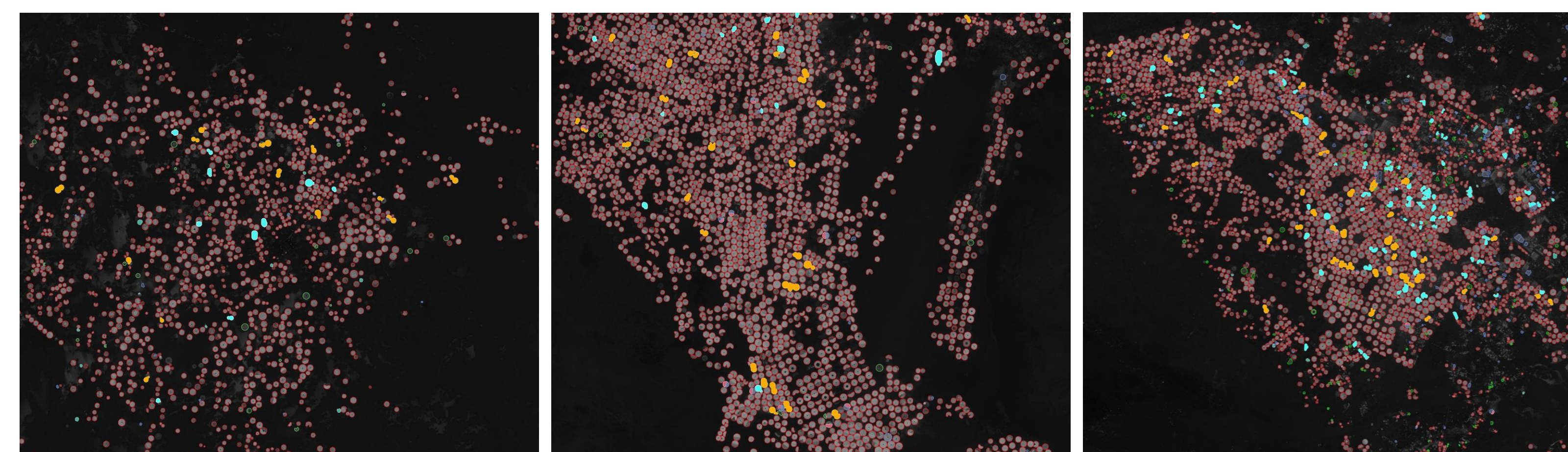
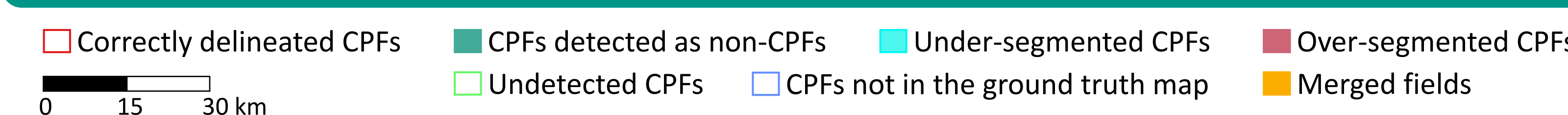
Labels to train the CNNs classification model

Agricultural regions in Saudi Arabia

The primary agricultural regions in Saudi Arabia are distributed in Al Jawf, Tabuk, Ha'il, Al Qassim, Riyadh, Wadi ad-Dawasir, and the Eastern Province. These regions were classified into three major geographic regions: the north, central, and east regions.

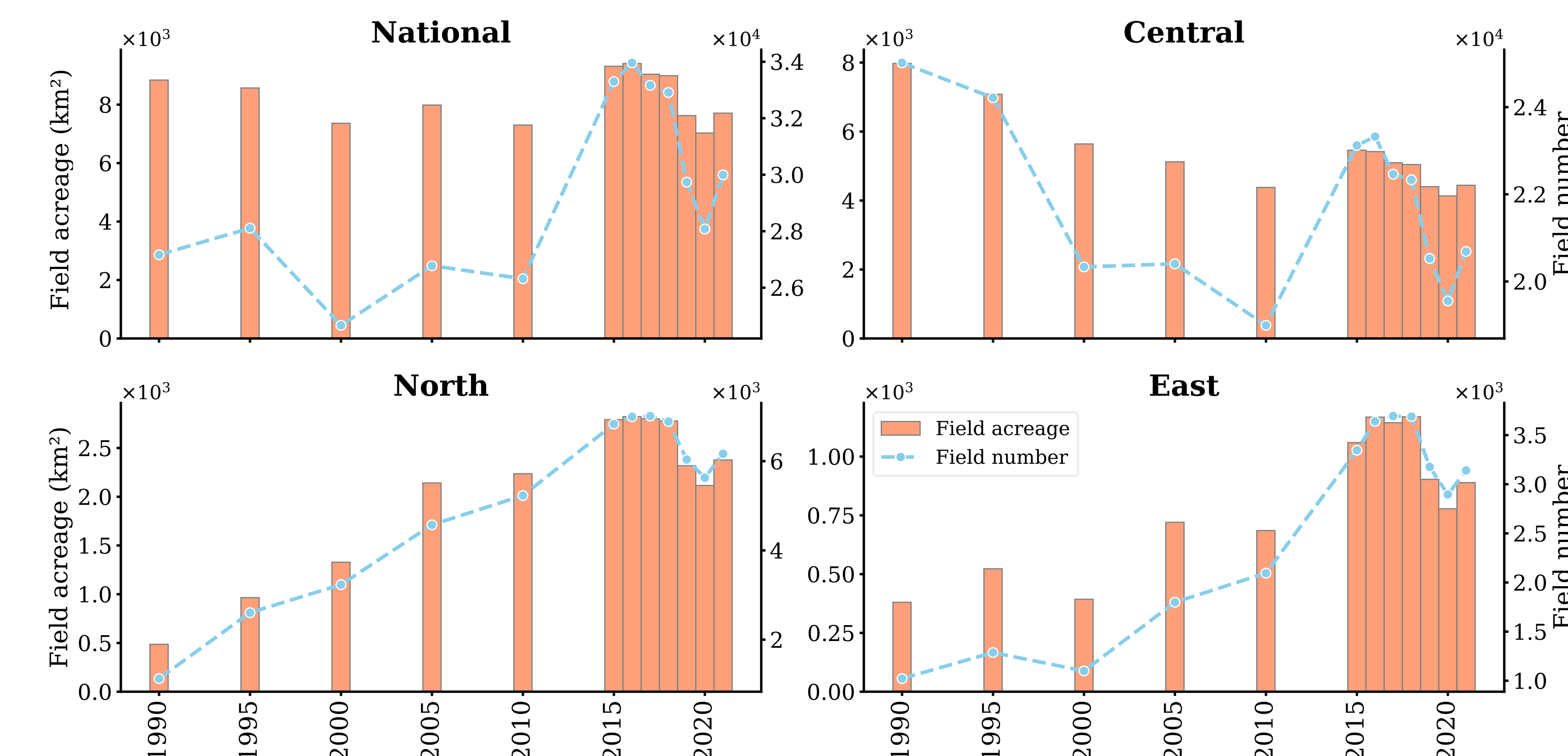


Evaluation of the framework

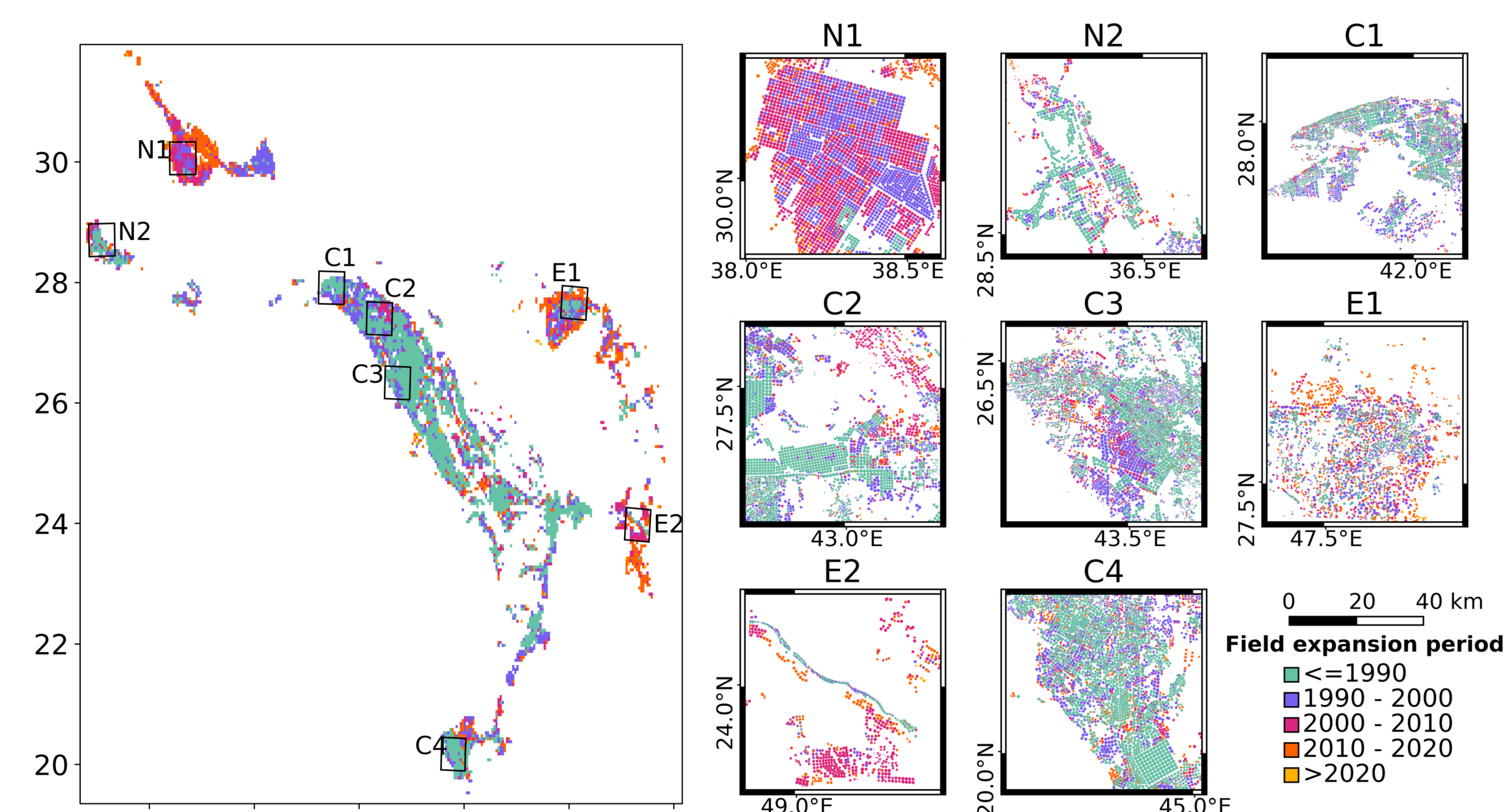


	Qaryat Al Ulya			Wadi ad-Dawasir			Al Qassim		
	2000	2010	2015	2000	2010	2015	2000	2010	2015
Producer's accuracy	89.7%	90.3%	93.7%	94.5%	92.4%	94.8%	83.7%	84.8%	86.8%
User's accuracy	96.7%	96.3%	97.9%	97.0%	95.3%	95.9%	90.2%	93.0%	91.0%

Results



The acreage (left y-axis related to bars) and number (right y-axis related to dashed lines) of center-pivot fields from 1990 to 2021



Field expansion map showing the year a field was initialized

Socio-political drivers

The gradual decrease between 1990 to 2010 was related to policy initiatives designed to phase-out wheat, while increases between 2010 to 2015 were linked to fodder crop expansion. The decrease after 2016 was due to the National Water Strategy implemented that year to promote sustainable development in line with Saudi Vision 2030. There is recent evidence of a potential increase in agricultural land in 2021 and 2022, likely due to global events such as the COVID-19 pandemic or the conflict in Ukraine.