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## Temporal dynamics of subsoil compaction risks in Sweden under a seasonal perspective

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Soil compaction poses significant challenges to agricultural productivity worldwide, with Sweden being particularly vulnerable due to its heavy machinery usage and moist soil conditions. Negative effects of compaction may persist for decades, especially in case of subsoil compaction. This risk is anticipated to escalate as agricultural machinery continues to grow heavier. The temporal variability in soil compaction risk, influenced by seasonal changes in weather, crops, and machinery, is often overlooked but is crucial for optimizing crop rotations and machinery use to reduce the negative impacts of field traffic. This study aims to evaluate the seasonal variability of subsoil compaction risks in major cropping areas of Sweden. We integrated data from in situ soil moisture monitoring from selected representative fields with precompression stress data to examine the seasonal dynamics of soil strength throughout a growing season. By combining variations in soil strength and estimated soil stress for different machinery, we conducted a seasonal evaluation of subsoil compaction risk. We evaluated which field operation pose the highest risk of subsoil compaction and examined how this varies across different regions in Sweden. We examine compaction risks during tillage and show that conventional in-furrow ploughing is an overlooked risk of subsoil compaction. By using historical machinery data, we show how “windows of opportunity” (i.e., periods with low compaction risks) have become smaller and how the critical field operation causing subsoil compaction has shifted over time. The findings underscore the growing challenge of subsoil compaction and highlight the need for developing targeted management strategies to mitigate its impacts.