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Fifty years of sustainable no-tillage agriculture in the semi-arid Canadian Prairies

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Agriculture collapsed in the Canadian Prairies during the multi-year drought of 1926-1934. Two changes to local agriculture practice became critical in the recovery of top-soil and agricultural yield. One was abandonment of summer fallow, the other was adoption of no-tillage techniques pioneered in this region. We have obtained soil samples from commercial fields in cereal production (up to one century), from long-term experimental field-plots at research stations, from undisturbed prairies, and from secondary grasslands converted from agriculture. The data provides a chronosequence of fields about 40 years in continuous no-tillage, to contrast against fields in traditional tillage, against secondary grasslands, and undisturbed native prairie. For all samples, we measured free-living nitrogen fixation capacity (15N) in the laboratory, aggregate size distribution, microbial nitrogen fixing community (*nif* gene), and both bacteria (16S DNA) and eukaryote (18S DNA) diversity. We reconstructed eukaryote community structure and food web structure for the fields. Our results indicate that despite decades of continuous no-tillage, free-living nitrogen fixing capacity remains far below undisturbed prairies, but improved from ploughed fields. Soil aggregate size distribution remains lower in continuous no-tillage, but grasslands contain more larger-sized aggregates enabling more nitrogen fixation. Biodiversity indices follow a pattern of reduced diversity with increased disturbance from agriculture. Biodiversity improves with years into no-tillage or abandonment to secondary grasslands. Overall, we had anticipated a greater recovery of biodiversity, food web complexity, and of free-living nitrogen fixation in decades old continuous no-tillage fields, compared to continuous tillage. Nonetheless, the region of Canadian prairies in no-tillage has been resilient to cyclical droughts, and has accumulated soil organic carbon since adoption of no-tillage. The results are significant because about 95% of the area in cereal crops (~10 million Ha) is in no-tillage, and significant soil organic matter has accumulated in the agroecosystem to contribute to carbon storage to mitigate climate change.