



Assessing crop sequence diversity and agronomic quality in grassland regions

Noé Vandevoorde^{*}, Philippe V. Baret

SYTRA, Earth and Life Institute—Agronomy, Université catholique de Louvain (UCLouvain), Louvain-la-Neuve, Belgium

ARTICLE INFO

Keywords:

Crop rotation
Crop sequence
Agro-environmental indicator
Temporary grassland
IACS

ABSTRACT

Industrial inputs have replaced crop rotations for fertility and pest management in input-intensive agriculture, resulting in a high number of crop sequence permutations and negative impacts on ecosystems and human health. Strengthening diversified and agronomically optimised crop sequences is critical to promoting sustainable practices. Comprehensive crop sequence diagnosis methods play an important role in evaluating and improving current crop sequence practices. However, recent literature has focused on annual crops, leading to biased results in crop sequence analysis for organic farming and livestock regions, where multiannual temporary fodder crops are a key aspect of crop sequences. This paper extends two methods of crop sequence analysis by including multiannual temporary fodder crops. By applying these generalised methods to a case study in the beef grassland regions of Belgium, using IACS crop data from 2015 to 2020, we reveal significant differences in the agronomic quality of the crop sequences across the territory and between organic and non-organic fields. In contrast to the existing literature, the inclusion of multiannual temporary fodder crops highlights the prevalence of high diversity and high agronomic quality sequences in livestock farming regions. Maize monoculture (of low agronomic quality), temporary grasslands (associated with high quality crop sequences) and organic certification are the main drivers of crop sequence quality in the regions studied.

1. Introduction

While mixed crop-livestock farming with crop rotations was dominant in pre-war Europe (Mazoyer and Roudart, 2017), industrial inputs have gradually replaced rotations for fertility and pest management during the agricultural intensification of the past century (Stone, 2022). Together with the mechanisation of production processes and genetic improvement, this intensification led to shorter rotations and monocultures (Barbieri et al., 2017; Bullock, 1992; Wijnands, 1997). Overall, this has resulted in agricultural production becoming dependent on a limited number of high-yielding, lucrative crops (Khouri et al., 2014), with crop choices being driven more by policy and market incentives than by agronomic requirements (Song et al., 2021).

The high-input agricultural systems stemming from this intensification have been recognised as unsustainable for more than six decades (Carson, 1962; Cleaver, 1972; Meadows et al., 1972; Paddock, 1970). Despite this, they remain widespread in developed countries (van der Ploeg, 2018). They have been associated with global negative externalities, such as biodiversity loss and reduced ecosystem services

(Leenhardt et al., 2023), as well as high social costs and food insecurity in both developed and developing countries (Alliot et al., 2022; Rasmussen et al., 2018). In response, the European Union's Common Agricultural Policy (CAP) is progressively implementing sustainability objectives (Directive 2009/128/EC of the European Parliament and of the Council, 2009; Regulation (EU) No 1307/2013 of the European Parliament and of the Council, 2013). Among these, Integrated Pest Management (IPM) practices favour diversified and agronomically optimised crop rotations to reduce the use of synthetic inputs such as fertilisers or pesticides, directly mitigating the negative externalities of high-input cropping systems (Francis and Clegg, 1990).

In its broadest sense, crop rotation refers to the agricultural practice of growing a cyclic succession of crops of different types on a single field over several seasons. This practice differs from monoculture where the same crop is grown repeatedly over the years. Crop rotations have many agronomic benefits due to the temporal diversity of the crops grown in the field. These include (Selim, 2019): (1) breaking pest/weed cycles (e.g., Curl, 1963; Liebman and Dyck, 1993; Médiène et al., 2011; Puliga et al., 2021); (2) allelopathic suppression of pests/weeds (e.g., Farooq

Abbreviations: CDT, crop diversity type; CSI, crop sequence indicator.

^{*} Correspondence to: UCL/ELI/ELIA/SYTRA, Croix du Sud 2/L7.05.14, 1348 Louvain-la-Neuve, Belgium.

E-mail address: noe.vandevoorde@uclouvain.be (N. Vandevoorde).