Optimising productivity of silvoarable agroforestry systems in the temperate zone: screening crop species and varieties in an artificial shade experiment.

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Abstract
To further increase the adoption of silvoarable agroforestry in Europe, system optimisation to improve productivity and performance at field level is key. This encompasses e.g., improved tree-crop combinations, selection of adapted crop and tree varieties, smart design and proper management of trees and tree rows. In North-Western Europe, light is likely to be the principal limiting resource for understorey crops, and most agronomic studies show a systematic reduction of final yield as shade increases (Artru et al. 2017, Pardon et al. 2018). Whereas this effect itself has been thoroughly assessed in previous research for a range of arable crop species and both through empirical studies and modelling work (Dufour et al. 2013, Artru et al. 2017, Pardon et al. 2018, Dupraz et al. 2019), more work remains to be done on gaining practical insights in how to adapt agroforestry system composition to reduce this negative effect of shading. One important aspect in this quest, is the selection of adapted crop species and varieties (Arenas-Corraliza et al. 2021). Context specific climate conditions but also other aspects such as soil conditions, nutrient availability, pest and disease risks need to be considered in this search for adapted varieties.
Thereto, in 2021, ILVO together with Inagro and Praktijkpunt Landbouw Vlaams-Brabant set up a program to start field screening of crop species, varieties and mixtures for agroforestry conditions typical for Belgium. In a long-term experimental setup, we have installed an artificial shade construction at a long term research site, mimicking a mature agroforestry system through the use of military camouflage netting to provide discontinuous light through the day (based on Artru et al. 2017). The construction is made of vertical concrete poles (representing the tree stems) with a height of 3,5m and with a metal crossbeam of 3m long attached on the top of the poles. These poles are installed in a straight row of 110m on the field, approximately North-South oriented, with a spacing of 5m between the individual poles and with the camouflage netting fixed on top of the crossbeams (see Fig. 1a). In the alleys East and West from this construction, nine crop plots of 12m long (along the row of poles) and 12m wide

(perpendicular to the row of poles) are installed, enabling us to have three crop treatments in three replicates per season (see Fig. 1b).
The light reduction is monitored at six positions in the field, i.e., at 2, 4 and 8m East and West from the row of poles, using pyranometers (type SP-110, Apogee Instruments). At the same positions, also air humidity and temperature (type CS215, Campbell Scientific), soil water content (CS616, Campbell Scientific), soil temperature (type 107, Campbell Scientific) and soil water potential (type Teros21, Meter Group) are assessed.
Hence, starting from the growth season of 2022, we will evaluate the impact of the partial shade conditions on crop productivity for a range of well-selected crop varieties, and with a focus on cereals (wheat, barley and/or triticale), grasses or grass-clover mixtures, as well as leguminous crops (e.g., soybean). First methodological experiences and the trial with grass-clover mixtures currently in place will be presented at the EURAF 2022 conference.

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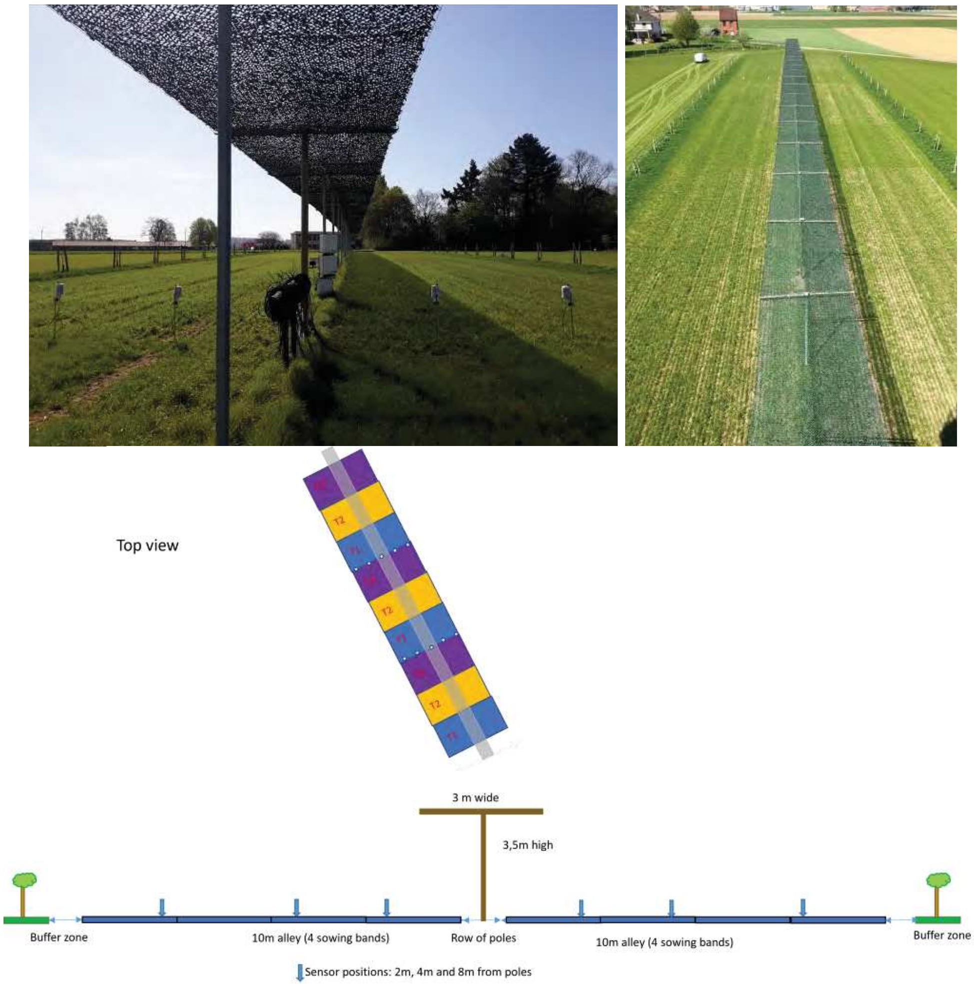

Figure 1. Artificial shade construction at the ILVO experimental site (Merelbeke, Belgium). Top: Field view with three treatments of grass-clover mixtures in the understorey crop Bottom: Experimental design showing the shade structure (grey bar) and the crop plots with their respective treatments.