# Materials and Methods

## Field management

This study was conducted within a larger experiment which was established in 2002 on a sandy loam near Flakkebjerg, Denmark (55.317, 11.400). In total, the experimental footprint covered XX ha. Averaged across the site, soil texture was 14.7% clay (<2 mm), 13.7% silt (2-20 mm), 42.6% fine sand (20-200 mm), and 27% coarse sand (200-2000 mm), with 1.2% organic carbon content (0-25 cm).

Weather data was obtained from the Danish Meteorological Institute's (DMI) Open Data API for the Flakkebjerg station (55.322, 11.388). The 30-year (1990-2020) mean annual temperature and precipitation for the site are 8.9 degrees Celsius and 589 mm, respectively.

The experimental design was a split-split plot with four replications. The main plot factor was straw management (remove or retain). Subplots consisted of three randomly assigned tillage treatments within each main plot. Subplots were 5 meters wide and 40 m long. Each tillage sub-plot was divided into two columns with three sub-subplots arranged within each column for a total of six sub-subplots that were 2.5 m wide and 12.5 m long. One sub-subplot was reserved, resulting in two straw treatments, three tillage treatments, and five cover crop treatments for a total of 30 treatments. A visual aid representing the experiment is available in supplemental material.

The same straw managements and categorical tillage treatments (no tillage, non-inversion tillage, and inversion tillage) have been in the same sub-plots since 2002, but the exact machinery used to achieve each tillage treatment has varied over the years. For the timeframe of the present experiment (2018-2020), non-inversion tillage consisted of one pass of a rotary harrow (Bomford Dyna Drive??) before cash crop sowing to 8–10 cm depth. The inversion tillage treatment consisted of a mold-board plowing to a depth of 20 cm in the late fall, and harrowing to a depth of 3-4 cm before cash crop sowing (ANOTHER paper from CENTS says the inversion plots were harrowed, but that is not included in the management data I received).

Starting in 2018, five cover crop treatments were randomly applied to the sub-subplots (**Table x).** The same sub-subplot treatments were maintained for 2018 and 2019. During those years, the sampling area was located in the inner 1.5 m x 10 m area of the sub-subplots.

Table X. Summary of the five cover crop treatments applied in this experiment

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment name | Cover crop | Seeding rate | Seeding method |
| Mix-early | Grass *(Lolium perenne)* and clover *(Trifolium repens)* mix | 3 kg ha-1 grass + 8 kg clover ha-1 | Sown in 12.5 cm rows at 1 cm depth shortly after cash crop planting |
| Mix-mid | Grass and clover mix | 3 kg ha-1 grass + 8 kg clover ha-1 | How was this planted? |
| Radish-mid | Fodder radish *(Raphanus sativus)* | 14 kg ha-1 | Broadcast into standing crop |
| Radish-late | Fodder radish | 14 kg ha-1 | Broadcast into harvested crop stubble |
| No CC | - | - | - |

The entire experiment was planted to the same crop in each year: barley (Hordeum xx) in 2018, oats (Avena sativa) in 2019, and faba bean (XX) in 2020. In the no till and non-inversion tillage treatments, crops were sown with a single-disc drill (Gaspardo Scan-Seeder DP300). In the inversion-tillage treatments, crops were sown with a traditional seed drill (Nordsten Lift-omatic CLH300). Barley and oats were sown in 17.5 cm spaced rows, and faba beans in 35 cm spaced rows. All treatments received XX fertilizer according to best management practices (I don’t know what happened with N application). Herbicide treatments varied by tillage and cover crop treatment.

The site is non-irrigated, but in 2018 all plots were irrigated with 25 mm of water on XX due to severe drought, which compromised the integrity of the long-term experiment. How was it irrigated, what date.

## Measurements

### Crop yields

Need Bo to fill this out, don’t know how yields were measured (by hand? Using a combine? What area was harvested?)

### Vegetation measurements

Three vegetation measurements were associated with each cover cropping phase (**Table X**). Following the cash crop harvest fall ground cover, fall biomass, and spring weed counts were measured and associated with the 2018 and 2019 cover cropping seasons, respectively.

Table X. Summary of vegetation measurements

|  |  |
| --- | --- |
| **Measurement** | **Units of identification** |
| Fall ground cover (%) | Soil  Cover crop/species (according to treatment)  Other/species or genus (see supplementary material) why are these to Cirsium species, and spring weed counts are only Cirsium arvense? |
| Fall biomass (g m-2) | Cover crop (according to treatment)  Volunteer (according to previous crop)  Other (all other biomass) |
| Spring weed counts (number m-2) | Cirsium arvense  Equisetum arvense  Dicot  Monocot |

Timing of measurements relative to other field activities is presented in **Figure X1**.

A screenshot of a computer

Description automatically generated

Figure X1. Timeline of field activities and sampling events. Non-inversion tillage consisted of…(I’m not sure) early spring harrowing and chisel plowing, inversion tillage of mold-board plow

#### Fall ground cover composition

Ground cover composition was estimated from digital images taken in the fall (9 November 2018 and 1 November 2019) as done in Melander et al. (2013). A 0.5 m2 quadrat was placed in the plot, and an image was taken from a height of XX above the center of the quadrat. Three images were taken in each plot. Each image was subsequently overlaid with a grid consisting of 17 vertical and 17 horizontal lines, resulting in 289 intersections per image. Each intersection was classified as a soil or plant. Plant intersections were identified to the genus or species level (Table X), and classified as ‘cover crop’ or ‘other’, depending on the plot treatment. For example, a *Lolium perenne* intersection was classified as ‘cover crop’ in plots with an *L. perenne*-*Trifolium repens* cover crop mixture, but as ‘other’ in all other plots. Percent coverage of each category in the quadrat was then calculated by dividing the number of touched intersections in that category by 289 intersections.

#### Fall biomass

**Need details from Bo.**

#### Spring weed counts

**Need details from Bo.**