USER MANUAL

Intercropping cereals and legumes to enhance ecosystem services provision

The overall objective of EcoStack is to develop and support ecologically, economically and socially sustainable crop production via enhancement of ecosystem services provision and protection of functional biodiversity.

Practice principles

Adding legume crops in cereal fields aims to increase cultivated diversity. This is one way to enhance ecosystem services provision such as pest regulation, nutrient cycling, nitrogen fixation, soil protection, and supporting higher biodiversity in fields. The additional legume crop may or may not be harvested along with the cereal crop. In EcoStack, research teams focused on growing forage legumes in combination with cereals, harvesting the cereals in summer and leaving the forage legumes in the field longer as a cover crop to support ecosystem services.

Research context

During the EcoStack research project, research teams from the United Kingdom, Serbia, Bulgaria, Sweden, Finland, Bosnia and Herzegovina, France and Spain worked on intercropping cereals with forage legumes, in order to measure the effects of increasing in-plant diversity on aphid colonisation, aphid and natural enemy abundance, and crop performance. These experimentations took place from 2019 to 2022 in farmers' field or on experimental stations in different European pedoclimatic contexts.

Main results

- The addition of forage legumes to cereal crops showed some effects on aphids regulation during the growing season in all countries, but which were often low. Forage legume crop biomass was low at most sites, which was also related to dry weather periods, and might have reduced the potential effect on insect pest regulation by attracting natural enemies to the field.
- Good establishment of the clover mixtures intercropped with cereals is a key point to produce enough biomass and provide the expected ecosystem services during the growing season.
- If the establishment of forage legume intercropped is sufficiently high, e.g. 2 t/ha in France, a dense and homogenous legume cover will result after the cereal harvest, controlling weeds, protecting the soil, and providing up to 50 kg N/ha for the following crop through nitrogen fixation in the soil.

Information on crop production protocol

To be successful with intercropping, we provide some information about time application, machinery and crop type, also based on farmers' experience and feedback.

Machinery and companion crops

Depending on each country's context, different cereal crops and forage legumes were used during EcoStack in on-farm or on-station experiments (Table 1).

Table 1 : List of plants used as companion cropping in cereal fields during EcoStack experiments, and partners involved in the countries.

Country	Crop	Intercropped forage legume
United Kingdom (RRes)	Winter wheat	Mix of berseem clover, white clover and crimson clover
Serbia (FBUB)	Winter wheat	Mix of berseem clover, white clover and crimson clover
Bulgaria (AUPL)	Winter wheat	Mix of berseem clover, white clover and crimson clover
Sweden (SLU)	Spring barley	Mix of berseem clover, white clover and crimson clover
Finland (LUKE)	Spring barley	Mix of berseem clover, white clover and crimson clover
Bosnia & Herzegovina (UBL)	Spring barley	Mix of berseem clover, white clover and crimson clover
France (ISARA)	Winter barley	Mix of berseem clover, white clover and crimson clover
Spain (UB)	Winter wheat	Bur Clover (*Medicago polymorpoha)*

The clover mixture used in several countries was sown at 13 kg/ha, with 5 kg/ha of berseem clover and crimson clover and 3 kg/ha of white clover.

Forage legumes and cereals were sown at the same time, in autumn or spring depending of the cereal type.

Sowing of forage legume required machinery to spread seeds, like a small broadcaster and, if available, one intervention with a harrow to bury seeds. No specific machinery was used. As forage legume crops are small seeds, they should not be sown deep into the soil.

Crop management

Cereal sowing

Figure 1

Cereal harvest

Forage legume sowing

Figure 2

Figure 3: Clover cover crop intercropped with winter barley, after cereal harvest in October (photo: ISARA 2022)

Figure 1 : Clover intercropped with cereal in April (photo: ISARA 2022)
Figure 2 : Intercropping of cereals and clover at harvesting time (photo: ISARA 2022)

Points to pay attention to

Once the forage legumes are sown with the cereals, weeds cannot be controlled mechanically or only with limited application of chemical herbicides.

A minimum density of forage legumes is required to ensure biomass production and enhance ecosystem services provision during the growing season and after cereal harvest. Density and sowing date of legumes must be adapted to local conditions.

Overview of the practice

Researchers at the Julius Kuehn Institute (Germany) gathered information to systematically identify the socioeconomic impacts and potential costs and benefits of EcoStack strategies. The description of expected impacts is based on a literature and data review, as well as interviews with EcoStack researchers about their field trials and expected outcomes. Here are the main results for the measure “intercropping”:

++ At field scale, strong positive effects are expected from additional plants in the field, especially on soil fertility and limiting soil erosion.

\+ Minor positive effects are also noticed at the field level in aspects such as water regulation, yield stability and weed competition. At crop rotation level, intercropping can lead to a reduction of fertilizer need, especially for the next crop. At the regional level, legume crops will become a cover crop after harvest thus limiting nutrient leaching and supporting water protection.

= The legume cover crop can be harvested for forage, if seen as an opportunity for additional use or sale, but then the effect of fertilisation for the next crop is somewhat limited.

− Implementing this practice will make seed costs more important, especially for forage legumes.

⛔ If farmers want to maintain a living legume mulch and seed the next crop directly into the living mulch, specific machinery is then required and crop rotations have to be redesigned to take full advantage of the mulch.

The analysis of all subjects shows an overall positive effect of this practice. Intercropping legumes and cereals can lead to agronomic benefits on management of the main crop: Limiting soil erosion, weed control, nitrogen supply to the following crop, and also in a longer term on crop rotation and soil fertility. These benefits are balanced by the additional costs of seeds for the additional crop and the need to redesign crop rotation.

Reference : *EcoStack deliverable 4.4, “Description of companion cropping strategy“,2023*

Questions? Please contact us info@ecostack-h2020.eu

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