

Mixture and technical brochure Edition 2026



KWS Fit4NEXT

Catch crop mixtures for vitality

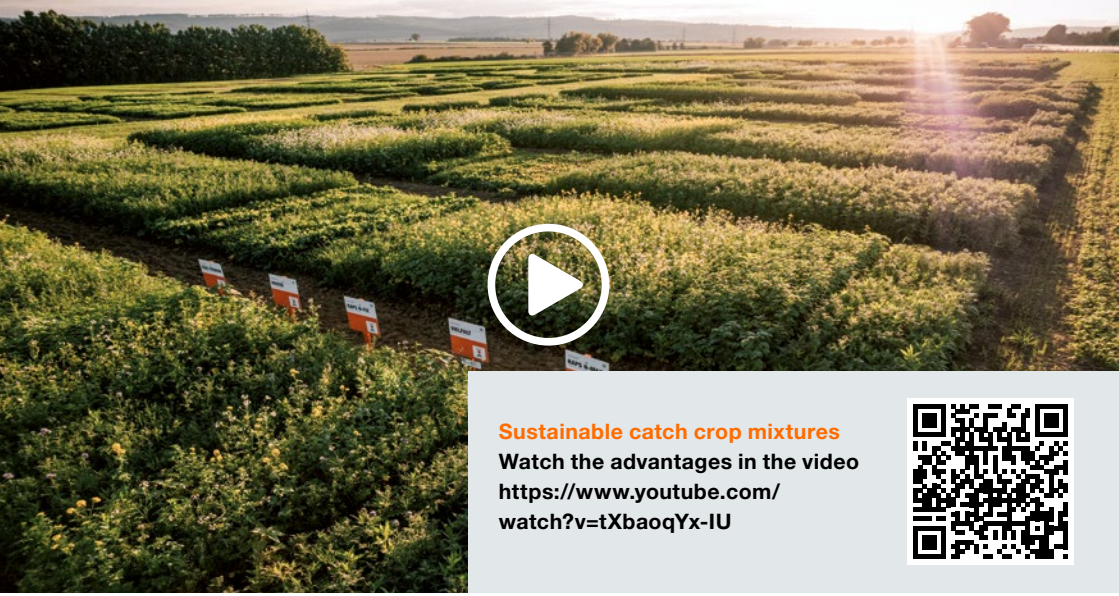


<p>SEEDING THE FUTURE SINCE 1856</p>	<p>KWS</p> 
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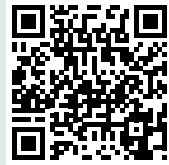
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Sustainable catch crop mixtures
 Watch the advantages in the video
<https://www.youtube.com/watch?v=tXbaoqYx-IU>



What is KWS Fit4NEXT

KWS Fit4NEXT is the product range for catch crop mixtures from KWS. For decades, KWS has been breeding, producing, and distributing the most important field crops and catch crops worldwide. Our goal is to offer you the opportunity to supplement your crop rotation with site-adapted and high-performance varieties from KWS to achieve the ideal catch crop mixture. With the right mixture, you can make your crop rotation even more sustainable, and successfully meet the challenges of field crop cultivation as well as political and social requirements.

Our many years of experience with catch crops contribute to the component selection, making it possible to integrate the right species into the mixtures with regards to phytosanitary and cropping aspects for different crop rotations. Thanks to the intense trial system, it was possible to develop ideal mixture compositions and define cropping recommendations over the course of several years. The mixtures and mixture partners were selected and tested based on their characteristics, such as youth development, blooming time, biomass growth, freezing behaviour, and root systems.

Your advantages with KWS Fit4NEXT

- A one-stop shop
- Clear and focussed portfolio
- Use of components from in-house breeding
- Premium component quality
- Mixtures and components tested in field trials
- Contributes to creating sustainable and socially acceptable field crop cultivation

Advantages of KWS Fit4NEXT catch crop mixtures

- Easy integration in **various crop rotations**
- Good rooting of the soil thanks to the combination of **tap roots and tuft roots**
- Strong youth development and rapid crop closure for better and faster **soil coverage and weed suppression**
- Diversified crop rotation and increased **biodiversity**
- Promotion of **soil organisms**
- **Humus formation**
- Additional **CO₂ sequestration**
- **Nutrient conservation and mobilisation** as well as **nitrogen fixation**
- Reliable crop establishment under different weather conditions
- High **biomass growth** over a longer period of time
- **Control** of pests such as **nematodes** thanks to a longer vegetative phase



Catch crops – breeding and testing at KWS

For many decades, KWS has been breeding a wide variety of catch crop species. Just like for our main crop, we rely on many years of experience and know-how.

In addition to cruciferous plants such as winter turnips, false flax, oil radish, white and brown mustard, our activities also focus on phacelia and Tartary buckwheat. More crops are available from other KWS breeding programmes, such as sunflowers.

The main breeding objectives for all species are rapid soil coverage, fast youth development, a dense crop that suppresses weed growth, and an adapted, rather late flower formation. The development of late-blooming varieties is the declared breeding objective of KWS, particularly for mustard, oil radish, and Tartary buckwheat, since late blooming offers more flexibility in terms of earlier sowing dates and reduces the risk of shedding seeds. Plants with a longer vegetative phase can also grow longer and therefore absorb more nutrients. At the same time, late blooming also ideally complements the main breeding objective for white mustard and oil radish – nematode resistance towards beet cyst nematodes (see p. 30/31).

We perform standardised greenhouse tests for nematode resistance with mustard and oil radish before approving the varieties. In addition, we use the test to verify the seed lots from our propagations.



For other species, early blooming is actually desired – for example with phacelia and sunflowers. Both species play an important role in bee pastures.

The desired characteristics of new potential varieties are tested on a yearly basis in field trials with two sowing dates (early after winter barley and late after winter wheat). Our mixtures are also tested on several sites under different field conditions. In addition to pure evaluation and observation, we also determine the biomass of the species and mixtures. Biomass is a significant factor in achieving the objectives: nutrient conservation, humus formation, and CO₂ storage. At the same time, we evaluate the nitrogen content of the vegetation to better assess nitrogen uptake from the soil and fixation from the atmosphere.

Most of the catch crop species we breed are cross-pollinated, where insects can contribute to a strong exchange of pollen among the plants. The breeding lines must therefore be elaborately separated from each other for breeding purposes. Later during multiplication as well, the required isolation distance from other varieties of the same species must be strictly observed to ensure that the desired characteristics (e.g. nematode resistance) are maintained.



For more information about the breeding of nematode-resistant mustard and oil radish, watch the video:



Root systems of various species

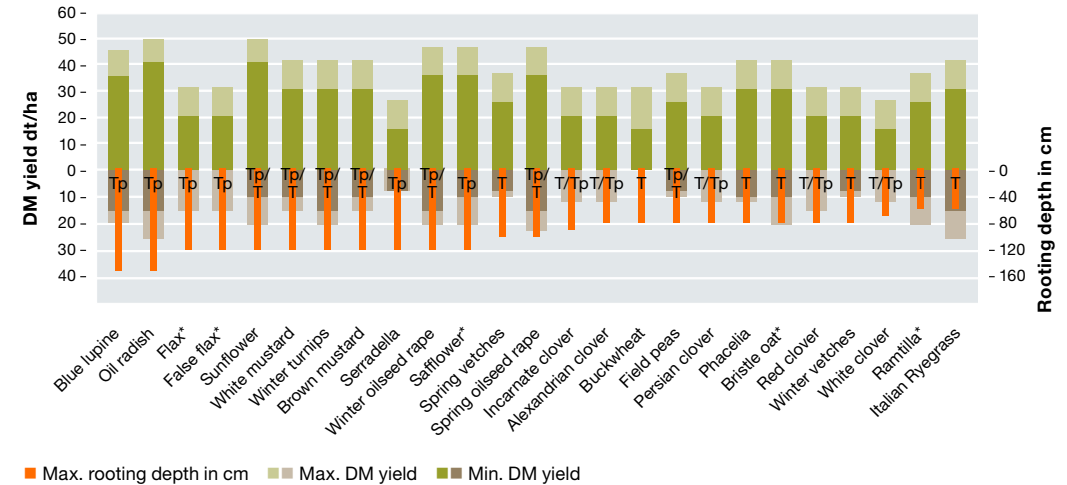
One of the most significant advantages of catch crop mixtures is the possibility to combine different types of roots and characteristics on one field. The root systems are divided into tap and tuft roots. Depending on the plant species, one or the other system can predominate or be combined. The topsoil and subsoil can be optimally exploited with a diverse mixture. Nutrients can be conserved, the formed biomass serves as a basic food resource for soil organisms and for humus formation. Root channels that are left behind improve the air and water absorption capacity and are used by the subsequent main crop for root development. Lupines and oil radish even break up soil compaction with their strong tap roots. Species such as phacelia or Tartary buckwheat can mobilise phosphorus through their root exudates. One of the reasons is also the capacity of many catch crop species to form symbioses with fungi, so-called mycorrhiza. The responsible fungi interact with the fine roots of e.g. clover species, flax, or bristle oats, thereby increasing the root surface and improving nutrient absorption.



For more information, watch the video: "A glance below the surface"

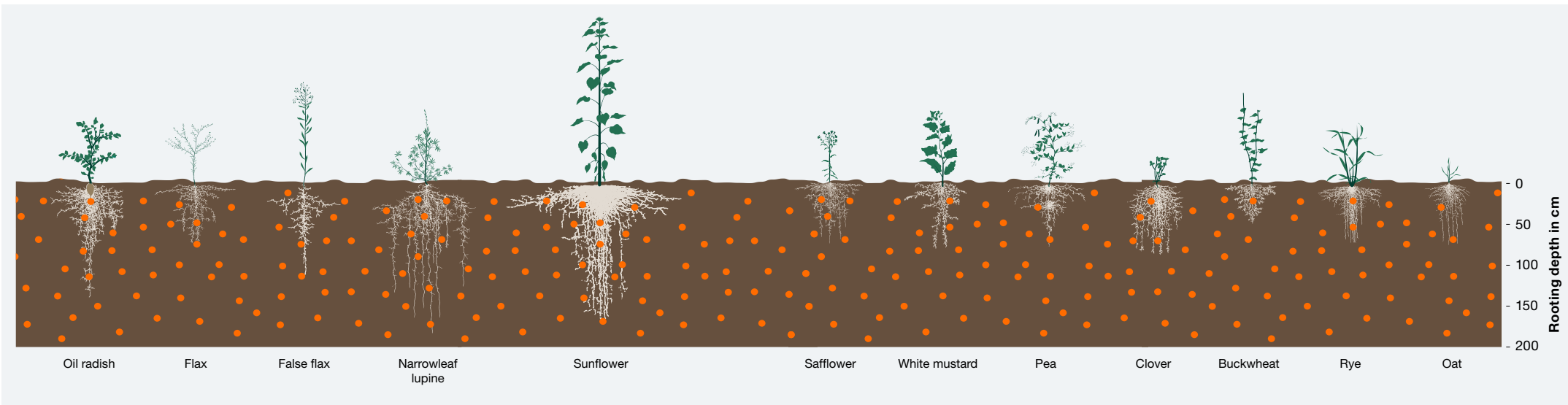


Root development and biomass potential of different catch crop species



* Rooting depth/DM yield based on first-hand experience. T = Tuft root system; Tp = Tap root system
Source: Zwischenfruchtpass Landwirtschaftskammer NRW (Catch Crop Booklet by the Chamber of Agriculture NRW), M. J. Kanders, Dr. C. Berendonk, 2013

Different species mutually improve root development and nutrient absorption



Schematic representation of root development in the soil and nutrient absorption, own illustration based on Kutschera et al., 2009

When is the planned sowing date?

The **cultivation time** frame for winter catch crops after harvesting summer cereals is often strongly determined by external factors: on the one hand, by the harvesting date of the previous crop, but also by many other factors such as thorough stubble cultivation, various maintenance and (basic) fertilising measures, water availability, subsequent crop, and also significantly by other work on the farm needing to be done around the same time, and therefore by the capacities of labour and technology. Another factor in the selection of the sowing date can be the risk of seed formation, which can be more or less significant depending on the species and variety. Political guidelines also determine the cultivation of catch crops.

For more information on the sowing date trial, watch the video:



No matter which reason has the highest priority, we constantly focus on the question regarding the **effect of the sowing date on catch crop cultivation**. How do KWS Fit4NEXT catch crop mixtures and the individual species develop with different sowing dates? The focus is on comparing the mass development of the crops, soil coverage, winter freezing behaviour (p. 26), and the amount of fixed nitrogen in the **aerial** above-ground growth. We look at characteristics such as floescence and ultimately also seed maturation of the different species and varieties.

Maximum vegetation time vs. generative growth

From an economic and usually also from a crop production point of view, intercropping in summer should ideally maintain a green population until the end of vegetation – without switching to generative development with flowering and seed formation. Depending on the species and variety, catch crop mixtures can be designed to allow a long period of vegetative growth. However, depending on sowing date, water and nutrient supply, this alternation cannot always be avoided. Late flowering is less dramatic in this regard. Only a few species still have the potential to form germinable seeds. One example is the Tartary buckwheat.

There are enormous differences in the choice of varieties for many species. In white mustard in particular, we rely on very late-flowering varieties such as SIMPLEX, SINEX or SIBELIUS from KWS' own breeding program. With these varieties, seed formation in the fall is rather unlikely.

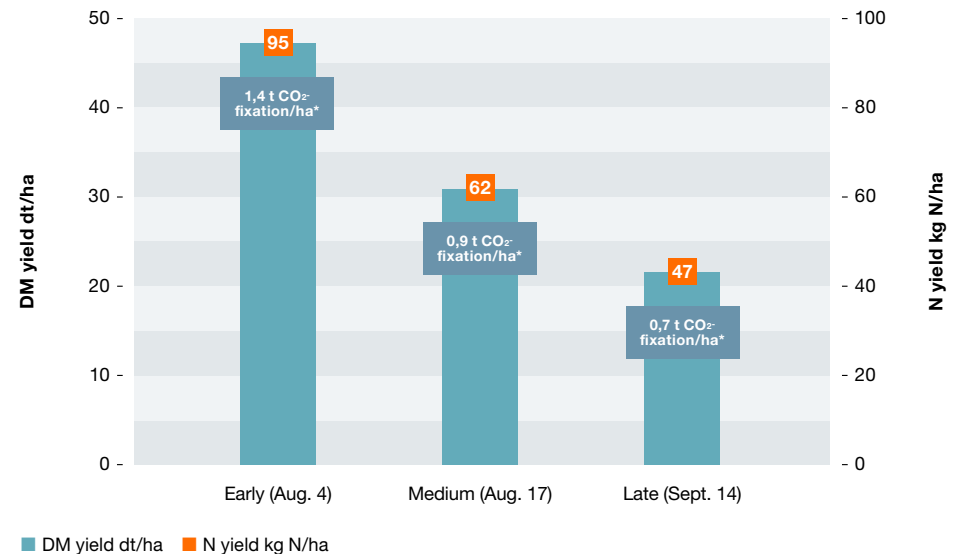
Ground coverage

An early **sowing time** generally always has **advantages in terms of soil cover** and thus **reducing erosion and water evaporation**. Even during later seeding times, a good level of cover can still be achieved. Here, however, mixtures with fast-growing crucifers such as mustard or oil radish have a clear advantage or generally also species that tend to provide rapid, extensive cover such as Phacelia or Tartary buckwheat. Bristle oat can also be very competitive, especially under dry conditions.

Sowing earlier benefits the field more

One day in July is like one week in August, and is like the whole month of September – this popular wisdom is well-known and particularly true for the cultivation of catch crops. It is clearly demonstrated in our trials. In the three sowing dates we selected, at the beginning and middle of August as well as mid-September, the advantages of early sowing dates on the dry mass development of aerial plant growth are evident. The **higher the dry matter, the more nitrogen is fixed per hectare** in the **plant mass**. This applies both for the quantities absorbed from the soil and generally also for the quantities fixed by legumes from the atmosphere.

An earlier sowing date increases the chances for more biomass as well as more fixed N and CO₂ per hectare!



DM and N yield of KWS Fit4NEXT catch crop mixtures depending on the sowing date. In-house results of the catch crop sowing date trial, Einbeck 2021/2022. The N content in the aboveground biomass is estimated at 2% of DM.
 * Aboveground CO₂ fixation based on our own analysis results (C content = 40%). Assumption that up to 20% of the aboveground DM biomass retains carbon over the long term. Conversion based on molar weights



Catch crop sowing date trial at the Einbeck site in 2021/2022 with early, medium, and late sowing date (each block from the bottom left to the top right)

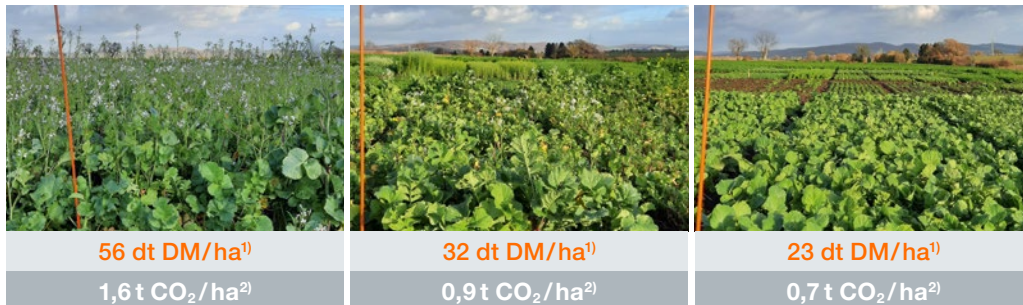
CO₂ sequestration through catch crop mixtures

What applies to nitrogen also applies to **carbon**. With more dry matter formed, a catch crop also binds **more CO₂ per hectare**. This means that the **potential for higher humus enrichment** through the organic catch crop residues is also increased through more bound carbon. This has a positive effect on increasing soil fertility. If the above-ground growth of a catch crop is analysed for carbon, the values vary depending on the cultivation conditions, stage of development and also the composition of the mixtures. From analyses of KWS Fit4NEXT catch crop mixtures harvested by us, we assume an average of 40% carbon in the above-ground biomass. This means that **0.4 tonnes of carbon** are sequestered **per tonne of dry matter (DM)**. If we continue to calculate on this basis, **around 1.5 tonnes of CO₂** are fixed per tonne of dry matter through the cultivation of catch crops.

This is where a significant lever lies in the DM yields per hectare. This in turn can be positively influenced by many factors – the described factor of sowing time and thus vegetation period probably has the greatest effect.

In the majority of cases, the catch crop serves as green manure. However, it is not possible to bind 100% of **the bound CO₂ in the soil** in the **long term**. The accumulation and release of CO₂ are also subject to dynamics here.

Longer vegetation periods promote biomass formation and CO₂ sequestration



* Comparison of plant development and above-ground ¹ DM yields of the catch crop mixture KWS Fit4NEXT N-FIX FOR POTATO at the Einbeck site, 8 November 2021. Sowing dates from left to right: 04 August, 17 August, 14 September. Calculation of above-ground CO₂ fixation based on own analysis results (C content = 40%). ² Assumption that carbon remains fixed in up to 20% of the above-ground DM biomass in the longer term. Conversion via molecular weights

According to estimates by the Thünen Institute in Braunschweig, **up to 20%** can nevertheless be stabilised in the long term when considering the carbon sequestration in the soil that goes hand in hand with the build-up of humus.

Although this assumption is also subject to fluctuation, **catch crop cultivation** as a **CO₂ sink** can still make a **significant contribution to climate protection** and CO₂ sequestration in the agricultural sector. According to studies by the Thünen Institute, catch crops currently still have considerable potential to increase this contribution. This relates to both the area under cultivation and the cultivation management.

[Click here for the interview](#)

with Prof. Dr. Axel Don, Deputy Director of the Institute of Agricultural Climate Protection at the Thünen Institute in Braunschweig:

Catch crops: Nitrogen, erosion control, humus build-up

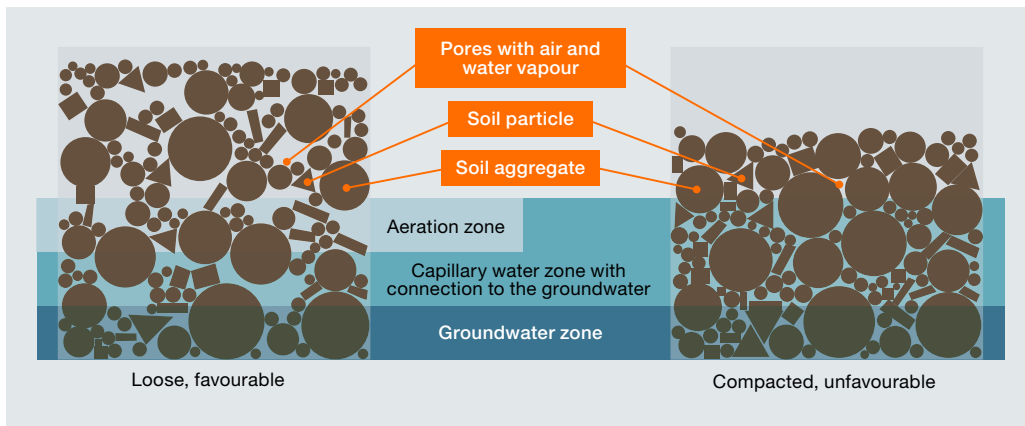


Reducing soil erosion by cultivating catch crops

Soil erosion is the displacement of soil particles at the soil surface by wind and water, and it is associated with reduced soil fertility. The prevention of soil erosion still remains one of the main purposes for cultivating catch crops.

Wind erosion mostly occurs in regions with light soils and/or landscapes with few trees and shrubs (high proportion of large open areas). The finest soil particles are picked up by the wind, transported over a distance of several metres, and accumulate in front of hedges and field trees. Wind erosion is particularly problematic in spring when the soil surface is dry and the spring crops have not yet grown enough coverage. The mulch layer produced by catch crops can reduce the risk of erosion in these cases.

Stabilising the soil structure with catch crops



Own illustration according to "A guide to better soil structure", National Soil Resources Institute, Cranfield University, 2001

On slopes, strong or persistent precipitation can cause water erosion. The impact of raindrops can destroy soil aggregates, and the water can then pick up and transport small soil particles and cause surface sealing. These types of erosion usually occur on bare fields. Continuous plant coverage and a mulch layer consisting of dead catch crops are suitable countermeasures, which also apply for cross-compliance (CC land). The faster a catch crop can become established, the lower the risk of soil erosion.

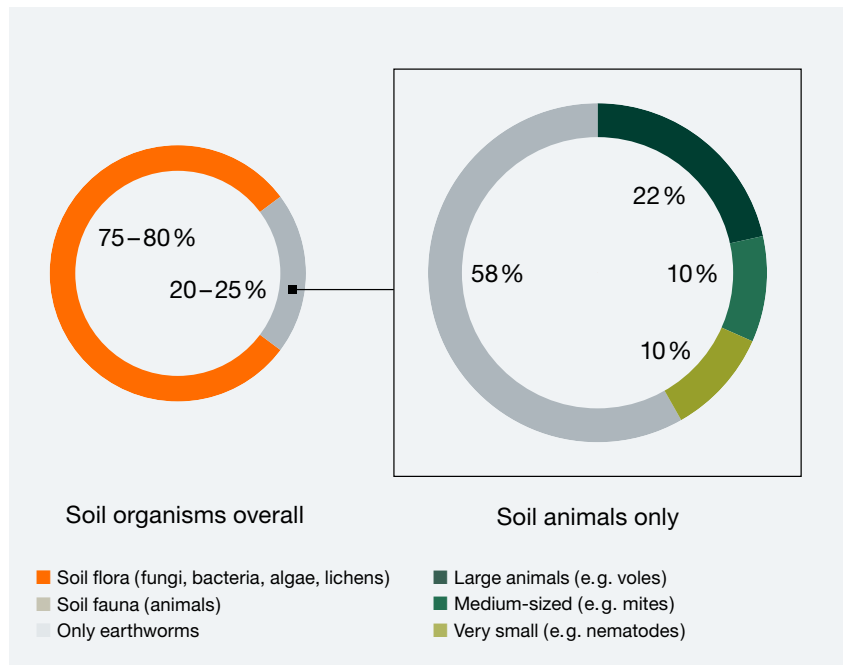


Wind and water erosion on arable fields in spring

What influences the decomposition of catch crops in spring?

Decomposition of the catch crop biomass is accomplished by the soil flora (mainly fungi, bacteria, algae, and lichens) and fauna (animals), which are grouped together as the so-called edaphon. The cultivation of catch crops promotes their activity, and therefore also activity in the entire crop rotation.

Classification of soil organisms



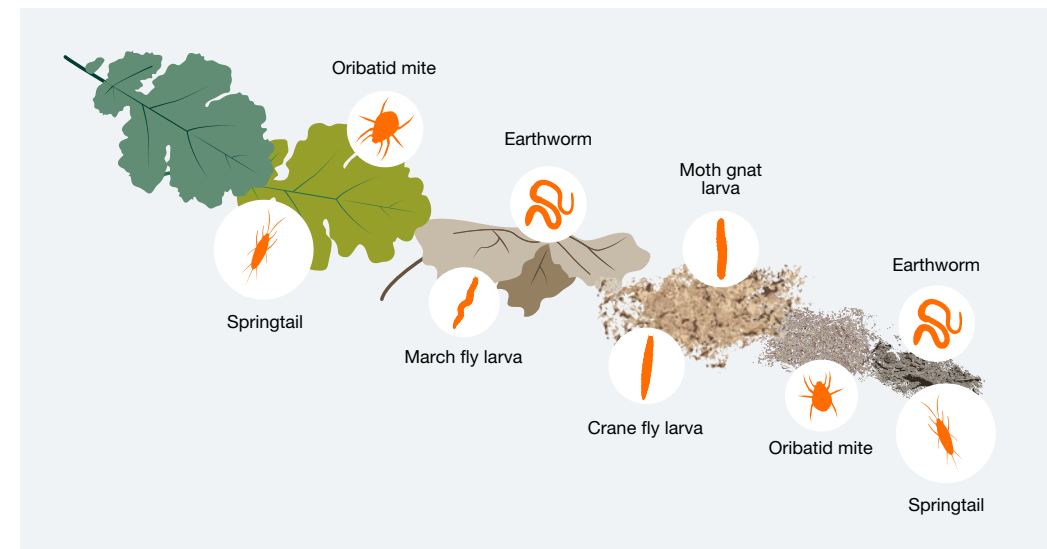
Adjusted according to DUNGER, 1964 and BRAUNS, 1968

A food supply with a narrow carbon and nitrogen ratio (C/N ratio) has a positive effect. This ratio provides an indication of how fast plant material can be decomposed by the soil organisms (mineralisation). As a general rule, the narrower the ratio, the faster the decomposition. Nutrients that come from plant material with a narrow C/N ratio are then more readily available to the subsequent crop. However, the ratio not only depends on the plant species, but also on the growth stage.

Older plants that have already formed more fibrous tissue (lignification) generally have a wider C/N ratio than young plants.

Due to their very short vegetation period, catch crops have a very narrow C/N ratio of approx. 30:1. In contrast, cereal straw has a very wide C/N ratio of approx. 100:1. However, there are also differences among catch crops, which can be influenced by crop management and species selection. In addition to nutrient supply, crop management also includes the growing date of the catch crops. With regards to species selection, legumes are decomposed more rapidly, while cruciferous plants or phacelia are decomposed more slowly. By mixing these different species, nutrients are gradually released from the catch crops for the subsequent crop in spring.

Decomposition of an oil radish leaf



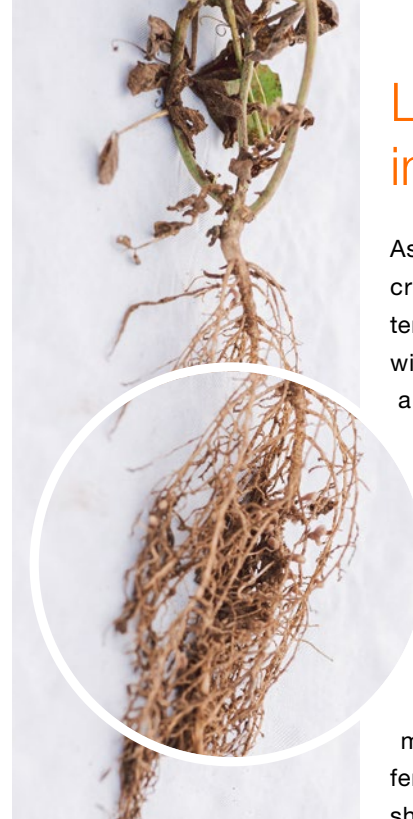
Adjusted according to SCHÄCHTER, 1988



Habitat and food sources for organisms

Catch crops are used as a habitat and food source for a wide variety of organisms. In the aerial leaf mass, for example, birds can hide from their predators. The vegetation serves food for hares, rabbits, insects and wild animals. The soil organisms, in contrast, feed on dead catch crop residues, on organic material, plants roots, faeces from other animal groups, as well as bedding and harvest residues, living both at the soil surface and underground.

For example, the anecic earthworm (deep burrowing) comes to the surface looking for food, pulls dead plant residues down into the ground, and uses them as a food source in addition to the soil. At the same time, the excretions of this worm are a highly concentrated fertiliser, containing 5 times more nitrogen, 7 times more phosphorus, and 11 times more potassium than the surrounding soil (Pfiffner et al., 2013).



Enlarged view of forage pea roots (*Pisum sativum* L.) with root nodules.

Legumes as a nitrogen source in catch crop mixtures

As a result of the reduced use of organic and mineral nitrogen fertilisers, cropping systems used in agriculture must be further optimised in terms of nutrient efficiency. Legumes are currently regaining importance within the scope of the revised Fertiliser Ordinance. They can form a symbiosis with nitrogen-fixing bacteria (rhizobia) in their root nodules and therefore fix atmospheric nitrogen.

This puts you in line with the times, considering the high cost of mineral nitrogen and an overall favorable CO₂ footprint. This nitrogen can be incorporated in the cropping system. Legumes primarily supply themselves autonomously with atmospheric nitrogen and can thus reduce nitrogen absorption competition with non-leguminous plants in a catch crop mixture. To a certain extent, legumes can also share atmospheric nitrogen with non-leguminous mixture partners. The mode of operation without additional nitrogen fertilising is illustrated in the figure below, and shows a possible relationship between nitrogen absorption from the air, the soil reserves, and the distribution within a clover/grass mixture. In this example, the clover was able to share approx. 1/5 of the bound atmospheric nitrogen with the grass. Additional nitrogen fertilisation generally results in decreased atmospheric nitrogen reduction by the legumes.

Improvement of the nitrogen balance based on the example of a grass /white clover mixture

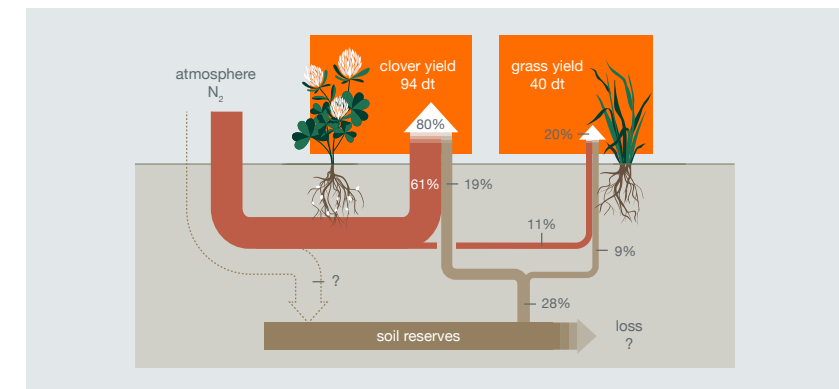


Illustration of the nitrogen fluxes (kg/ha) in a grass/white clover crop without N fertilisation in a main production year, adjusted according to B. Boller, 1988

Nutrient conservation and mobilisation by catch crops

Catch crops are essential in current and future cropping systems to support the nutrient cycle in crop rotations in a sustainable, economically expedient way. Three main aspects are relevant in this context: conserving nutrients from the soil in the plant mass, mobilising poorly available nutrients in the soil, and fixing of atmospheric nitrogen by nodule bacteria.

Especially the macronutrients nitrogen, phosphorus, potassium, and sulphur can be conserved thanks to the cultivation of catch crops, and made available to the subsequent crop. In addition to these purely crop-related reasons, the European Water Framework Directive has a decisive effect on the cultivation of catch crops and particularly the conservation of nitrogen. The objective of modern agriculture is to protect nutrients against leaching with seepage water into deeper soil layers or loss through surface runoff. This is part of the guidelines for good agricultural practice.

P Phosphorus

Mobilise phosphorus

Since phosphorus is not very mobile in the soil solution, plant roots must actively grow towards it. An important prerequisite for optimum phosphorus supply is therefore to ensure a sufficient supply of plant-available phosphorus in all layers of the soil. Particularly with non-inverting soil tillage, there is a risk that the nutrient concentration strongly increases in the upper soil layer, since this is where mineral and organic fertilisers are added. The concentration can be much lower in deeper soil layers if the nutrients are not incorporated deeply enough. Due to the poor mobility of phosphorus, this produces an imbalance in the soil layers. Although the topsoil often has a good supply, there is a risk of desiccation in case of longer periods of drought, which inhibits plant growth.

The cultivation of a catch crop mixture that is specifically matched to the subsequent crop can help in this case. Recent research has confirmed that catch crops per se have a positive effect on phosphate availability. One of the reasons is the promotion of mycorrhiza, i.e. the symbiosis of plant roots and fungi. Catch crops such as lupines, buckwheat, and phacelia are particularly well suited to improve phosphorus availability.



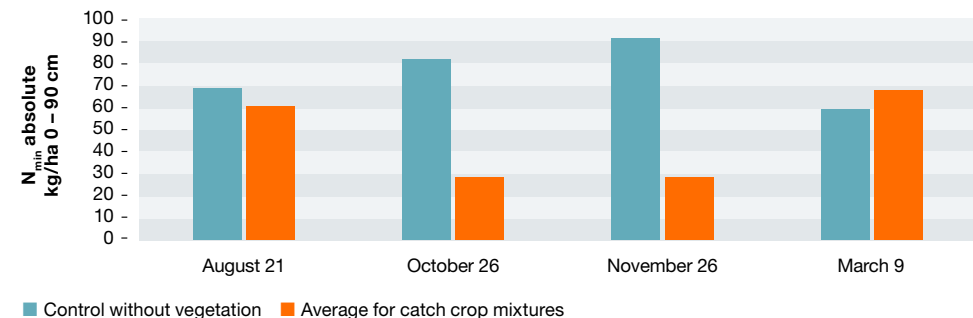
N Nitrogen

Efficient nutrient storage

In regard to nitrogen, there are essentially two tasks that an catch crop mixture should fulfill, depending on the composition of the mixture partners: the conservation from the previous crop into the following crop rotation and, if legumes are included, also the fixation of atmospheric nitrogen in the root nodules with the help of nodule bacteria, which are usually native to the soil (pp.18/19).

Particularly on light, sandy soils, there is a very high risk that mineralised nitrogen in the soil will be transported into the groundwater as a result of autumn and winter precipitations. During the sometimes very long cultivation pauses between the cereal harvest in summer and the spring sowing of the subsequent crop, catch crops and catch crop mixtures can feasibly conserve 100 kg of nitrogen per hectare in the plant mass, depending on the development conditions, species, and composition. The majority of this nitrogen is then available again in the nutrient cycle and/or accumulates in the soil as humus. Catch crops can thus make an active contribution to **water conservation**. In our scientific trials on a Luvisol site, we compared the nitrogen absorption by the catch crop mixture from sowing in summer until the end of winter to a barren control plot (comparable to stubble or bare fallow). The figure shows that regardless of the mixture composition and the presence of legumes in the mixture, a catch crop mixture can reduce the N_{min} content to a level equal to or lower than 30 kg/ha before winter, whereas in the barren control plot in this example, there is about 90 kg N_{min} /ha in the soil solution before winter, which can potentially be transported. The final sampling in March shows that a portion was transported and that bound nitrogen from the catch crop mixture was already mineralised for the cultivation of the subsequent crop. The degree of mineralisation is generally influenced by the degree of conversion of the biomass, and proceeds faster when mechanical shredding, frost, or similar effects have broken down the material.

Better with than without – catch crop mixtures conserve nitrogen



Comparison of N_{min} contents in the 0–90 cm soil layer on fields without vegetation and with catch crop mixtures (average from the mixtures KWS Fi4NEXT BEET, N-FIX FOR OILSEED RAPE, and N-MAX FOR OILSEED RAPE). Scientific plot trial on a Luvisol site in South Lower Saxony. Sowing date for the catch crop mixtures: 18 August.



Sowing nitrogen and reducing fertilizer costs

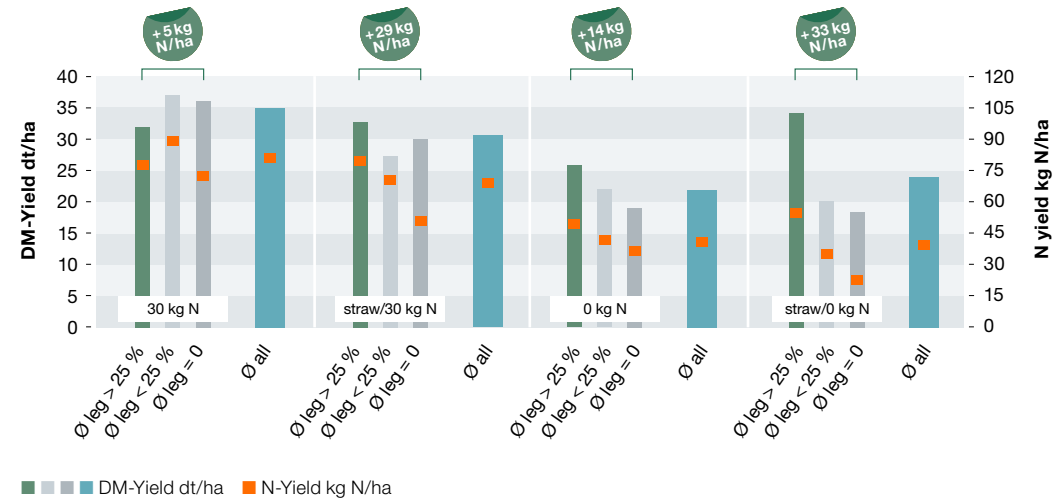
In a separate exact trial, we tested the influence of nitrogen availability and nitrogen deficiency in combination with various KWS Fit4NEXT catch crop mixtures.

The general advantages of legumes in a catch crop mixture with regard to nitrogen have already been described on page 19. The question behind this trial has become more and more important due to various factors.

On the one hand, due to the designation of nitrogen limited areas, catch crop cultivation is only possible without additional fertilisation, and on the other hand, for economic reasons and the increased prices for nitrogenous fertilisers, there is great interest in reducing fertiliser costs in the intercrop, but also in the subsequent crop.

All catch crop mixtures were grown both fertilised (30 kg N/ha from KAS) and unfertilised and in one half of the trial the straw from the previous crop, winter barley, was removed. As the straw residue generally also binds nitrogen, there are different levels of nitrogen availability from fertilised without straw (30 kg N) to unfertilised with straw (straw/0 kg N).

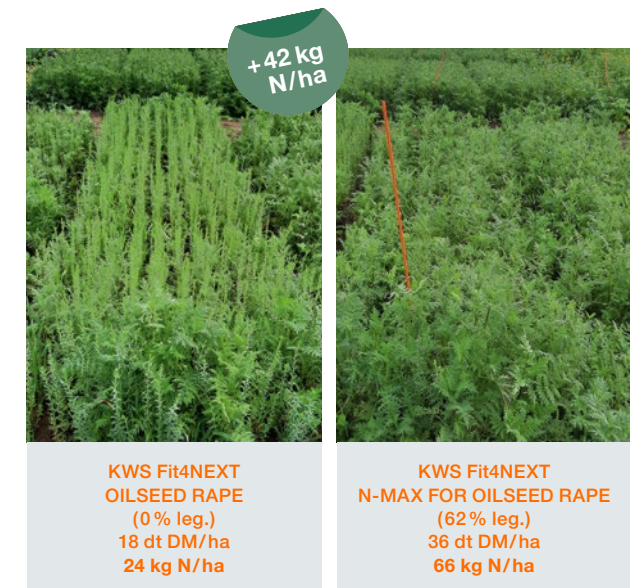
Nitrogen availability promotes catch crop mixtures if there is a nitrogen deficiency, leguminous mixtures are recommended!



Above-ground DM yields and N yields kg/ha in the nitrogen fertilisation trial at the Einbeck site, in each of the four tested variants with straw & without N fertilisation (S/0), with straw & with N fertilisation (S/30), without straw & with N fertilisation (30) and without straw & without N fertilisation (0). N fertilisation (S/30), without straw & with N fertilisation (30) and without straw & without N fertilisation (0). Average values grouped according to freezing Fit4NEXT catch crop mixtures with legume seed content > 25 % (n=4), < 25 % (n=3) and 0 % (n=6)

The dry matter (DM) and nitrogen (N) yields in kg/ha from the above-ground biomass clearly show the advantage of legume-containing catch crop mixtures when N is in short supply. Under these conditions, KWS Fit4NEXT catch crop mixtures with a higher proportion of legumes such as DIVERSITY, N-MAX FOR OILSEED RAPE, N-FIX FOR BEET, N-FIX FOR POTATO can still form a good crop and thus fulfil the diverse functions of a catch crop mixture. This can be seen very clearly in a direct comparison of similar mixtures using the example of N-MAX FOR OILSEED RAPE.

Comparison with and without legumes



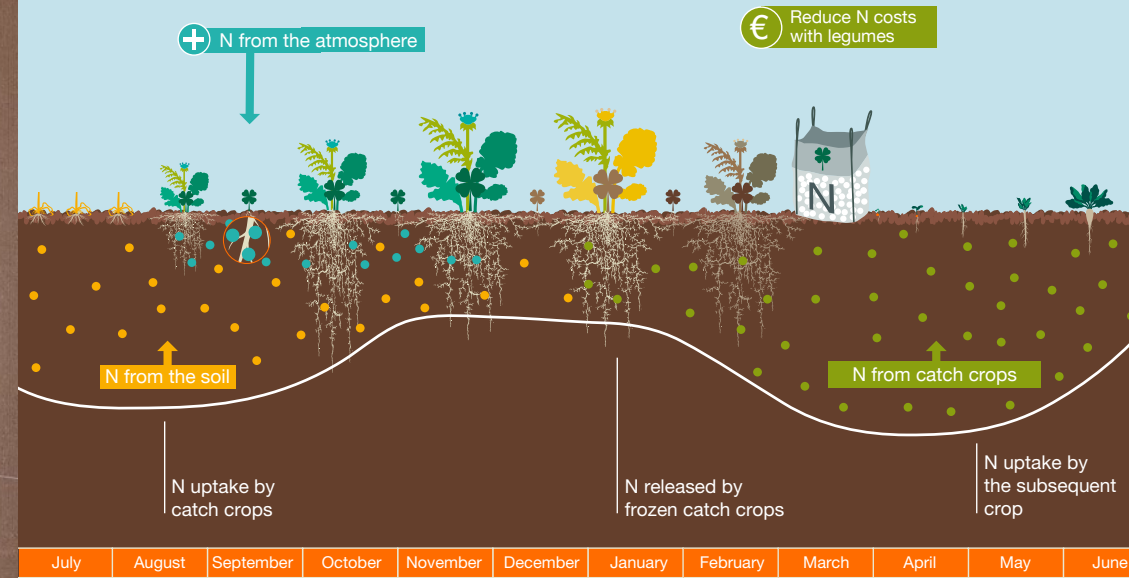
Comparison of the catch crop mixtures KWS Fit4NEXT OILSEED RAPE (legume-free) and KWS Fit4NEXT N-MAX FOR OILSEED RAPE (62% legume seed content) in terms of DM and N yield in above-ground growth, with straw & without nitrogen fertilisation, in the trial in Einbeck.

Check out the video from within the N fertiliser trial:



Aerial photos of the N fertiliser trial at the Einbeck site on 24 September

Conserve nitrogen in the system and lower costs thanks to catch crop mixtures containing legumes!



Schematic course of nitrogen (N) dynamics in a cereal-root crop rotation using the example of maize with the cultivation of freezing legume intercrop mixtures between the cereal harvest and maize sowing

If nitrogen is available, this type of mixture still achieves good results, although less legume-rich and completely legume-free catch crop mixtures can also score well here. It has also been shown that a **diverse species composition** can have a **good buffering effect and adaptability** to different conditions.

The additional nitrogen provided by the legume-containing catch crop mixtures benefits the catch crop and the subsequent crop. It therefore directly benefits the catch crop and can also **reduce the N fertilisation costs per hectare** in the crop rotation. In the system as a whole, the use of biologically fixed nitrogen makes farming **more CO₂-efficient** and at the same time further reduces the **CO₂ footprint in the crop production process chain** thanks to the additional CO₂ savings.



The main task of catch crops is to store nutrients, primarily nitrogen of course!

Tobias Schröder

Farm manager at Agrarhof Veelböken eGz

Freezing behaviour for catch crop mixtures

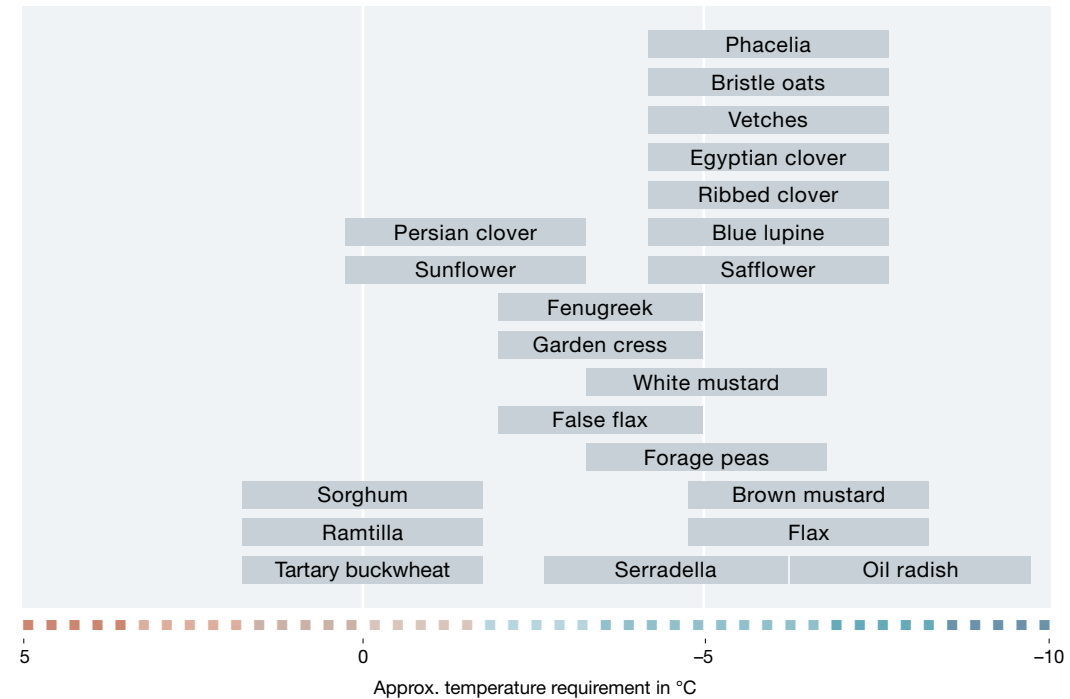
How effectively a catch crop mixture is frozen depends on various factors, some of which you can control.

1. Species and variety selection

Among common catch crop species, the range of frost sensitivity is quite broad. The illustration shows how the species generally react. This evaluation is performed at a development stage that focuses more on the mass and where all species are about equally developed. Tartary buckwheat or ramtilla already react with cellular death at low temperatures around 0°C. Minor frost events reliably ensure freezing of these two species. Many other species, such as false flax, flax, or white mustard react adequately to frost. Other species, such as oil radish, require longer and/or stronger single frost events. There are also differences among the varieties within a species. In extreme cases, they can also go beyond the ranges specified here. With mustard and oil radish, for example, this can also be associated with youth development or early blooming.

Once-off frost events in combination with regeneration phases at temperatures that allow growth do not lead to the desired freezing. This is evident during mild winters. The plants can recover and continue to grow. Time periods of several nights with frost or also longer periods with freezing temperatures are reliable.

Comparison of the freezing behaviour of different non-hardy catch crop species



Assessment based on results from in-house trials

2. Seedbed preparation and crop establishment

After selecting the species, here too you can lay the foundation early on for the later, easier “disappearance” of the catch crop mixture. A good start, which ensures good development and a homogeneous crop, also improves the freezing behaviour. This includes the elimination of volunteer grain, oilseed rape or competing vegetation, site-adapted primary soil tillage, as well as sowing technique. The more effort is invested in the start of a catch crop mixture, the more likely good results can also be achieved with the freezing.





3. Sowing density

Unlike the cultivation of main crops, higher sowing densities and therefore crop densities can offer many benefits – denser crops and weaker development of the individual plants. Weaker development is not a disadvantage in this case. It generally ensures increased frost sensitivity. The best example is with oil radish. If the sowing density is too low and the individual plants grow vigorously, the stem and radish body can be very strongly developed.

Different radish development due to different crop densities

Pictures 1 – 6: Freezing behaviour using the example of the KWS Fit4NEXT N-FIX FOR OILSEED RAPE mixture with different sowing dates



Pictures of the catch crop mixture trial 2019/2020 at the Einbeck site

Both the massive stems and particularly the large radish may impede or even prevent freezing in the event of insufficient frost. As a result, this otherwise excellent catch crop species falls from grace, because later elimination with herbicides is also difficult. This is where a higher sowing density helps. If the field is trafficable, an additional roller pass during the winter season can be worthwhile. It breaks and damages the stem, and later frost events help to kill the entire plant.

4. Sowing date

A very impressive effect can be achieved by selecting an adapted sowing date. This is supported by long-term scientific trials. The same mixture and individual species were sown in the trials at different dates (early: beginning of August; middle: mid-August; late: beginning/mid-September). It was demonstrated that early or timely sowing results in good and massive development of the crops. These well-developed crops react more sensitively to frost events, particularly if the plants have already reached the blooming stage. Moreover, larger plants are more susceptible to mechanical loads such as snow. Of course, an early sowing date must fit into your operational schedule, and the previous crop and soil moisture must cooperate. With extremely early sowing, there can be a risk that individual species or plants still form seeds.

5. Mechanical cultivation

In cultivation areas without reliable frost and with mild winters, an intermediate or subsequent mechanical cultivation of the catch crop mixture can make sense. Where applicable, the timing or technological specifications must be observed here. Use of mulchers or Cambridge rollers (high area efficiency) ensure good results. Measures with soil tillage (e.g. disc harrow, cultivator) can be used (during greening, only after 15 February). In addition, please also observe the requirements of the Common Agricultural Policy (CAP). **In any case, the trafficability of the field is decisive!**

Nematode-resistant catch crops – an important component in nematode management

Beet cyst nematodes (*Heterodera schachtii*) damage the root system of sugarbeet. If there is an infestation, water and nutrient absorption is significantly limited, which can cause yield losses (picture on the right).

The cultivation of nematode-resistant catch crops is an important biological control method to prevent the build-up of high nematode population densities in tight sugarbeet rotations or to reduce existing high populations. In addition to choosing nematode-resistant sugarbeet varieties, the cultivation of nematode-resistant catch crops is a decisive factor in nematode management. This was demonstrated in recent years both by numerous trials and in practice. Nematode-resistant catch crops are capable of significantly reducing the population density of beet cyst nematodes and even enable a positive yield effect on the adjusted sugar yield in the following sugarbeet crop (illustration below).

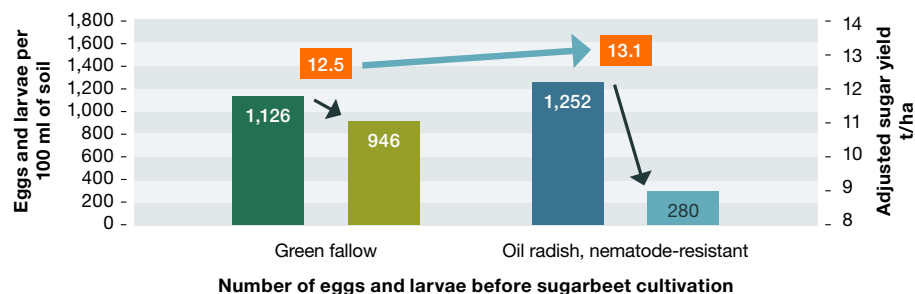
The principle of action consists in interrupting the development cycle of *Heterodera schachtii*. Just like the host plants, nematode-resistant catch crops stimulate hatching of the nematode larvae, attract them with the promise of a rich food supply, and allow them to penetrate into their root system.



Sugarbeet crop with nematode infestation nest and dormant beet

Unlike the susceptible host plants, the nematodes cannot establish an adequate nurse cell system in the resistant host plants. The nematodes then starve to death. While a female-male ratio of almost 1:1 is observed in susceptible host plants, it reaches 100:1 in resistant plants. The nematode females require 40 times more food than the males, so that the development cycle is only completed in isolated cases. This leads to a reduction in the nematode population. The nematode-reducing effect of resistant catch crops drops considerably after the beginning of flowering. Cultivation of early sowing-compatible **varieties with long vegetative development and a low tendency to bloom or late blooming** is recommended. Hatching is stimulated where the nematodes come into contact with the root system of the catch crop. The seedbed must therefore be prepared such that the plants germinate uniformly and good root development is ensured later on. A plant density of more than 160 resistant plants/m² is ideal to reduce the populations of *Heterodera schachtii*. The varieties of oil radish and mustard used both have the best resistance grade of 1 or 2.

Effect of nematode control on the yield of a nematode-resistant sugarbeet variety with the catch crops “Green fallow” and “Nematode-resistant oil radish”



■ Initial nematode population (Pi) ■ Final nematode population (Pf)
 ● Adjusted sugar yield after green fallow/oil radish (t/ha)

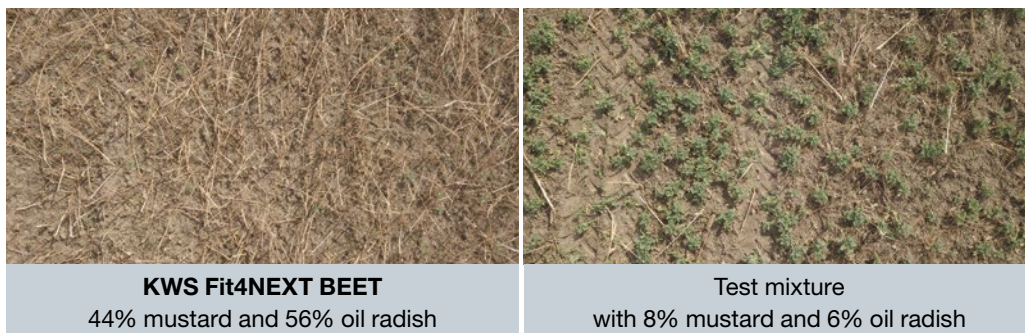
Weed suppression

From today's perspective, weed suppression is a goal that is gaining importance in the cultivation of catch crops. Although undesirable weeds and grasses as well as volunteer grain or oilseed rape should germinate, their growth should be suppressed by the rapid development of the catch crops, so that they die before flowering and developing seeds and do not serve as a green bridge for diseases and pests in the crop rotation.

Effective weed suppression can be achieved with catch crop species that have strong youth development, rapid soil coverage, and high biomass growth. The weed suppression achieved by many cruciferous species, such as oil radish, white mustard, and Tartary buckwheat is per se higher than, e.g. clover species and flax. The reason is their rapid youth development and formation of leaf mass. In addition to the species combination, of course, factors such as the **sowing density, sowing date, nutrient and water supply**, as well as **seedbed preparation and sowing technology** play an important role for success.

The better a crop is established, the greater the probability that the desired effect will be achieved. Crops with gaps, which can also occur due to varying freezing behaviour of the mixture partners during the course of the catch crop season, can leave space for new waves of weed growth. Species that like warmth, such as ramtilla, sunflower, or also most legume species, can achieve good effects, but always taking account of the adapted sowing date.

Excellent weed suppression with KWS Fit4NEXT BEET

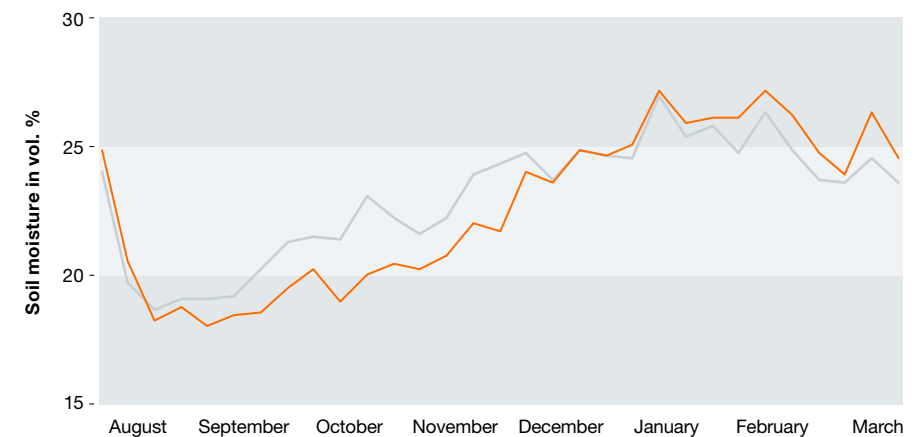


Efficient water utilisation by the catch crops

In recent years, the topic of water availability has been significant not only in classic arid areas. The declared goal is to offer the main crop the best possible development conditions. Again and again, the question arises as to whether a catch crop, due to its water use, is detrimental to the growing conditions for the following spring crop. In most cases, one can say: no, a catch crop tends to even have more of a positive effect! What are the reasons for this?

Several areas must be considered when addressing the water requirement and therefore the water use of a catch crop. First of all, it is important to know whether the absence of vegetation (e.g. bare fallow or stubble fallow) saves water compared with vegetation with a catch crop. Numerous trials by the German Meteorological Service (DWD) (Böttcher et al.), by official Austrian facilities (Bodner et al.), and in-house trials by KWS were performed on this subject. In all cases, the soil water content down to a depth of 60 or 90 cm /100 cm was analysed after harvesting the previous crop/sowing the catch crop until the end of the winter/seedbed preparation for the main crop

Soil moisture in comparison between fallow and catch crops

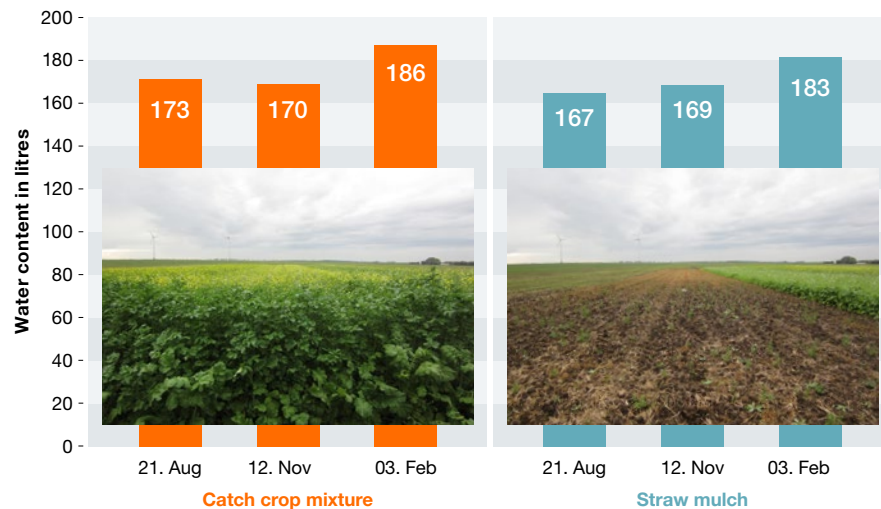


■ 12-year average fallow ■ 12-year average catch crop

Catch crop (mean of phacelia and catch crop mixture), mean value for the years 2012/13 to 2024/25, based on weekly gravimetric sampling (German Weather Service, Agrarmeteorological Advisory Centre Leipzig, 2025)

The DWD measured the effect of a freezing catch crop mixture compared to fallow on the soil water content from 0 - 60 cm over many years at the Threna site. The figure shows the course of the soil moisture content from August to March under the two variants. Compared to fallow, the catch crop has a more positive effect on soil moisture in spring and therefore does not have a negative effect on water availability in the following crop.

Determination and comparison of the soil water contents – straw mulch compared with catch crop mixture



Determination and comparison of the soil water contents in mm down to a depth of 1 m from August 2014 to February 2015 after winter barley as the previous crop at the Klein Wanzleben site. Straw mulch (repeated tillage until winter) compared with a catch crop mixture (sown on 11 August) before sugarbeet. The winter precipitation amounted to 71 litres.

The example of our dry site Klein Wanzleben shows that both straw mulch and a freezing winter catch crop provided the same starting conditions for the subsequent sugar beet. In both cases the water supply in the soil were about the same over the entire period.

How can this be explained? The water quantity consumed by the catch crop for the developed biomass is lost in the scenario with straw mulch through other factors, mainly evaporation and percolation water. The most important correlations and the influence of the catch crop are summarised in the table on page 36. A well-developed catch crop ensures better absorption of precipitation thanks to the additional creation of soil pores and because the leaf/mulch cover reduces surface evaporation. As a result, a catch crop uses water very productively! In the case of snow, particularly in areas with drift, a well-developed catch crop also reduces “snow erosion” and is additionally beneficial to the water balance of the surface.



Catch crop influences on the components of the water balance

Water balance component	Catch crop influence
Evaporation	Leaf and mulch cover reduce soil evaporation; bio-macropores transport water to deeper soil layers where soil evaporation cannot take hold.
Surface runoff	Soil cover and improved infiltration through biopores reduce surface runoff.
Leachate accumulation	Catch crop water absorption from deeper soil layers reduces the amount of leachate water (and thus the nitrate shift); humus build-up improves the storage capacity of the soil in the long term.
Transpiration	Catch crops absorb water from different soil depths according to their root distribution.

Source: Catch crop cultivation is also feasible in drylands. Bodner et al., 2011

What is the water requirement and water efficiency of the different catch crop species? Small-grain species have an advantage in terms of optimum establishment due to their lower germination water requirement. Depending on the location and conditions, this can be decisive for establishment. During vegetation, species such as rough oats, rachis, sunflower, phacelia, linseed or camelina have a certain advantage when water is scarce. Among the legumes, Persian and Alexandrine clover cope well with less water. Overall, however, most catch crop species show good water utilization efficiency. This can also be positively influenced by rapid ground cover and reduced evaporation. Species such as yellow mustard or Tartary buckwheat are very good at this.

Winter-hardy mixtures and unfrozen stands can continue to consume water after winter with the onset of vegetation. With the exception of water surplus sites, this is rather undesirable and can lead to disadvantages for the main crop. Interruption as early as possible is therefore advisable. At the same time, when selecting the components and during cultivation, emphasis should be placed on good freezing behaviour.

Keep water - with catch crop mixtures that freeze well!



Sowing the catch crops usually takes place during the busiest time of the year and is often carried out by the farmer himself using the technology available on the farm. Seed drills and spreader units, mounted on soil tillage implements or set down in front cultivation, have become established in practice.

In recent years, another option gained in importance - sowing catch crops by drone (or pneumatic spreader) before combine harvesting in the standing market crop. We have been involved in extensive trials and practical cultivation since 2022 and have been able to shed light on pre-harvest sowing.

The dry summer of 2022

In 2022, we set up our first trial at the Einbeck site. Using a catch crop mixture with 18 components, we compared drone sowing and pneumatic spreader sowing before combine harvesting with conventional sowing using a seed drill after combine harvesting. The wheat straw was left on the field, and the catch

crop was not fertilised. Precipitation in July and August totalled only around 40 l/m². The plants were correspondingly slow to develop both in the pre-harvest sowing and in the drill sowing. However, the result in November, at the end of vegetation, was convincing. **Both spreading variants had developed significantly better than the drill sowing variants.**

The cruciferous species in particular prevailed in the mixture. It became clear from isolated straw-free nests that pre-harvest sowing under dry conditions only works with a straw cover. After the winter, it could be seen that the drilled seeds contained significantly more volunteer wheat, whereas the pre-harvest sowing were very clean and were also very well frozen.

If the catch crop succeeds well in the pre-harvest sowing, it was also observed in subsequent years that volunteer cereals/rape and companion plants were better suppressed in the pre-harvest sowing (without soil movement). Depending on the situation, the use of herbicides can also be reduced in the crop rotation.

2023 and 2024 - more water and new general conditions

In both years, the trial in Einbeck and Wohlde was extended and expanded to include fertilisation, straw removal, more test links and an additional preceding crop. Sufficient water was available at both locations during the entire vegetation period in both years. As a result, straw removal had no negative impact on field emergence, and in fact had the opposite effect. In 2023, the weather conditions at both locations led to an unplanned delay in the harvest. This gave the plants up to three weeks to grow. At some locations, this led to problems in combine harvesting. In our trials, a lack of light was possibly more of a problem as well as damaged plants due to the crossing during harvesting and straw removal.

In contrast to 2022, in which there were still two weeks between spreading and combine harvesting, 2023 showed that the **ideal spreading time is up to a maximum of +/- one week before combine harvesting.**

Which catch crop mixtures and species are suitable?

Many of the species and mixtures tested work very well in the pre-harvest sowing method. The decisive factor is always the interaction with the expected conditions, which have a greater influence with this extensive sowing method than with drill sowing, for example.

For example, a shortage of germination water can have a more drastic effect on clovers in pre-harvest sowing than in drill sowing. Similarly, phacelia as a dark germinator can be disadvantaged in field emergence if the seeds lie uncovered on the surface. Losses due to animal damage were difficult to trace, so that seeds or small plants disappeared prematurely. **All cruciferous species performed very well across all years and conditions.** Reliable field emergence was also achieved with oil flax and Tartary buckwheat. Among the legumes, vetch, field pea and blue lupin performed particularly well.

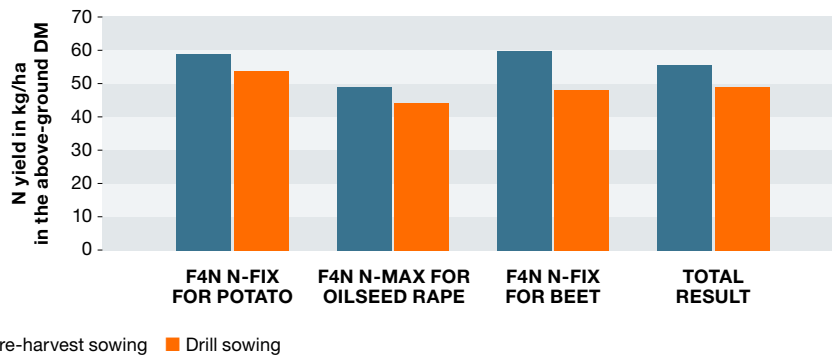
If possible, care should be taken to use late-flowering species and varieties due to the early sowing time. Otherwise, attention should be paid to possible seed formation in autumn. Sowing in early July is therefore much more challenging than in the second half of July or early August.



Nitrogen fixation factor

A particular advantage of pre-harvest sowing concerns legumes. In most cases, residual nitrogen levels of approx. 30-50 kg N-Min 0-90 cm/ha are found after the cereal harvest. Under these conditions, legumes can do very well and, depending on the proportion and species, can also dominate a population. They can utilise the additional time gained in the field to fix atmospheric nitrogen. This was demonstrated by our trials in direct comparison with the drilled variants. **The pre-harvest sowing stands tended to have a higher N yield kg/ha in the above-ground growth than the drilled stands.**

Hold more nitrogen with pre-harvest sowing



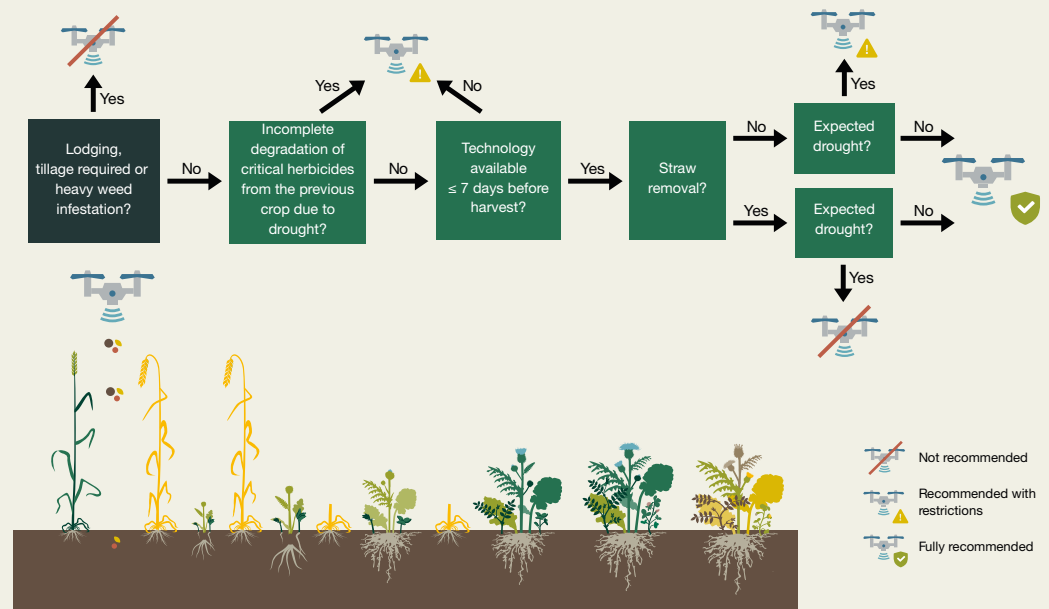
N yield in comparison of pre-harvest sowing methods by drone and drill sowing methods in leguminous catch crop mixtures. Sites Wohlde and Einbeck, 2023

Conclusion

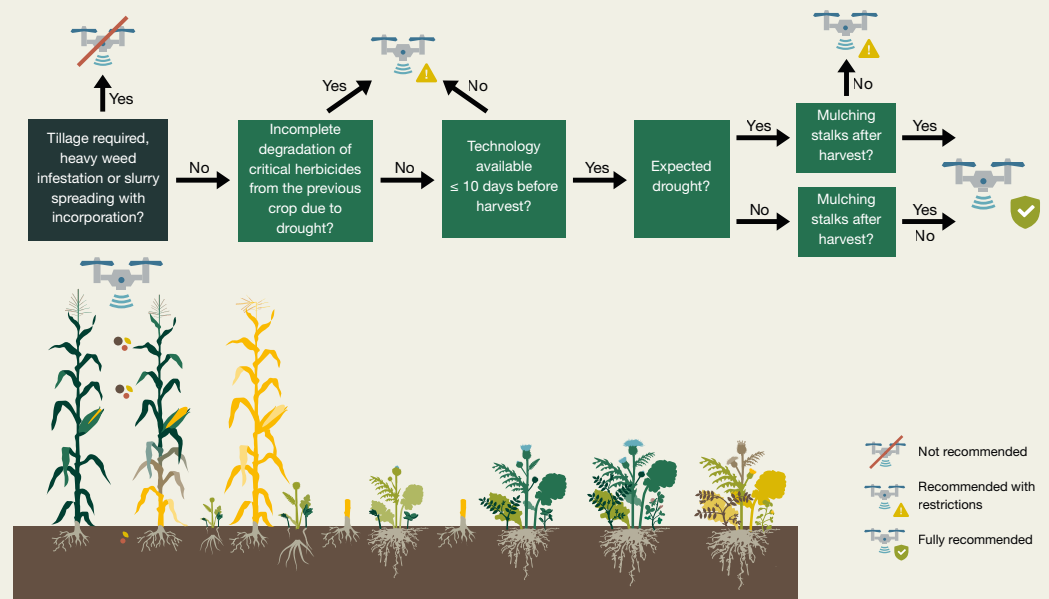
Pre-harvest sowing offers a genuine and interesting alternative to the classic sowing methods for catch crops. Decisive for the overall success of pre-harvest sowing are above all the availability of the sowing technique at the right time, the crop rotation and your own prioritisation of the objectives to be achieved with the catch crop mixture. The method can be more cost-effective than drill sowing. The main lever here lies in a reduced scope of tillage. Depending on the calculatory approach and the farm's equipment, pre-harvest sowing with a drone or pneumatic spreader can bring additional savings potential.

Decision guide – sowing catch crops with drones

Cereals



Corn



Summarised comparison of different sowing methods

Pre-harvest sowing

Principle

- Spreading the seed into the standing crop before combine harvesting (ideally up to approx. seven days before) using a drone or pneumatic spreader
- Placing the seed on the soil surface
- The remaining straw covers the seed
- Germination and growth of the plants starts, depending on the lead time, even before combine harvesting

Advantages

- Maximum utilisation of the growing season
- Maximum utilisation of the water supply
- Very high potential for biomass formation and N fixation (depending on species from soil and air)
- Early covering of the soil promotes shadow fermentation
- Competition avoidance through reduced germination stimulus for volunteer cereals/rape and companion plants
- Reduced competition for nitrogen for straw rotting
- Also suitable for short cultivation windows (e.g. before the autumn sowing of cereals)
- Effective process, if necessary, on the edge of work peaks
- Measure independent of soil moisture
- Low machine costs per ha possible
- Very low energy requirement per ha

Challenges

- Reduced field emergence compared to placement in the soil
- Depending on annual and site conditions, there are clearer differences between the species in terms of establishment compared to the other methods
- Depending on the species, risk of seed formation due to early establishment
- No possibility of tillage to remove compaction, levelling, straw mixing, etc.
- No mechanical possibility of control of snails and mice
- Limited seed volume for drone sowing
- Straw cover necessary in dry years
- Limited time window for spreading
- Not recommended for lodged grain

Drill sowing

- Sowing after combine harvesting
- Placing the seed in the soil via sowing units
- Depending on sowing technique prior tillage necessary

- Precise seed placement promotes field emergence, crop density and plant development
- Utilisation of numerous and diverse grain sizes
- The possibility of tillage allows control of slugs and mice as well as mixing in straw
- Time flexibility after the main crop harvest
- In combination with tillage, easier root penetration of the soil

- In combination with tillage, additional delay in sowing date
- Tendency towards higher machine costs per ha
- Depending on the soil moisture
- Competition with volunteer cereals/rape and companion plants due to soil movement

Spread sowing with incorporation

- Sowing after combine harvesting
- Placing the seed on the soil surface via spreader. Depending on the technology the seed is guided via a spreading disc or hoses
- Incorporation of the seed via a soil tillage implement (e.g. cultivator, harrow), directly in combination with spreading

- Integration of spreading into stubble cultivation enables low machine costs per ha
- Tendentially powerful procedure
- The possibility of tillage allows control of slugs and mice as well as mixing in straw
- Time flexibility after the main crop harvest

- In combination with tillage, additional delay in sowing date
- Depending on the soil moisture
- Competition with volunteer cereals/rape and companion plants due to soil movement
- Spreader usually suitable for smaller seeds

More yield with catch crop mixtures?!

Intercrop mixtures contribute in many ways to more sustainable arable farming through their performance potential. In addition, the question of the profitability of catch crop cultivation is raised time and again. Here, depending on the function of the catch crop mixture, farm and area-specific assumptions can be made (e.g. reduction of tillage), which can be offset against the costs of catch crop cultivation. However, the question often remains as to the benefits for the subsequent crop or even the crop rotation.

The approach

In order to provide an answer to this question, we carried out exact trials at the Einbeck site to determine whether catch crop mixtures can provide added value for the following crop, grain maize, compared to fallow. To this end, we selected four different KWS Fit4NEXT catch crop mixtures, which differed primarily in terms of the crop-forming species and the proportion of legumes. In addition, the nitrogen fertilisation (0 and 30 kg/ha) and straw management (with and without) were varied in blocks in the trial. Each test element was cultivated three times so that a statistical analysis was possible.

The catch crop mixtures were sown on 23 August 2023 and left until preparation for maize sowing. The biomass growth of the catch crop mixtures was determined at the end of November and the above-ground growth was also analysed for nitrogen and carbon. Maize was sown on 16 May 2024. All measures that took place in the maize were carried out uniformly throughout the trial. The mineral nitrogen fertilisation was set low, taking into account the measured N_{min} values in March, and was set at 64 kg N/ha (1 dt/ha DAP and 1 dt/ha urea) for sowing in May. KWS EMPORIO (S 220/K 210) was used as the standard variety. The grain maize harvest took place on 7 November 2024.



Test plots of catch crop mixtures 2023

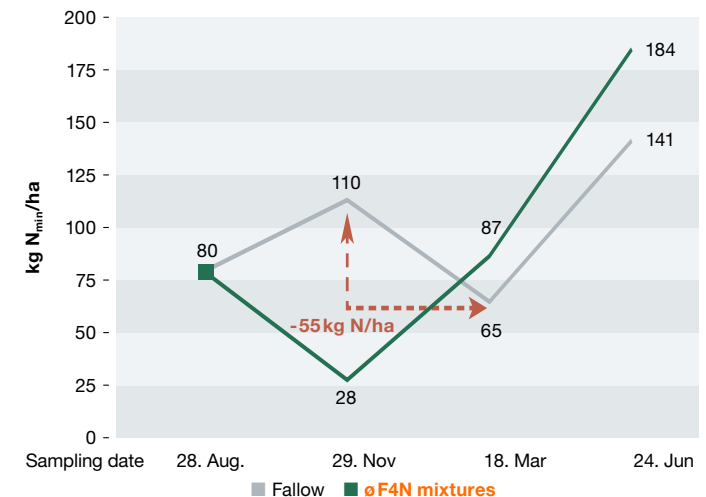
Test plots with grain corn 2024



Over 50 kg of nitrogen secured

We documented the development of the soil nitrogen content at 0-90 cm during both intercropping and grain maize cultivation. Soil samples were taken on four occasions. The results were remarkable. The catch crop mixtures were able to significantly reduce the soil nitrogen content before winter, convert it into biomass and thus protect it from leaching. In contrast, the black fallow plots showed an increasing N_{min} content until the end of vegetation, which was significantly reduced after winter. Over winter, approx. 55 kg of nitrogen was transferred to deeper soil layers in this variant. This difference was found in approximately the same order of magnitude in the last measurement in June. Here, the average of all catch crop mixtures showed a clear advantage in the nitrogen supply for the grain maize. This means that groundwater protection is also important.

KWS Fit4NEXT Catch Crop mixtures conserves nitrogen

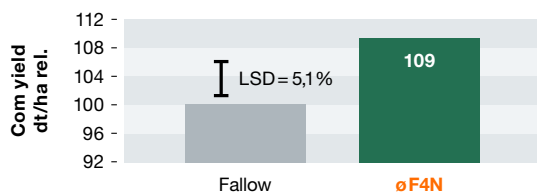


Data from crop rotation trial 2023/2024, site Einbeck. Results of mineralized nitrogen in the soil, 0-90 cm depth. Soil sample results from fallow and catch crop mixture plots. Sampling at four different dates. F4N mixtures = F4N N-FIX FOR POTATO, F4N BEET MUSTARD FREE, F4N N-MAX FOR OSR, F4N FOR OSR

9% additional yield after intercropping

The grain maize yields ultimately showed an enormous yield advantage in favour of the variants with catch crop mixtures. On average, grain maize yields were 9 % (approx. 11 dt) higher than the black fallow varieties. One reason for this is certainly the better and more efficient nitrogen management when growing catch crop mixtures, which is evident from the measurements.

KWS Fit4NEXT Catch Crop mixtures conserves nitrogen & increases Corn yield by +9%



Data from crop rotation trial 2023/2024, site Einbeck Corn yield 100 % = 121,6 dt/ha at 14% moisture. Average values of four different treatments (with and without straw & with and without 30 kg N/ha). F4N mixtures = F4N N-FIX FOR POTATO, F4N BEET MUSTARD FREE, F4N N-MAX FOR OSR, F4N FOR OSR



Comparison of sample plots from the intercropping trial. Left picture plot with KWS Fit4NEXT N-FIX FOR POTATO, right picture plot with black fallow. Pictures taken on 04 March 2024

Conclusion

Looking purely at the additional yields in maize, it can be said that these have already justified the cultivation of catch crop mixtures. If the other benefits of intercropping mixtures are added to this, their suitability for cultivation becomes even more excellent and is more than just a compulsory or safeguarding measure.

Despite the nitrogen-retentive soil type (silty loam) in this trial, the precipitation events led to a significant loss over winter. Statistically, all catch crop mixtures were equal across the variants, whereby the mixtures with oil radish tended to bind more nitrogen than those with phacelia as the main component. The better soil structure and more revitalised soil in the intercropping mixtures compared to the black fallow variants was also evident. This was already evident on the soil surface. It can therefore be assumed that a good soil structure can have positive effects on grain maize even with sufficient water availability (approx. 470 l/m² from 1 May to 31 October 2024). In other trials, this was the case for silage maize, especially in dry years.

After harvest is before harvest

Perfect for the transition:
KWS Fit4NEXT Catch Crop Mixtures



KWS Fit4NEXT enriches your soil, boosts biodiversity, and strengthens your main crop yields. By fueling your soil today, you also set the foundation for a more profitable harvest tomorrow.

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