NCS
NITROGEN CLIMATE SMART

# Pea & Bean Crop Development Benchmarks

## Produced by partners of the NCS project

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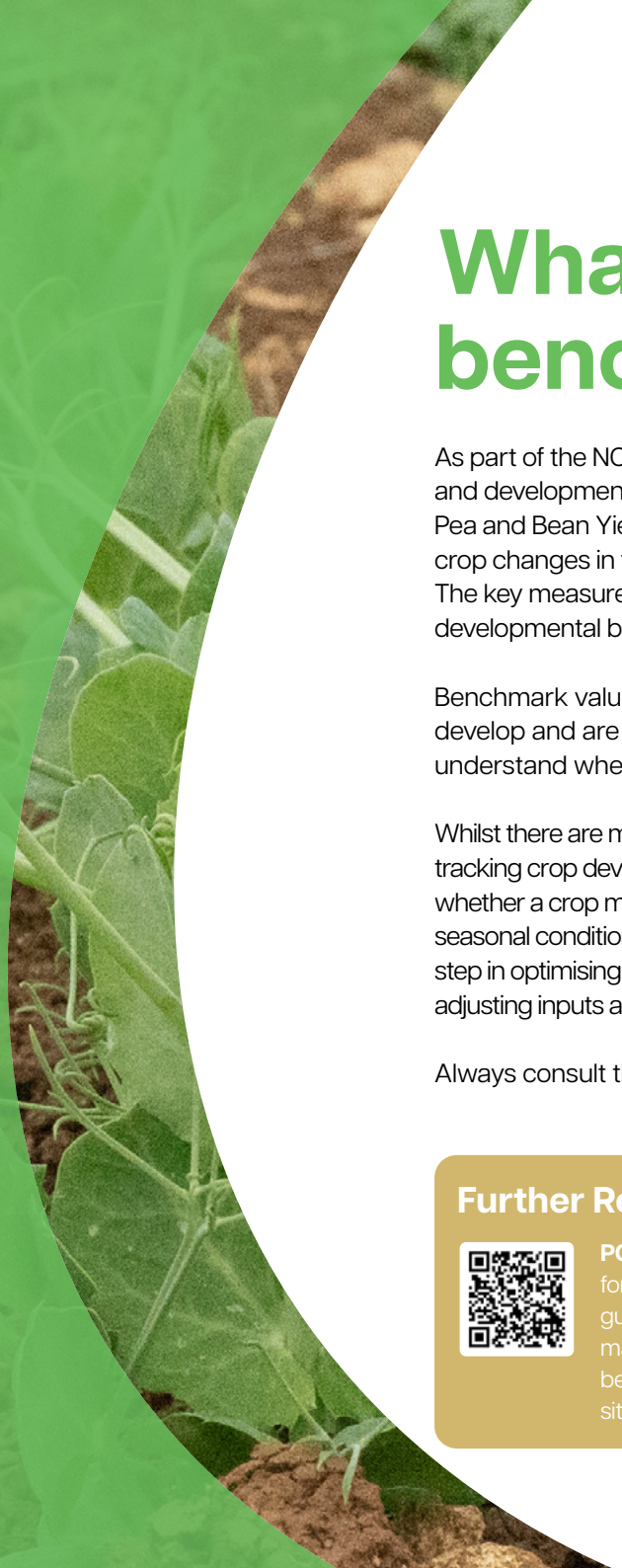

# What are crop benchmarks?

As part of the NCS project, ADAS and PGRO have summarised the growth and development of typical crops that have been monitored through the Pea and Bean Yield Enhancement Networks (YEN). Throughout the season a crop changes in form (development) and accumulates dry matter (growth). The key measures of how the crops develop have been summarised as developmental benchmarks.

Benchmark values can be used as a comparison for how other crops develop and are therefore a resource for new and experienced growers to understand whether crops are developing as expected.

Whilst there are many ways for how a crop should develop or be managed, tracking crop development against benchmark values can help determine whether a crop may have been limited by a particular management choice or seasonal conditions. Understanding what causes variation on farm is the first step in optimising practice towards the ideal. Setting targets, assessing progress, adjusting inputs and monitoring success complete the management cycle.

Always consult the PGRO Agronomy Guide for best practice for pulses.

## Further Resources

**PGRO Agronomy Guide** for specific agronomy guidance and how management should be adjusted in certain situations

**BASF Growth Guides** for more information on how pulse crops develop and build yield.

# Growth & developmental benchmarks: Combining peas

Benchmarks are based on data from the top-yielding 50% of crops monitored between 2017 and 2025. The crops were mainly grown in the East of England under conventional management systems, with average row widths of around **13cm**. Typical nutrient applications were **30kg/ha of $P_2O_5$, 40kg/ha of $K_2O$** and **30kg/ha of $SO_3$**. Crops generally received one to two applications each of herbicide, insecticide and fungicide.

Combining pea benchmarks (excluding marrowfats) are based on **38 crops averaging 5.0 t/ha at 15% moisture content (MC).**

Marrowfat benchmarks are based on **23 crops averaging 4.2 t/ha at 15% MC.**

| Benchmark | Combining peas – all except marrowfats | Combining peas - marrowfats |
|---|---|---|
| **GS0 - Sowing Date** | 01-Apr | 30-Mar |
| **GS10 - Full Emergence** | 19-Apr | 22-Apr |
| **GS34 – Nodulation** | 15-May | 10-May |
| **GS60 – First flowers open** | 10-Jun | 05-Jun |
| **GS89 – Senescence** | 27-Jul | 01-Aug |
| **GS99 - Harvest date** | 08-Aug | 10-Aug |

| Benchmark | Combining peas – all except marrowfats | Combining peas - marrowfats |
|---|---|---|
| **Plant population per m²** | 83 | 69 |
| **Fertile shoots per plant** | 1 | 1 |
| **Pods per shoot** | 9 | 10 |
| **Total plant height (cm)** | 86 | 88 |
| **Height of the lowest pod (cm)** | 70 | 60 |
| **Harvest index (%)** | 55 | 51 |
| **Total biomass (t/ha at 100% DM)** | 8.3 | 7.7 |
| **Straw yield (t/ha at 100% DM)** | 4.0 | 4.2 |

| Benchmark | Combining peas – all except marrowfats | Combining peas - marrowfats |
|---|---|---|
| **Seeds per pod** | 4.0 | 2.6 |
| **Seeds per m²** | 1966 | 1061 |
| **TSW (thousand seed weight at 15% MC), g** | 260 | 393 |
| **Seed N%** | 3.72 | 3.95 |
| **Straw & chaff N%** | 1.00 | 1.07 |
| **Seed N offtake (kg/ha)** | 158 | 140 |
| **Straw N content (kg/ha)** | 41 | 46 |

# Growth & developmental benchmarks: Field beans

Benchmarks are based on data from the top-yielding 50% of crops monitored between 2019 and 2025. The crops were grown across the UK, predominantly under conventional management systems, with average row widths of around **20cm**. Typical nutrient applications were **15kg/ha of $P_2O_5$, 30kg/ha of $K_2O$ and 10kg/ha of $SO_3$**. Crops generally received one to two herbicide and fungicide applications, and zero to one insecticide applications.

Winter sown benchmarks are based on **39 crops averaging 6.3 t/ha at 15% moisture content (MC).**

Spring sown benchmarks are based on **65 crops averaging 5.7 t/ha at 15% moisture content (MC).**

| Benchmark | Winter sown | Spring sown |
|---|---|---|
| **GS 0 - Sowing Date** | 28-Oct | 17-Mar |
| **GS 10 - Full Emergence** | 26-Nov | 14-Apr |
| **GS34 – Nodulation** | 08-Mar | 14-May |
| **GS60 – First flowers open** | 01-May | 04-Jun |
| **GS89 – Senescence** | 12-Aug | 26-Aug |
| **GS99 - Harvest date** | 27-Aug | 13-Sep |

| Benchmark | Winter sown | Spring sown |
|---|---|---|
| **Plant population per m²** | 31 | 42 |
| **Fertile shoots per plant** | 1.7 | 1.1 |
| **Pods per shoot** | 12 | 15 |
| **Total plant height (cm)** | 117 | 116 |
| **Height of the lowest pod (cm)** | 30 | 25 |
| **Harvest index (%)** | 54% | 61% |
| **Total biomass (t/ha at 100% DM)** | 10.2 | 7.9 |
| **Straw yield (t/ha at 100% DM)** | 4.7 | 3.2 |

| Benchmark | Winter sown | Spring sown |
|---|---|---|
| **Seeds per pod** | 2.9 | 2.8 |
| **Seeds per m²** | 889 | 959 |
| **Thousand seed weight (TSW), g** | 731 | 602 |
| **Seed N%** | 4.28 | 4.66 |
| **Straw & chaff N%** | 1.02 | 1.04 |
| **Seed N offtake (kg/ha)** | 229 | 224 |
| **Straw N uptake (kg/ha)** | 46 | 33 |

# The benchmarks explained

| Metric | How to measure | Considerations |
|---|---|---|
| **Crop development dates** | Follow the BBCH system provided in the PGRO agronomy guide. | Sowing date should be based on appropriate conditions rather than sticking to calendar dates. The length between growth stages can be affected by environmental conditions. For example warm temperatures, drought, nutrient limitation or disease may reduce the length of seed filling. |
| **Plant population** | At growth stage 10 count the fully-emerged plants using a 1 by 1 m quadrat.<br>Alternatively, carry out stubble counts at harvest. | Plant population is a factor of seed rate and establishment. The most appropriate seed rate depends on crop type, sowing date and expected establishment rate. See the PGRO agronomy guide for more information. |
| **Fertile shoots per plant** | Shortly before harvest, check the base of the stem on at least 10 plants across the field to get a robust average number of shoots per plant that produce pods. | Winter beans tend to branch more than spring beans, but branching can be influenced by plant spacing and water supply. |
| **Total plant height** | Shortly before harvest, measure height to the canopy top at 10 locations to measure to the top of the canopy. If the crop has lodged, stand it up to measure. | Influenced by variety and seasonal conditions. Excessive plant height could increase lodging risk, however, a plant with more nodes, could be more resilient to stressful conditions which cause flower or pod abortion. |
| **Height of the lowest pod** | Shortly before harvest remove the shoot from the ground at soil level and measure from the base of the stem to the lowest pod. | Very low pods may be difficult to harvest, but sections of the stem without pods may indicate where flowers or pods have been aborted due to stressful conditions. |
| **Seeds per pod** | Measure shortly before harvest. | May be influenced by variety type, and conditions around flowering and start of pod fill. The metrics reported are the average number of seeds across all pods. Some pods may be empty, meaning the number of seeds in seed-producing pods are higher than this average. |
| **Harvest index** | The ratio of seed yield to total above ground biomass, adjusted to the same dry matter percentage. | Affected by variety type and seasonal conditions. As pulse crops are semi-determinate, vegetative growth can continue after flowering. |
| **Total biomass at 100% dry matter (DM) (t/ha)** | Shortly before harvest this can be estimated by sampling all of the above ground crop by chopping stems at ground level. Expressed at 100% DM. | |

| Metric | How to measure | Considerations |
|---|---|---|
| **Straw yield at 100% dry matter (DM) (t/ha)** | Subtract seed yield from total biomass, adjusted both to the same dry matter percentage (100% DM). | |
| **Yield (15% MC)** | Use a calibrated combine yield mapper, or measure an area (e.g. spray maps, satellite imagery or measuring wheels) and put the harvested seed over a weighbridge. Adjusted to 15% moisture content. | |
| **Thousand seed weight (TSW), g** | Post harvest, weigh approximately 100-150g of seeds and count the number in the sample.<br>Divide the number of seeds by the weight of the sample, then multiply by 1000 (adjusting to a standard moisture content). | TSW is strongly influenced by variety type, but also by the ability of the crop to fill seeds, related to light interception and duration of seed filling. PGRO's descriptive list provides values for individual varieties. |

| Metric | How to measure | Considerations |
|---|---|---|
| **Seeds per $m^2$** | Divide weight per seed by yield per unit area, adjusted to the same dry matter percentage. | Influenced by variety type due to genetic differences in TSW, so this should be considered in the context of crops with similar TSW values. However, the number of seeds set is often a limitation to yield in pulse crops. |
| **Seed N%** | Can be determined by commercial lab analysis on harvested seed samples. Crude protein % can be estimated by multiplying pulse seed N% by 6.25. | PGRO's Descriptive List provides typical protein values for individual varieties, but can also be influenced by direct nitrogen uptake, biological nitrogen fixation, and distribution of nitrogen from the canopy to the seeds during grain fill. |
| **Straw & chaff N%** | | |
| **Seed N offtake (kg/ha)** | Multiply seed yield by seed N content. | Likely influenced by direct N uptake, biological N fixation, and distribution of N from the canopy to the seeds during grain fill. |
| **Straw N uptake (kg/ha)** | | |

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# www.ncsproject.co.uk

### About the NCS project

Nitrogen Efficient Plants for Climate Smart Arable Cropping Systems (NCS) is a four-year £5.9M research programme involving 200 UK farms and 17 partners.

The main aim is to enable UK agriculture to bring about a reduction of 3.4Mt $CO_2e$ per annum or 54% of the maximum potential for the industry.

The ambitions of the project are to increase pulse and legume cropping in arable rotations to 20% across the UK and to develop and test new feed rations. This will help livestock farmers to substitute up to 50% of imported soya meal used in feed with more climate-friendly home-grown pulses and legumes.

These twin aims are being steered by science and proven by real farm enterprises, with significant benefits for both crop and livestock productivity, including cost savings of over £1bn/year.

The NCS project is funded by the Farming Futures R&D Fund: Climate smart farming, part of Defra's Farming Innovation Programme. Defra is working in partnership with Innovate UK which is delivering the programme.
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