

# Maize and runner bean intercropping

## Diversifying silage maize production

Anja Bonzheim, Thorsten Haase and Philipp Roth



Silage maize (*Zea mays* L.) is grown over a large area and is closely associated with cropping systems that lack diversity with relatively high impacts on soil quality and nature. Mixed or intercropping can reduce the risk of erosion, increase crop biodiversity, and improve nitrogen utilisation. The combination of maize and runner bean (*Phaseolus vulgaris* var. *vulgaris*), which originated in Latin America, has this potential and has been the subject of more intensive research in Germany and Switzerland for several years. Runner bean is closely related to the 'bush' or 'French bean'. It has a climbing stem.

A mixture of maize and runner beans, if well planned, differs only slightly in yield from maize pure stands. The combination increases the protein content of the silage. Maize silage is low in protein and consequently maize silage-based diets require protein supplementation. In this form of intercropping, the maize serves as a climbing aid for the high-protein bean boosting the protein content of the silage. In addition, the

runner bean fixes nitrogen, especially where the nitrogen supply in the soil is low. The additional soil cover in the row suppresses weeds, reduces erosion risk, and promotes biodiversity.

### Practical considerations

The most important practical consideration is the choice of bean cultivar. The key traits are seed size, time of maturity, and the phytohemagglutinin (phasin) content. Phasin is a toxic substance found in raw phaseolus beans. Seed cost is also a consideration.

### Cultivar selection

For some years now, breeding has concentrated on improving the suitability of both mixture partners for mixed cultivation. Where silage for feeding is grown, low-phasin, high-yielding, small-seeded cultivars with a high protein content should be selected. The cultivar WAV 612 with a thousand grain weight (TGW) of only 225 g is an example.



Beans bring more biodiversity. Photograph: Willmar L. Leiser (Universität Hohenheim)

The grain size of the beans is an important feature. The large seed means seed costs are high and sowing the beans and maize together using precision seeders is difficult. The seed of the bean and maize should be similar in size if they are to be sown together using a precision seeder. Cold-tolerant bean varieties that have a high proportion of early, well-formed pods up to harvest should be used. It is also important for the maize to have good stability with good resistance to stem rot.

The dry matter content of runner bean is low at harvest (about 20%) and decreases with time as harvest is delayed into late autumn. Late harvesting should be avoided. Early maturing maize cultivars should be chosen. Otherwise, the dry matter content of the mixture could be too low due to the bean content, making successful ensiling more difficult. The earlier ripening maize cultivars can compensate for the low dry matter in the beans because they have a high dry matter content at harvest.

### **Cultivation methods**

Sites with medium to good water supply and low to moderate weed pressure are suitable. The bean seed should be inoculated with the appropriate rhizobia where the runner bean is grown on a field for the first time.

Simultaneous sowing of maize and beans has proven to be more cost-efficient and practical. Conditions are often already too dry if the beans are sown later than the maize. In addition, later sowing of the beans disturbs the soil shield effect of pre-emergence herbicides greatly reducing their effectiveness.

The bean is more frost sensitive than the maize. Late frosts can damage the bean while the maize is unaffected. Therefore, depending on the region, the joint sowing should take place somewhat later (around the beginning of May) than the sowing of the pure maize crop. The result is the seed of both species is concentrated in the same rows which leads to shading and thus suppression of weeds within these rows.

Widely used maize row spacings are suitable. However, if the row spacing is lower than 50 cm,

there is a risk that the beans will interfere with the neighboring row, which can lead to problems at harvest. The sowing depth is a compromise between the requirements of both crops but should tend towards that of maize as the main biomass producer.

The target plant density is in the range of 6–9 plants/m<sup>2</sup> for maize (only very slightly reduced compared to pure stands) and 3–6 plants/m<sup>2</sup> for beans. The proportion of the crop biomass provided by the bean increases with increased bean sowing rate but the total dry matter yields tend to be reduced. It is recommended not to set the bean proportion in the mixture too high due to the phasin content and the weight and long reach of the beans, which can become a problem during harvesting due to breakage of the maize stems. The high performance of the maize must be protected. It should be complemented by the bean, but not hindered. The basic nutrients phosphorus and potassium should be in the optimal range. Farm manure can be used and, depending on the supply situation, mineral fertiliser can be added.

Only pre-emergence herbicides can be used. The post-emergence herbicides otherwise approved and commonly used on maize in Germany may not or cannot be used on runner bean. The only herbicides that can be used in Germany are pendimethalin (e.g., "Stomp Aqua") and pendimethalin plus dimethenamid P (e.g., "Spectrum Plus"). The use of mechanical hoeing is also an option. A hoeing operation can be carried out shortly before the closing of the crop canopy when the effect of the soil herbicides has worn off.

The use of a stale seedbed is common in organic farming. This may be combined with careful tined weeding at the 3-leaf stage of the maize onwards. Inter-row hoeing with crop protection plates can also be used from the 3-leaf stage of the maize. Later on, the row can also be carefully ridged. However, maize and runner bean plants should not be covered with soil. The mixture is harvested with a forage harvester fitted with a maize header, which may be equipped with a side knife that cuts through the mass of climbing beans.

## Opportunities and impacts

The cultivation of maize-runner bean mixtures is eligible as a separate crop under the crop diversification agri-environmental measure in some German federal states if the runner bean accounts for at least 25% of the crop plants.

### Yield and crude protein content

With about 14% crude protein in the dry matter (DM), the protein concentration of the bean crop is about twice that in maize (5–7% in maize). The beans account for 10–15% of the total dry matter. The crude protein content of the forage mixture increases by about one percentage point to around 6–8% crude protein in the DM if the seeding ratio described above is used. This increased protein content reduces the need for supplementation with high-protein feeds.

With yields of the current bean and maize cultivars and the current growing techniques, the total dry matter yields of the intercrops are about 10% lower than those of maize pure stands. The crude protein yield per ha is about the same as that of maize pure stands.

### Biodiversity

Silage maize is grown on 2.3 million hectares in Germany. This is the second largest crop area after wheat. Especially in regions with a high proportion of maize, the introduction of another crop can promote biodiversity and the public acceptance of cultivation systems. Initial studies indicate that the flowering bean in the mixture seems to have a particularly positive effect on bumblebees.

### Nitrogen economy

The beans fix nitrogen where soil mineral nitrogen supply is low. Biological nitrogen fixation is greatly reduced and may be prevented completely where soil supplies are high enough for good crop growth.

Research has shown that the maize-bean mixtures are better able to maintain total dry matter yields compared with maize pure stands where nitrogen fertilisation is restricted. In addition, a reduction in N fertilisation in pure and maize-bean mixed stands lowers post-

harvest mineral nitrogen level in the soil. These observations suggest that the mixed stand is able to utilise soil mineral nitrogen but that the beans compensate where there is nitrogen deficiency. This can be particularly interesting in regions or situations where the application of nitrogen-containing fertilisers is constrained due to legal restrictions.

### Ground cover

The shading effect of runner beans in maize stands suppresses weeds and can reduce the need for mechanical control measures in organic farming. Due to the spreading early growth of runner beans and the higher total number of



Maize and bean mixed in a row. Photograph: Strickhof

plants per m<sup>2</sup>, the soil is shaded more quickly and unproductive evaporation from the soil is reduced. This tends to help the crop survive dry periods.

Maize cropping is associated with a high risk of soil erosion due to the late sowing in spring. This problem can be partially alleviated by the faster soil cover in mixed cultivation with beans.

## Feeding maize-bean silage

A mixed silage of maize and beans can be used for dairy cattle and as a roughage in pig fattening. Because of its high phasin content, maize-bean silage was formerly rarely used in feeding. However, the proportion of beans in the mixture is usually only 10-15% of the dry matter (the decisive factors are seed density and timing, as well as the choice of variety). Ensiling reduces the phasin content. In addition, breeding is increasingly focused on low-phasin cultivars. However, the proportion of beans can also be kept low by ensiling with pure maize, so that the phasing content of the maize-bean silage only very rarely becomes a constraint.

The ensiling of the crop is usually straightforward if a dry matter content of about 30–35% is achieved. In feeding trials, maize-bean silage (9% bean dry matter in maize-bean silage) led to the same milk yields or, in pig feeding, to the same fattening performance and carcass quality with comparable animal health. The silage is both well absorbed and digested by dairy cattle and pigs where introduced gradually. Phasin is partially degraded in the rumen of cattle. Only the urea content in the milk can increase slightly.

## Key practice points

- Mixed cultivation of maize and runner bean increases the crude protein content of the silage.
- On-farm biodiversity is supported.
- Simultaneous sowing of both mixture partners in customary maize row spacings has proven successful.
- When choosing the pole bean variety, make sure the grain size and shape are similar to those of maize (with simultaneous precision seeding) as well as having a low phasing content (e.g., the WAV 612 variety).
- The target stand density is 6–9 maize and 3–6 bean plants per m<sup>2</sup>.
- Only fields with low to medium weed infestation should be selected for cultivation due to very limited possibilities in chemical weed control.
- Mechanical weed control can be carried out with a harrow and hoe in a similar way to pure-stand maize cultivation.
- Compared to silage maize cultivation, approx. 10% lower total dry matter yields and approx. 10% higher crude protein contents can be expected.
- Due to the N-fixation of runner beans, N-fertilisation can be reduced compared to pure-stand silage maize cultivation.
- Ensiling is easy if the dry matter content of the crop is between 30 and 35%.
- The mixed silage can be used in both cattle and pig feeding.

## Further information

### Video

Thünen Institute, <https://vimeo.com/thuenen>

### Web links

Bayrische Landesanstalt für Landwirtschaft, Mischanbau von Mais zur Substratproduktion und Futtererzeugung, [www.lfl.bayern.de/ipz/mais/148685/index.php](http://www.lfl.bayern.de/ipz/mais/148685/index.php)

Thünen Institut, Mais und Bohnen im Gemenge, [www.thuenen.de/index.php?id=2280&L=0](http://www.thuenen.de/index.php?id=2280&L=0)

Landwirtschaftskammer Niedersachsen, Mais-Mischkulturen erfolgreich anbauen, [www.lwk-niedersachsen.de/lwk/news/35477\\_Mais-Mischkulturen\\_erfolgreich\\_anbauen?nav=183](http://www.lwk-niedersachsen.de/lwk/news/35477_Mais-Mischkulturen_erfolgreich_anbauen?nav=183)

## Sources

Böhm, H. et al., 2016. Improvement of protein and energy supply in ruminants and monogastric animals through mixed cultivation of maize with pole beans or fire beans. In: BLE 2016. proceedings congress "Legumes – Signposts for a more sustainable agriculture", 3 and 4 November 2016 in Berlin, pp. 46–48.

Carrel, K., 2020. Update on the cultivation of mixed maize-bean crops. At: [www.strickhof.ch/publikationen/aktuelles-zum-anbau-von-mais-bohnen-mischkulturen/](http://www.strickhof.ch/publikationen/aktuelles-zum-anbau-von-mais-bohnen-mischkulturen/)

German Maize Committee, 2020. Workshop discussion on the topic of maize- bean mixed cultivation, short presentations.

Metz, G., 2018. Maize and bean strong together. Bioland Magazin 6/2018, pp. 8–10.

Paul, N., 2016. Maize and beans in duet. dlz Magazin, 3/2016, pp. 74–77.

Schumann, C., 2020. ecological assessment of the cultivation of maize-bean mixtures. maize 3/2020 (47. Jg.), pp. 18–20.

Wyss, U., Enggist, A., Brugger, D., 2019. Mixed crops for animal feed: maize- pole bean mixture and phasing content. Agrarforschung Schweiz 10 (5), pp. 190–197.

Darnhofer, B., 2020. Maize as a climbing aid for beans. In: LOP 4/2020, pp. 30–35.

## About this practice note and Legumes Translated

**Authors:** Anja Bonzheim, Thorsten Haase and Philipp Roth

**Publisher:** Landesbetrieb Landwirtschaft Hessen (LLH)

**Production:** Donau Soja

**Permalink:** [www.zenodo.org/record/6347203](http://www.zenodo.org/record/6347203)

**Copyright:** © The Authours, 2022. Reproduction and dissemination is permitted for non-commercial purposes provided the authors and source are fully acknowledged.

This practice note was prepared within the Legumes Translated project funded by the European Union through Horizon 2020, Project Grant Number 817634.

**Citation:** Bonzheim, A., Haase, T. and Roth, P., 2022. Maize and runner bean intercropping. Landesbetrieb Landwirtschaft Hessen (LLH). Legumes Translated Practice Note 61. [www.legumestranslated.eu](http://www.legumestranslated.eu)

The content is solely the responsibility of the authors. No warranties, expressed or implied, are made with respect to the information provided. Information relating to the use of plant protection products (pesticides) must be checked against the product label or other sources of product registration information.



This project is funded  
by the European Union

