Combining sorghum with running partners in the mix, such as lablab and running beans (photo), is particularly interesting.

SoBinEn – ECOLOGICALLY VALUABLE SORGHUM CULTIVATION

COMBINING SORGHUM WITH FLOWERING CATCH CROPS FOR INSECT-FRIENDLY ENERGY CROPPING SYSTEMS

Many farmers and experts are looking at sorghum as a forage crop and an alternative to maize, because sorghum has many useful properties and is more tolerant to drought. Various project partners working in the "SoBinEn" plant breeding programme have now produced varieties of sorghum that are suitable for use as substrate in biogas plants and as dairy cow feed. The "SoBinEn" research project aims to further the ecological value of sorghum.

Sorghum is a promising alternative to maize thanks to its drought tolerance, nutrient efficiency and its resistance to diabrotica (the corn rootworm). And there are more agro-ecological advantages: It promotes humus formation which is considered to be similar to that of legumes (source: Final Report on FKZ 22007110 from the Agency for Renewable Resources (FNR)). In addition, sorghum pollen can supply bees with protein during deficient summer months and it can significantly support winter bee breeding (and thus ensure the viability of an entire colony).

However, in order to be suitable as bee food, varieties with strong and stress-resistant pollen shedding have to be cultivated. The plant breeding programme carried out by Deutsche Saatveredelung AG (DSV) along with Norddeutsche Pflanzenzucht (NPZ) and the Justus Liebig University of Gießen (Department of Plant Breeding) is specifically focussing on so-called "dual-type hybrids" for feed storage (for use as substrate in biogas production or as dairy cattle feed). Compared to the tall and late-maturing sorghum varieties that are currently grown mainly for biogas production, these dual types flower earlier and shed much more pollen. In addition, thanks to their lower height of approx. 200 cm, they are more stable and easier to harvest. Their yield structure (panicle/grain content makes up to 50 % of the total dry matter) and material composition (starch content of over 40 %) are similar to maize silage. Two such dual-type hybrids from the plant breeding programme are expected to be approved and made available to farmers in Germany in 2021.

The research project "SoBinEn: Combining sorghum with flowering catch crops for insect-friendly energy cropping systems" aims to further the ecological value of sorghum crops. The project started in spring 2020. The project combines and tests sorghum dual-type hybrids with various insect-friendly mixes and catch crops. This significantly extends the flowering period and thus the period in which valuable nectar is available

to bees and other pollinators in summer in addition to sorghum pollen as a source of protein. This approach of mixed cropping will improve the ecological value of bioenergy crop rotations in terms of diversity, erosion control, reduction of nitrate leaching in winter (if the catch crop is continued) and humus balance. The synergetic effects of mixed crops can also help stabilise yield levels. These effects include a higher rate of pollinated sorghum blooms, because the catch crop attracts additional bees. For farmers, mixed crops can be an attractive way to meet greening requirements. If the catch crop is maintained until 15 February of the following year, mixed cropping with sorghum is weighted by the factor 0.3; if the main crop in the following year is a legume or a legume mix, it is weighted by the factor 1.0.

The photos show different leaf positions in sorghum dual-type hybrids. Sorghum has an upright leaf position (centre) and this appears to be a particularly promising feature for combining this crop with soil-covering catch crops.

SoBinEn is a joint research project that was initiated by the German Agency for Renewable Resources (Fachagentur Nachwachsende Rohstoffe e. V.) (FNR) in collaboration with partners from different disciplines. The Kirchhain Bee Institute of the State Agricultural Office of Hesse (LLH) examines and verifies the value of the newly developed mixes for bees and other insects. The Technology and Promotion Centre (TFZ) in Straubing, Bavaria, is working on optimising the mixes for cropping systems. This includes looking at sowing techniques, crop densities, row spacing, sowing dates and weed control. The Department of Plant Breeding at the Justus Liebig University of Giessen is selecting new sorghum breeding material which offers a plant architecture that goes well with catch crops. The aim is to select so-called erectophilous plant species with upright leaves and a vertical root system. In addition, these species should cast as little shade as possible on the catch crops and leave sufficient water in the upper soil layers. Working with the NPZ, DSV will select catch crops that tolerate shade well while also pushing ahead with the development and production of suitable dual-type hybrids.

This approach of mixed cropping will improve the ecological value of bioenergy crop rotations in terms of diversity, erosion control, reduction of nitrate leaching in winter and humus balance.

Sorghum and yellow sweet clover (*Melilotus*) at the Groß-Gerau site. Both plant species coped well with the local dry and warm conditions.

SoBinEn has implemented a multi-stage procedure to determine and optimise suitable mixes. During the first year of the project (2020), 21 different plant species were screened to see if they could be combined with sorghum in a multi-factorial trial design. The main objective here was to assess the basic suitability of these mixes for insects in terms of yield potential, practical feasibility and ecological value. These trials are taking place at the following sites: Straubing (Lower Bavaria) as a prime location in southern Germany, Groß-Gerau (Southern

View of the Rauischholzhausen test site. While red clover went well with sorghum here, buckwheat clearly suppressed sorghum.

The combination of sorghum with alfalfa also seems to work well. Tatar buckwheat, on the other hand, grows too vigorously.

Hesse) as a warm site that is threatened by drought stress, and finally Rauischholzhausen (Central Hesse) and Ven-Zelderheide (Netherlands) . The last two sites include two stands of sorghum with different densities (normal vs. reduced), two different sorghum dual-type hybrids and, in most cases, two varieties of the partner species in the mix. Sorghum and maize were also grown as moncrops to compare the yield levels. Other variants include a two-year approach, whereby the catch crop is left in the field during the winter and is harvested again the following spring, as well as a strip-till trial. In the latter case, the researchers explore the question whether sorghum can be sown directly into a stand of clover or "Landsberg" mixture that was established in the previous summer.

So far, the trials have been promising. At the Groß-Gerau location in southern Hesse, which is characterised by light sandy soils and dry, warm weather, sorghum is displaying a high level of competitiveness with almost all other species in the mix. Although alfalfa and yellow sweet clover also developed satisfactorily in combination with sorghum, other clovers had major problems on this site. Buckwheat, white mustard and phacelia seemed to dominate sorghum in the juvenile stage, yet in the end sorghum also grew well here. Currently, sorghum only has difficulties with oil radish and sunflowers. The location in Rauischholzhausen in central Hesse is characterised by a cooler climate and fertile loess soils with a high field capacity (water content in the soil). In comparison to the Groß-Gerau location, all the clover species that were tested here appear to be coping well with sorghum. However, sorghum is at a disadvantage here compared to vigorous mixes such as buckwheat. At both locations, the combination of sorghum with running mixes such as runner beans and hyacinth beans (Lablab) is promising. In addition, Lablab is very tolerant to drought stress. However, it is still too early to make a final assessment as yield data is not available yet.

In 2021 and 2022, promising combinations and more variants will then be tested and optimised for cultivation on more sites and with more factor levels. The main challenges in this context are how to drill these mixes and how to exercise weed control. Establishing soil armour quickly by sowing a catch crop can help with weed control, but there would still be time for weed control if sorghum and the catch crop are sown at different dates. A demonstration project on various farms will provide further valuable insights into the practicality of combining sorghum with other crops. Large-scale trials on large plots and with plant coverings are also planned over the next two years to see how attractive such mixes are for bees and how ecologically valuable they are.

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